DRAFT REPORT MARCH 2013

Draft report on the economic and social impacts of protecting environmental values in Great Barrier Reef catchment waterways and the reef lagoon

Report prepared for Queensland Department of Environment and Heritage Protection

MARSDEN JACOB ASSOCIATES

Marsden Jacob Associates
Financial & Economic Consultants

ABN 66 663 324 657
ACN 072 233 204

Internet: http://www.marsdenjacob.com.au
E-mail: economists@marsdenjacob.com.au

Melbourne office:
Postal address: Level 3, 683 Burke Road, Camberwell
Victoria 3124 AUSTRALIA
Telephone: +61 3 9882 1600
Facsimile: +61 3 9882 1300

Brisbane office:
Level 14, 127 Creek Street, Brisbane
Queensland, 4000 AUSTRALIA
Telephone: +61 7 3229 7701
Facsimile: +61 7 3229 7944

Perth office:
Level 1, 220 St Georges Terrace, Perth
Western Australia, 6000 AUSTRALIA
Telephone: +61 8 9324 1785
Facsimile: +61 8 9322 7936

Sydney office:
Rod Carr
119 Willoughby Road, Crows Nest
News South Wales, 2065 Australia
Telephone: +61 418765393

Contributors: Angelica Austin
aaustin@marsdenjacob.com.au
Gene Tunny
gtunny@marsdenjacob.com.au
Kirby Prickett
kprickett@marsdenjacob.com.au
Amanda Fitzgibbons
afitzgibbons@marsdenjacob.com.au
Jim Binney
jim@mainstreameco.com.au

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

List of Figures

Page

Foreword

There is a great deal of effort being made by governments and the community to enhance water quality in the Great Barrier Reef (GBR). One of the key approaches to enhancing water quality has been the establishment of Water Quality Improvement Plans (WQIPs), a major initiative funded by the Australian Government's previous Coastal Catchments Initiative (CCI), and Healthy Water Management Plans (HWMPs) under the Queensland *Environmental Protection (Water) Policy 2009* (EPPW). The WQIPs/HWMPs also form an important implementation tool under the Reef Plan. In essence, WQIPs/HWMPs:

- identify relevant environmental values (e.g. aquatic ecosystem function, fishing, recreation, primary industries, drinking water quality, etc.);
- establish water quality objectives to protect the environmental values;
- establish management actions (e.g. best management practice) and management action targets consistent with achieving water quality objectives; and
- identify the economic and social impacts of protecting or enhancing water quality outcomes (expressed through environmental values for waters).

The purpose of this project was to undertake an assessment of the economic and social context for, and implications of, implementing the WQIPs/HWMPs being developed. As with all of the CCI, this project was primarily funded by the Australian Government, with significant in-kind and direct funding from the Department of Environment and Heritage Protection (EHP). Importantly, the WQIPs and HWMPs use the process in the Queensland EPPW to establish environmental values and water quality objectives. From EHP's perspective, this project also outlines the economic and social context and impacts of protecting the environmental values before they can be scheduled in the EPPW.

The scope of this project is necessarily broad, but the major focus is on pollutants on the 'coastal' waters – the Great Barrier Reef Lagoon. Point source, urban and rural diffuse loads, alterations to flow regimes and riparian and in-steam disturbances are all within the scope of this project. Key pollutants include sediment, nutrients and pesticides from all potential sources. Outcomes from the project aimed to:

- more formally link social and economic analysis to environmental values, water quality objectives, and management action targets;
- provide information on social and economic impediments to changing practices that will improve water quality outcomes and to outline indicative estimates of the socio-economic impacts of WQIP/HWMP implementation;
- identify the potential efficient set of actions to reduce pollution loads and the policy tools to facilitate those actions, including the potential roles and responsibilities of various stakeholders – government, regional NRM bodies, industry, etc.;
- inform the development of future interventions (regulatory, investments etc) to address water quality;
- identify issues and lessons common to multiple WQIPs/HWMPs;
- assist in the identification of priority areas for actions across the GBR catchments (including gaps in knowledge and recommendations for future actions); and
- fulfil a major component of each of the WQIPs/HWMPs currently being developed.

The project therefore aims to deliver information to inform multiple stakeholders, both the government and non-government sectors (particularly regional NRM bodies, industry groups and other parties with responsibilities for WQIP/HWMP development).

It should also be noted that this report encompasses an updates of assessment undertaken for WQIPs in 2010 and the addition of several other regional assessments for the HWMPs in the Wet Tropics in 2012.

Executive summary

As part of developing Water Quality Improvement Plans (WQIPs), Healthy Water Management Plans (HWMPs), and other policy approaches to address water quality in the Great Barrier Reef (GBR) catchments, it is important to consider the economic and social aspects of any targeted natural resource and environmental management practices.

Marsden Jacob Associates (MJA) was engaged by the Department of Environment and Heritage Protection (EHP) to investigate the economic and social impacts of protecting GBR catchment waterways and the GBR lagoon, particularly through the implementation of WQIPs and HWMPs. Given resource constraints, this project is primarily a 'desktop' study, drawing on existing research and priority issues being developed under the WQIP/HWMP process.

The project also uses simple, but robust, economic modelling techniques to determine the likely benefits and costs of different suites of management actions in each WQIP/HWMP.

This report summarises the key findings and information in ten sections and three appendices.

- Section One provides the policy and planning context for the assessments;
- Section Two provides a brief overview of the assessment framework used;
- Section Three broadly outlines the benefits and potential costs of enhanced water quality, including an overview of the drivers behind current practices. Section Three also examines the principal risks to current water quality objectives;
- Section Four provides an overview of the suite of policy and program options available to address water quality in GBR catchments and considers the potential pros and cons of each approach. Section Four also identifies key gaps in information and knowledge that could constrain the development and implementation of the most efficient policies and programs;
- Sections Five to Fifteen provide individual economic and social assessments for the WQIPs/HWMPs being developed for the Fitzroy, Mackay Whitsunday, Burdekin, Townsville (Black Ross), Tully Murray, Burnett Baffle, Herbert, Barron, Johnstone, and Russell Mulgrave;
- Appendix A provides an economic snapshot of each key industry that impacts water quality (e.g. sugar) or is impacted by changes to water quality (e.g. tourism);
- Appendix B provides a series of indicative cost schedules for natural resource management issues based on a review of relevant literature and a review of programs; and
- Appendix C is a detailed report by MJA completed for DEHP (then DERM) in 2011 on "The economic and social impacts of protecting the environmental values of the Fitzroy Basin waters", which provides more detailed information on WQIP impacts, including for the mining sector.

State development priorities – the Four Pillars

In 2012, the State Government established an economic development strategy for Queensland based around the following "Four Pillars" for economic growth:

- **Agriculture.** The State is currently developing a strategy to double the value of production in Queensland by 2040. Meeting this target however will rely heavily on private investment and market conditions. Much of this development will occur within the GBR catchments. The four key pathways to achieve g this goal include: increasing resource availability (e.g. water for irrigation); driving productivity growth through innovation and biosecurity; focusing on access to key growth markets; and enhancing production and supply chain inputs to lower the costs of production.[1] The quality of the state's land and water resources is critical to sustainable cropping, aquaculture and fishing.
- **Resources.** Here the objective is to grow the resources industry through higher levels of productivity and innovation. Key initiatives range from enhanced exploration, the provision of a secure land and water titling system to underpin investment, and ensuring workplace safety. Higher production levels will then increase the royalties base that will underpin other aspects of economic development.[2] The continuing sustainable management and development of current and future activities is necessary to protect Queensland's water environment
- **Construction**. Construction is also seen as a significant activity underpinning economic growth. The State is focussing on growth in the broader construction sector through a number of planning initiatives (e.g. changes in planning regulation to expedite planning processes) through to targeting grants for first time home owners who build a new home. The state interest in healthy waters is achieved by land development and its construction that is planned, designed, constructed and operated to protect environmental values of Queensland waters and support the achievement of water quality objectives.
- **Tourism.** The Queensland Government has a growth target for the tourism sector to reach $30 billion by 2020. A strategy is currently being developed that will focus on enhancing tourism marketing to increase market share, increase expenditure during traditional shoulder and off peak periods, further develop tourism destinations and products, and reduce regulation for the industry.[3] The water quality of rivers, streams, wetlands and coastal waters underpins the tourism sector and outdoor recreation opportunities for all residents and visitors.

The State's desire for economic growth is clear, current policies and strategies outlined above for agriculture, resources, construction and tourism create both opportunities that enhance the livelihoods and lifestyles for all Queenslanders and potential sources of risk to the condition of the GBR, the key natural asset that underpins much of Queensland's international and national tourism potential. In effect, there are tradeoffs between achieving the four pillar economic growth strategy that are not explicitly identified. These risks of development are outlined in further detail below.

Economic growth – opportunities and risks to GBR

The continuing sustainable management of current activities and future economic growth opportunities within both the current legislative and policy framework (key is the Reef Water Quality Protection Plan 2009) is necessary to protect Queensland's water environment and

[1] Queensland Government, 2012, Queensland Agricultural Strategy: a 2040 vision to double the value of production – discussion paper.

[2] Department of Natural Resources and Mines, 2012, Strategic Plan 2012-16.

[3] Tourism Queensland, 2012, Tourism Queensland Strategic Plan 2012-16

address water quality risks. The activities of key economic sectors in the GBR catchments both require and impact water quality in various ways and to varying degrees. By understanding the growth potential of these sectors, the water quality issues can be better understood. The anticipated growth of key sectors is outlined below. [4] Key points to note include:

- **pastoral sector**: price and demand expectations are positive for the pastoral sector over the medium term. This means that the sector will most likely increase in size over the long term and that further intensification of the industry will occur. This has implications for sediment runoff from pastoral properties as stocking rates and areas under production increase. The Reef Water Quality Protection Plan 2009 has identified that most of the nutrient, sediment and pesticide pollutants affecting water quality in waterways entering the Reef come from non-point sources arising from agricultural land use activities in Reef catchments. This is a particularly important in the Fitzroy, and Wet and Dry Tropics regions where major work to advance sustainable land management practices is underway;
- **sugar**: this sector is essentially a price taker. The current world supply and demand balance for sugar and medium-term price expectations indicate the likelihood of large-scale changes in land use from low-intensity agriculture to sugar production are relatively unlikely. Therefore, the sugar industry is unlikely to trigger additional pollutant loads;
- **horticulture**: growth in horticulture production in GBR catchments has generally outstripped demand in recent years, particularly for fruit. The perishable nature of products, the distances to markets and the significant investments required for horticulture processing significantly constrain large-scale changes in horticultural land use. The risks of major development are probably greatest in the Burdekin WQIP region where the State is actively developing strategies to attract large scale horticulture processing;
- **aquaculture**: aquaculture development has increased in recent years. Despite significant interest in further aquaculture development, market conditions such as price trends and competition have not been favourable enough to trigger widespread expansion;
- **urban and peri-urban**: population growth across many of the GBR catchments has been relatively rapid in recent years. This trend is expected to continue, with the bulk of the population growth concentrated in coastal areas. The rapid population growth increases urban point and diffuse source loads. Existing and proposed policy approaches such as wastewater treatment standards and the proposed implementation of enhanced stormwater management for greenfield development will only partially mitigate the growth in pollutant loads from urban areas; and
- **resources**: while not explicitly addressed in any of the WQIPs/HWMPs assessed (except the Fitzroy), the continuing growth in the resource sector does pose further risks to water quality in the GBR catchments if not continued to be managed sustainably – particularly the risk to receiving water quality objectives during major rainfall events, such as changes to pH and salinity levels. Management approaches need to continue to mitigate the growth in risks to water quality potentially. These risks are greatest in the Fitzroy and the Burdekin basins.

The key point to note is that future development is likely to place even further pressure on the GBR via higher pollution loads from multiple sources, while the assimilative capacity of the GBR to absorb those loads is potentially declining due to the current load levels and other pressures such as climate change. Sustainable management of current and future

4 These trends are detailed in Section 3.1 and Appendix A.

activities is necessary to address the water quality risks from growth and potential decline in the condition of the GBR.

Benefits of protecting EVs by implementing WQIPs

There are a number of benefits that are likely to be derived from protecting environmental values of non-tidal and tidal waters. Key benefits of enhancing water quality include:

- enhanced water quality in catchments can provide significant opportunities to **reduce water supply and wastewater treatment costs** borne by the community;
- the value of **agricultural production** across the regions assessed in this report is significant. Water quality is impacted by agricultural production and water quality is an important input for some agricultural sectors. Often, the costs of enhancing water quality at a property scale exceed the private benefits of improvement. This creates the need for intervention. The relationship between management actions to reduce pollutant loads at a property scale and the split between private and public benefits from management actions are not well understood by landholders or government;
- the **commercial and recreational fishing** sectors are worth approximately $500 million per annum. Both sectors benefit from enhanced water quality, but the relationships between water quality and economic outcomes for commercial and recreational fishing are not well understood;
- **tourism** is a major sector in the GBR catchments and coastal waters, contributing in excess of $4.3 billion per annum. With the exception of a handful of specific studies, the relationship between worsening water quality and declining tourism activity is not well understood. However, all research to date has indicated tourism will be lower than business-as-usual if the condition of the GBR continues to decline. This is a major gap in knowledge and information;
- **recreation** benefits of maintaining water quality are likely to be significant and expenditure on recreational activities in the GBR catchments and coastal waters is in excess of $500 million per annum;
- **environmental values**: while there have been a number of studies into the non-market value and benefits of the quality of the GBR, the studies do not allow for sophisticated and comprehensive economic analysis of the benefits and costs of enhancing water quality in the GBR catchments. The different approaches taken for measuring and reporting benefits from previous studies do not allow estimates to be aggregated to arrive at a single estimate of the benefits of protecting and enhancing waterways and water quality through the implementation of WQIPs/HWMPs. In addition, the physical change in condition of the GBR attributable to the implementation of WQIPs is not well enough understood to establish more sophisticated estimates of economic values. However, there is significant evidence to suggest that the benefits are substantial. The waterways and water quality are highly significant environmental assets, some with outstanding universal value, on which the broader community heavily relies for both commercial and non-commercial benefits;
- broad studies of the benefits of maintaining the condition of the GBR indicate significant values. For example, the Oxford Economics group estimated the current value of the GBR to be around $51 billion, with the cost of a permanent bleaching event (a proxy for a permanent material loss in condition) at around $38 billion. **Previous studies reviewed**

also indicate that the community is willing to invest heavily in the protection and enhancement of waterways and water quality in GBR catchments;

- the protection of cultural and spiritual values that are important to both the indigenous and broader community.

Costs of WQIPs

The costs of enhancing water quality in the WQIP regions are significant. These costs will be borne by a mix of governments, consumers and producers, depending on the source of the pollutant and the policy approach chosen. A summary of the estimated costs of meeting the targets in the WQIPs for the period of 2009-14 is outlined in the table below.

ES Table 1: Approximate costs of implementing WQIPs for the period 2009 to 2014 ($ millions)

WQIP region	Rural diffuse		Urban diffuse		Total	
	Low	High	Low	High	Low	High
Fitzroy	18	25	27	40	45	65
Mackay Whitsunday	46	116	4	9	50	125
Burdekin	80	165	n.a.	n.a.	80	165
Townsville	1	1	30	30	31	31
Tully Murray	7	15	n.a.	n.a.	7	15
Burnett Baffle	47	77	15	15	62	92
Total	199	399	75	94	275	493

Source: MJA.

It should be noted that the costs outlined in the table above do not include the cost of all initiatives that are consistent with the objectives of WQIPs such as the costs of actions required by regulations. For example:

- point source pollutants from wastewater treatment plants, industry and discharges from mining are not priorities in many of the WQIPs and these are seen as State regulatory issues. However, the importance of managing these loads through the development and implementation of policies that provide a continuous incentive for polluters to reduce loads cannot be overemphasised. This is particularly the case where growth in these loads is expected to be rapid in the medium to longer term; and
- the implementation of water sensitive urban design[5] (WSUD) in greenfield development is an appropriate policy response, with the cost ultimately borne by property owners. However, most WQIPs do not emphasise WSUD as a priority policy approach as it is seen as a regulatory responsibility of the State and local government sectors.

5 A Single State Planning Policy (SPP) is currently being drafted and will be released for public consultation in the first half of 2013.

The Queensland Government is committed to establishing a new approach to state planning policies that simplifies and clarifies the state's interests. The new approach means that one single state planning policy will be developed to replace the various current state planning policies in existence. The State Planning Policy will set out policies about matters of state interest (includes water quality) in the planning and development assessment system, and forms part of the government's broader commitment to planning reform for finalisation in 2013.

The potential costs of implementing each of the WQIPs are outlined in their respective sections of this report.

Key points to note regarding costs include:

- the costs of implementing the plans are relatively uncertain as the net costs of many of the management actions required to implement the WQIPs are highly variable. However, the costs to meet the targets established in the WQIPs for the next five years could range from around $275 million, up to nearly $500 million;
- **estimated costs exceed funding available through the Reef Rescue Package and incentives available to complement the mitigation of rural diffuse loads, particularly** in the Fitzroy, Burdekin Dry Tropics, Wet Tropics and Mackay Whitsundays catchments;
- the costs represent proactive investment above regulatory requirements. The estimates do not include costs of practices to meet regulatory requirements, specifically the costs of wastewater treatment plants or implementing WSUD in greenfield development;
- analysis undertaken for individual WQIPs found significant variation in the cost effectiveness of investments in reducing loads. Generally investments in reducing loads from sugar and grazing are the most cost effective means to reduce rural diffuse loads. In addition, investments in abating rural diffuse loads are generally significantly more cost effective than investments in urban diffuse load abatement (e.g. retrofitting WSUD); and
- the relative cost effectiveness of different load abatement alternatives indicates a need to ensure the design and delivery of WQIPs specifically targets the most cost effective actions first.

Costs of Wet tropics Healthy Waters Management Plan

While the HWMPs developed in the Wet Tropics are still being established and formal management action targets are yet to be established, it is possible to gain some indication of their potential costs through an assessment of the likely actions being investigated. For rural actions, MJA developed and assessed a number of practice change scenarios, all ultimately moving toward all producers in each region reaching current best management practice. In addition, the costs of WSUD initiatives were assessed as a proxy for actions to address urban diffuse leads.

First, based on economic analysis undertaken for the Reef Plan, MJA has identified that for sugar, horticulture and grazing, it is likely that significant reductions in diffuse loads could be achieved at little, if any, cost to producers through moving from current practices to current best management practice (i.e., B practices). This is largely due to the fact that savings in input costs and increases in productivity offset implementation costs.[6]

For urban diffuse actions, the costs over the next ten years are likely to be in the range of:

- $2.0-2.4 million in the Herbert;
- $50-60 million in the Barron;
- $2-3 million in the Johnstone; and
- $2.2-2.6 million in the Russell-Mulgrave.

6 It should be noted that this analysis did not include consideration of the transaction and administrative costs of practice change.

The key driver of these costs is the forecast rate of new dwellings being established.

Growth in mining developments and other point sources of loads in the Wet Tropics are not anticipated to be significant over the foreseeable future (although upgrades to wastewater treatment plants will be necessary in some areas). The costs will be embedded within specific projects as part of meeting development approval conditions. These costs will be project specific.

Policy and program design and delivery

The variation on the effectiveness, benefits and costs of management actions between regions, industries and practices creates a very real need for robust policy and program design. This is particularly the case given the shortfall between the level of resources required to meet the WQIP/HWMP targets and the resources actually available. Key points to note about **policy and program design and implementation** include:

- there are several impediments to improving water quality that need to be addressed, ranging from broad market impediments, to attributes of particular practices, to social impediments to change. These impediments differ between regions, industries and practices. Therefore, ‘one size fits all’ or single policy approaches are unlikely to achieve water quality targets;
- efficient policy should be specifically designed to overcome any impediments to changing practices that negatively impact on water quality. These policies must provide the most efficient, or cost effective, outcomes possible within resource constraints;
- there are several policy options (regulatory, planning, market, suasive) and no single approach is best for all situations. Each policy approach has pros and cons. These should be considered along with the nature of the problem (e.g. spatial and temporal variability) and the proposed practices (e.g. public vs. private benefits) when selecting a policy or program. Where possible, the individual WQIP/HWMP sections identify what policy options are likely to be most effective to meet the specific WQIP/HWMP targets. The broader suite of potential policy approaches is shown in the table below (ES Table 2);
- most policies are best run in conjunction with complementary approaches to either reinforce or increase the efficiency of the main policy;
- in the absence of regulation, as is the case across many of the WQIP/HWMP regions assessed, market-based instruments (MBIs), in conjunction with suasive approaches, are likely to be the most effective approach for addressing diffuse rural pollutant loads. Regulatory approaches, often delivered in conjunction with MBIs and suasive approaches, are likely to be the most effective tool for urban diffuse and point source loads; and
- **the packaging and sequencing of efficient policies can deliver major gains in the efficiency of meeting targets outlined in WQIPs/HWMPs. For example, in the Tully Murray WQIP, by targeting ‘win-win’ outcomes for sugar producers first and then targeting the low-cost abatement from sugar and grazing, nutrient targets could be achieved at about half the cost of the lowest single-industry option.**

The broader suite of potential policy approaches to address different loads from different sectors is shown in the table below. For each policy option, the *potential* effectiveness (is it likely to achieve the objective?) and *potential* economic efficiency (will it achieve the policy at the lowest cost to society?) is shown below. Three ticks indicate the policy tool works well, while a single tick indicates the policy tool may not be as suitable.

Finally, there are significant gaps in biophysical, economic and social knowledge and information relating to enhancing water quality. These information gaps constrain the ability to design the most cost-effective suite of policies and programs to achieve desired water quality objectives in the GBR.

ES Table 2: Potential suite of policy approaches by sector load type

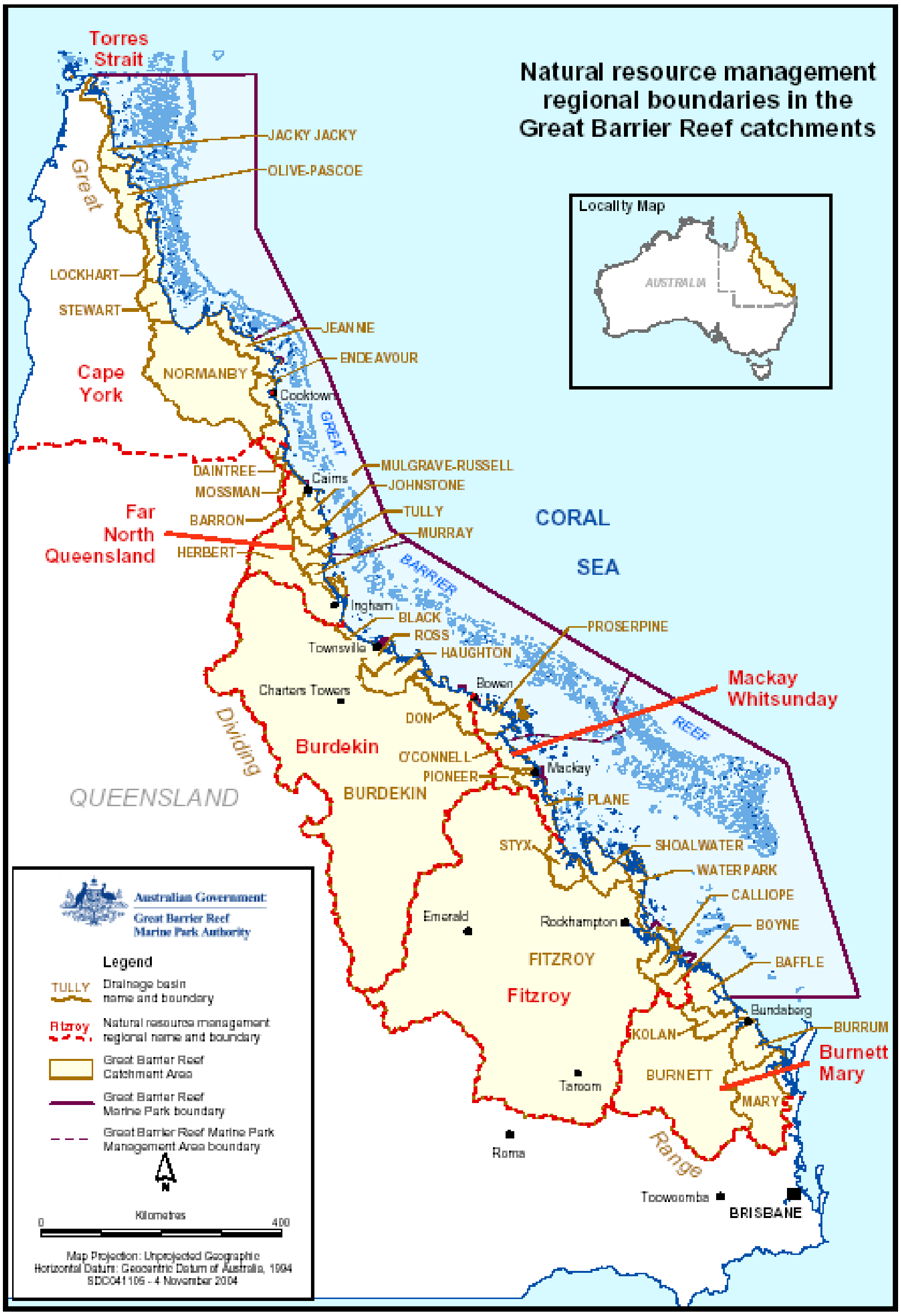
Sector and loads	Policy	Effective	Efficient	Comments
Urban point source	Regulated discharge of loads / concentrations	✓✓✓	✓✓	Regulatory approaches could be more effective if cumulative impacts were assessed and charges better reflected loads.
	Market-based approaches	✓✓✓	✓✓✓	Cap and trade mechanisms have potential large efficiency gains within regional thresholds for larger polluters (e.g. WWTPs, industry with discharge licenses).
	Suasive approaches	✓✓	✓✓	Potentially effective for smaller polluters where compliance of stricter regulations may be cost prohibitive.
Urban diffuse	Regulated practice – greenfield (e.g. WSUD)	✓✓	✓✓	Effective means to reduce bulk of loads and mitigate impacts on local waterways particularly, but only partial solution. Could work well in conjunction with market-based approaches such as offsets.
	Regulated practice – retrofit (e.g. WSUD)	✓✓	✓	Effective means to reduce bulk of loads and mitigate impacts on local waterways particularly, but only partial solution. Retrofitting is significantly less cost effective than greenfield applications.
	Suasive approaches	✓✓	✓✓	Particularly important during construction phase (e.g. best practice sediment management).
	Market-based approaches	✓✓	✓✓	Potentially efficient policy tool via water quality offsets. Would require change of Government policy to implement.
Mining loads	Regulated discharge of point source loads / concentrations	✓✓✓	✓✓	Regulatory approaches could be more effective if cumulative regional impacts were assessed and charges better reflected loads.
	Market-based approaches for point source loads	✓✓✓	✓✓✓	Cap and trade mechanisms that limit discharges / concentrations within specific local boundaries (e.g., local river systems) have potential large efficiency gains where trading of rights to pollute is possible. Markets that allow mines to purchase water to effectively dilute concentrations to meet regulatory requirements have potential.
	Market-based approaches for	✓✓	✓✓	The use of tenders and other incentives by mining companies to purchase load

Sector and loads	Policy	Effective	Efficient	Comments
	diffuse loads			reductions from other sectors (e.g., grazing) may prove cost effective.
Rural – diffuse loads	Regulation	✓✓✓	✓✓✓	Difficult to ensure compliance on anything but production inputs and reporting. Can prove efficient where economic and social barriers to achieving regulatory requirements are low.
	Market-based approaches	✓✓✓	✓✓✓	Can target high risk practices and locations directly and overcome impediments to change. Care needs to be taken to target correct segment of the market (e.g. landholder or contractor?).
	Suasive	✓✓	✓✓	Information and extension tools can be highly effective when targeted at information / knowledge impediments to practice change. Often an important tool to underpin other regulatory and / or market-based approaches.

1. Introduction

The Great Barrier Reef (GBR) is one of the world's greatest natural treasures. It is the world's largest collection of coral reefs, covering over 20,055 km^2.[7] The GBR stretches over 2,300 km along Queensland's coastline, from the Torres Strait in the north to Bundaberg in the south, as shown Figure 1.

Figure 1: Great Barrier Reef catchments



[7] http://www.environment.gov.au/heritage/worldheritage/sites/gbr/values.html. Accessed 28 October 2008.

In 1981, the GBR was listed as a World Heritage Area (WHA).[8] It is the most diverse ecosystem in the world and supports flora and fauna, including between 1,200 and 2,000 fish species, 26 species of whale and dolphin, six sea turtle species and some of the world's oldest living corals. [9]

The objective of this study is to review the economic and social impacts (benefits and costs) associated with changes in water quality levels in catchments of the GBR, and adjoining waters in the GBR lagoon. Specifically, this project considers:

- Tully River catchment;
- Burdekin River basin;
- Townsville, covering the Ross–Black catchments;
- Fitzroy River basin;
- Mackay–Whitsunday including Pioneer catchment;
- Burnett, Baffle, and Elliott catchments;
- the regions Herbert, Barron, Johnstone, and Russell Mulgrave (includes Cairns); and
- the waters in the GBR lagoon downstream of these areas.

1.1 Policy and planning context

Water Quality Improvement Plans[10]

A number of policy and planning initiatives are being established to address the risks to water quality in the GBR catchment and the adjoining GBR lagoon. These initiatives include the Reef Plan; regional WQIPs / HWMPs; and the continued implementation of the Environmental Protection (Water) Policy 2009.

This document is specifically addressing WQIPs, but applies to Healthy Waters Management Plans and more generally to Regional Body NRM plans addressing matters 1->4 below.

Under the Australian Government Coastal Catchments Initiative (CCI), a number of priority catchments have been identified. In these priority catchments, the government wants targeted reductions in pollution discharges into coastal waters.

The first step in implementing the CCI in priority catchments is to prepare a WQIP. WQIPs, and more recently HWMPs focus on reducing local pollutant loads.

Figure 2 shows how WQIPs are developed. Six WQIPs are currently being developed in the GBR catchments. WQIPs will be implemented by multiple parties including the State and local governments, regional natural resource management bodies and other stakeholder groups. WQIPs:

1. identify environmental values (EV) for waters in the WQIP study region;
2. establish water quality objectives (WQOs) to protect identified EVs within each WQIP region;

---

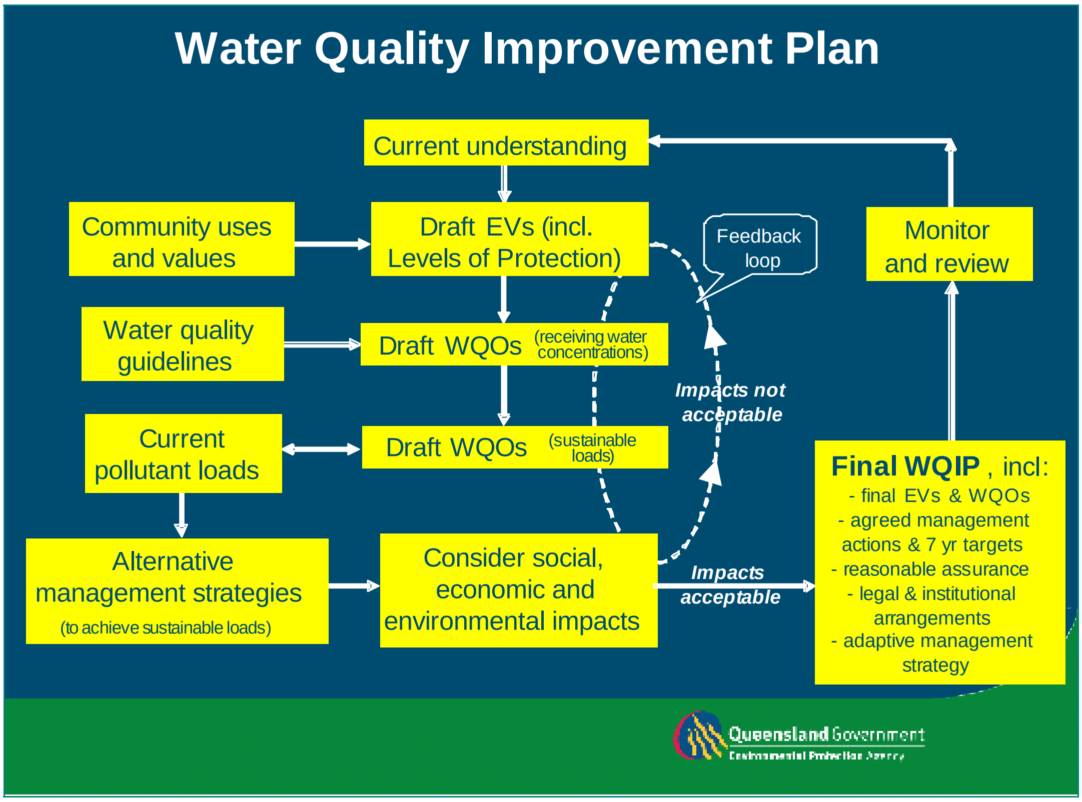
8 http://www.environment.gov.au/heritage/worldheritage/sites/gbr/values.html. Accessed 28 October 2008.

9 http://www.environment.gov.au/heritage/worldheritage/sites/gbr/values.html. Accessed 28 October 2008.

3. identify the economic and social impacts (broad level appraisal) of protecting and achieving WQOs; and
4. identify best management practices and actions required to achieve water quality objectives within the life of the WQIP.

This report will help to inform the third and fourth aspects of creating WQIPs.

Figure 2: Water quality improvement plan framework



Source: Queensland EPA.

1.1.1 State-based policy initiatives[11]

This report is also intended to contribute to the design of actions to implement Queensland Government policies such the Environmental Protection (Water) Policy 2009 (EPPW). This report also informs the preparation of a Preliminary Impact Assessment, under the Regulatory Assessment Statement System, for any regulatory proposal to amend the EPP Water 2009 to include the environmental values and water quality objectives for waters in Schedule 1.

In addition, the assessments have been undertaken in a manner consistent with Queensland Treasury Project Evaluation Guidelines and Queensland Treasury Public Benefit Test Guidelines.

1.2 Risks to the Great Barrier Reef and WQIP regions

The delivery of sediments, nutrients and other pollutants into the reef from rivers[12] is increasing. Increases to these loads pose risks to EVs in GBR catchments and adjoining waters in the GBR lagoon.

[11] Note Single SPP is in draft form and will be released in the near future.

The GBR Marine Park Authority (GBRMPA) lists nutrients such as phosphorus, sediments, pesticides, heavy metals, and global atmospheric changes as key influences on the GBR water quality.[13] Some of these pressures, such as climate change, are beyond the control of any WQIP or the EPPW, but may still impact on the attainability of objectives and targets. Therefore, they still form part of the context for policy and planning activities.

However, reducing the risks from land-based activities is the dominant focus of WQIPs and the EPPW. In particular, urban areas and agricultural production are likely to emit pollutants such as nitrogen and phosphorus, sediments and pesticides that are harmful to the health of the GBR.

1.2.1 Risks and priorities in WQIP regions

The risks, pollutants and the focus of actions of the WQIPs in the GBR region are not uniform. Table 1 briefly outlines priority areas being addressed in each of the WQIPs under development.

Most emphasis is on diffuse sources of pollution, particularly rural sources, to:

- improve fertiliser and other chemical use, particularly in irrigated and other intensive agriculture; and
- enhance management of groundcover to reduce sediment loads in pastoral agriculture.

In more urbanised regions, particularly Townsville, there is a greater focus on managing point-source pollutants and diffuse urban sources, particularly from greenfield developments.

Table 1: Key priorities for each WQIP currently under development in the GBR region

Region	Key priorities
Tully–Murray	Rural diffuse sources of pollution are the focus of this WQIP. Key pollutants include total suspended sediments (TSS), total nitrogen (TN), total phosphorus (TP) and pesticides. The pollutants mainly sourced from cane and horticulture holdings, with national parks and forests providing additional sources of TSS.
Burdekin	This WQIP focuses on TSS, nitrates and herbicides, primarily sourced from the cane and grazing industries. Management actions include improved fertiliser and herbicide management, the establishment of riparian management zones, advancing water management plans and improving groundcover and grazing practices.
Townsville	The Townsville WQIP focuses on urban point-source pollution and diffuse urban sources of pollution. Key pollutants in this WQIP are TSS, TN, TP. Actions to address these pollutants included the major upgrade of sewage treatment plants, completed in 2012.
Mackay–Whitsunday	Key pollutants addressed by this WQIP are TSS, residual herbicides, dissolved inorganic nitrogen (DIN), and dissolved inorganic phosphorus (DIP). Urban diffuse sources include TSS, particularly from new developments during the construction phase and DIN, DIP, and herbicides from existing parks, gardens and transport corridors. Diffuse rural sources of DIN, DIP and herbicide include cane, while DIN and DIP are also sourced from grazing. Cane, grazing and poor management of native vegetation underlie TSS loads. Improved management of riparian areas, waterways and herbicide application are proposed. Upgrades to Proserpine and Cannonvale sewage treatment plants are also progressing
Burnett–Baffle	Key pollutants of concern are TSS, TN, TP and pesticides. In addition to the TN and TP from point source sewage treatment plants, un-sewered coastal towns and stormwater runoff are also of concern. Pesticides, TN and TP are sourced from urban areas, horticulture and cane. Cane, horticulture and grazing are the sources of TSS, although the dams on the rivers are likely

12 The State of Queensland and Commonwealth of Australia 2006, Reef Water Quality Protection Plan Annual Report 2005–2006.

13 http://www.gbrmpa.gov.au/corp_site/key_issues/water_quality/principal_influences.html. Accessed 28 October 2009.

	to trap significant sediment loads before they reach the GBR. Rural point sources of TN and TP such as piggeries, feedlots and dairies are also of concern
Fitzroy	In the Fitzroy Basin, the *Central Queensland Strategy for Sustainability—2004 and beyond* (CQSS2) discussed the priority issues for water quality in the region. The priorities focus on gathering more information on the appropriate levels to set water quality targets due to the lack of sufficient background data. Given this, the focus initially is to reduce TSS loads by a cumulative 4.1 million tonnes in 10 years.
Barron	Rural diffuse loads (particularly TN, TP and herbicides) through enhancing best practice in cane and production and horticulture. Cane is likely to be the major focus for rural diffuse actions. Urban diffuse source pollutants (TSS, TN, TP) through the implementation of water sensitive urban design. Point sources will be managed through existing regulatory arrangements.
Herbert	A major focus on cane producers, particularly fertiliser use and other management practices to reduce nitrogen and phosphorus. Some further emphasis on pastoral activities where specific landholders have opportunities for enhance practices and reduce pollutant loads. Urban diffuse loads are less likely to be a focus given relatively low urban development prospects.
Johnstone	Rural diffuse loads (particularly TN, TP and herbicides) through enhancing best practice in cane and production and horticulture. Some further emphasis on pastoral activities where specific landholders have opportunities for enhance practices and reduce pollutant loads. Urban diffuse loads are less likely to be a focus given relatively low urban development prospects.
Russell-Mulgrave	Rural diffuse loads (particularly TN, TP and herbicides) through enhancing best practice in cane and production and horticulture. Urban diffuse loads are less likely to be a focus given relatively low urban development prospects—excluding Cairns, suburban development and northern coastal development.

1.3 Structure of the report

The remainder of this report is structured as follows:

- Section Two outlines the assessment framework and methodology used.
- Section Three summarises a cross-regional analysis across the six WQIPs.
- Section Four summarises potential policy and program interventions.
- Part B (Sections Five to Fifteen) outlines the key findings from the economic and social assessment of each of the WQIPs/HWMPs.
- Part C of the report includes a number of appendices containing sectoral outlooks and indicative costs of interventions.

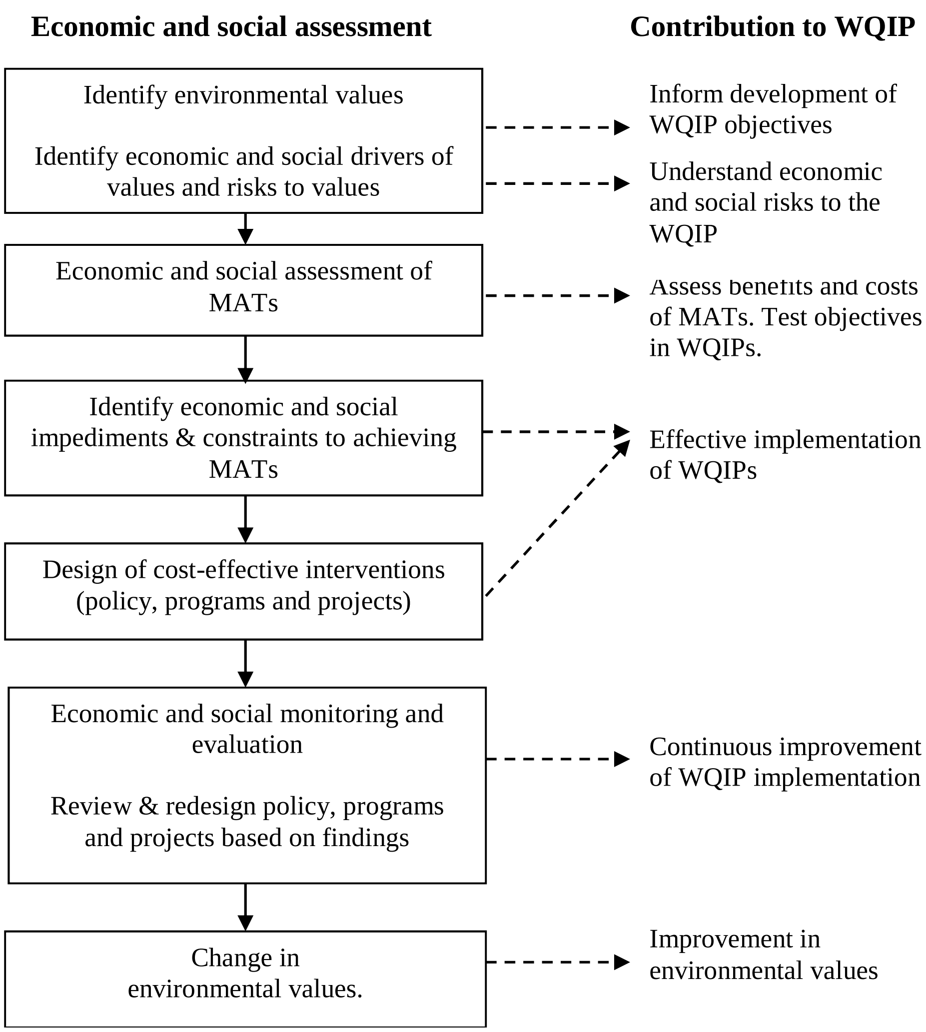
2. Assessment framework and methodology

While the development of WQIPs is largely driven by the need to reduce physical pollutant loads, the development of good policy and efficient programs requires economic and social assessment to:

- provide high-level evaluation of economic and social benefits and costs of interventions or Management Action Targets (MAT) and to determine if the proposed benefits of the proposed intervention exceed the costs;
- identify the economic and socials constraints of achieving the MATs;
- assist selection of effective and cost efficient interventions; and
- enhance interventions through ongoing monitoring and evaluation.

Figure 3 outlines the contribution of economic and social assessments to developing and implementing WQIP.

Figure 3: The role of economic and social assessment in developing and implementing WQIPs



Source: MJA.

The focus of this report is primarily on the second box in Figure 3 (i.e., the impact assessment) and Sections five to fifteen summarise the outcomes of the assessments for each of the six WQIPs. However, Appendix A provides much of the economic and social context for the assessments (the first box) and enhances the understanding of impediments to achieving desired management actions (i.e. the third box in Figure 3). The design of cost effective interventions (the fourth box) is outlined in Section 4.

2.1 Economic and social impact assessment

There are both economic and social benefits and costs of meeting MATs. Benefits include maintaining and enhancing the environmental values of water quality. Costs include both direct and indirect compliance costs. The direct program costs of implementing MATs will be borne by a range of groups such as regional natural resource management bodies and the three levels of government. Indirect and compliance costs may also be borne by industries and communities.

The desktop nature of this study does not allow for a comprehensive benefit–cost analysis (BCA). Financial quantification of the benefits and costs of each management action proposed in WQIPs is not available at the necessary level of detail. Instead, this study uses economic and social impact assessments, to:

- identify key demographic, social and economic data for affected groups;
- identify the economic activity (e.g. grazing) where changes are expected due to interventions;
- project the social and economic impacts on affected economic activities (potentially including flow-on impacts), including distributional impacts; and
- summarise likely impacts to inform WQIP development.

The analysis that underpins the economic and social impact assessments also forms the basis for consideration of the intervention approaches outlined in Section Four. Where possible, costs of alternative strategies to achieve MATs are assessed and the most cost–effective strategy or suite of strategies is identified.

2.1.1 Information and data sources

Information used in the report has been obtained from various sources:

- demographic data was primarily sourced from ABS data, particularly the 2006 census. Data has been concorded (best-fitted) to the WQIP regional boundaries by the Office of Economic and Statistic Research (OESR). Population forecasts are derived from official forecasts developed by the Queensland Government;
- information and data on relevant sectors is drawn from various sources including official statistics such as Australian Bureau of Agricultural and Resource Economics and State Government specific industry data;
- social and economic impediments information is drawn from literature reviews and previous studies;
- information on management actions, targets and physical impacts was primarily provided by the WQIP regions; and
- information on economic costs and benefits was primarily drawn from previous studies. Broad costs of management actions are outlined in Appendix B.

2.1.2 Economic modelling approaches

Each WQIP incorporates a series of MATs to achieve water quality objectives over time. Actions to meet the MATs include activities such as changed land management practices, engineering works, capacity building and modified planning arrangements. Actions are generally set to be achieved in the short term (1–7 years).

MATs link the scientific aspects of the WQIPs with the social and economic outcomes. This project used a bottom-up approach to modelling the impacts of the broad suites of actions proposed for each WQIP.

To do this MJA has developed a number of simple, but robust, models specifically for this project. Changes in practice in the sugar industry were assessed using existing representative farm models developed by MJA for several Water Resource Plans in Queensland. Where models are not available, simple calculations were made using existing data.[14]

Economic modelling is designed to estimate changes in producer or consumer surplus — in this case the changes are attributable to the implementation of actions to meet the MATs. The modelling used for this project is consistent with the Queensland Treasury project evaluation guidelines.[15]

While there is a reasonable amount of information available to establish estimates of the costs attributable to achieving MATs, data to estimate the likely benefits is not readily available. This means a full benefit–cost analysis of achieving MATs cannot be undertaken. Wherever possible, this report identifies benefits and estimates values for those benefits. Where data is sufficient, the distribution and variation in economic costs and benefits attributable to achieving MATs are highlighted.

Using scenarios

There are many possible scenarios for trends in resource condition that can be attributed to actions undertaken to achieve MATs. These are assessed as potential scenarios. The first scenario assessed is a ‘business as usual scenario’ or ‘do nothing’ scenario, depicting the likely changes in condition if no interventions are taken over a reasonable planning timeframe. The other scenario represents the deliberate interventions outlined in each WQIP.

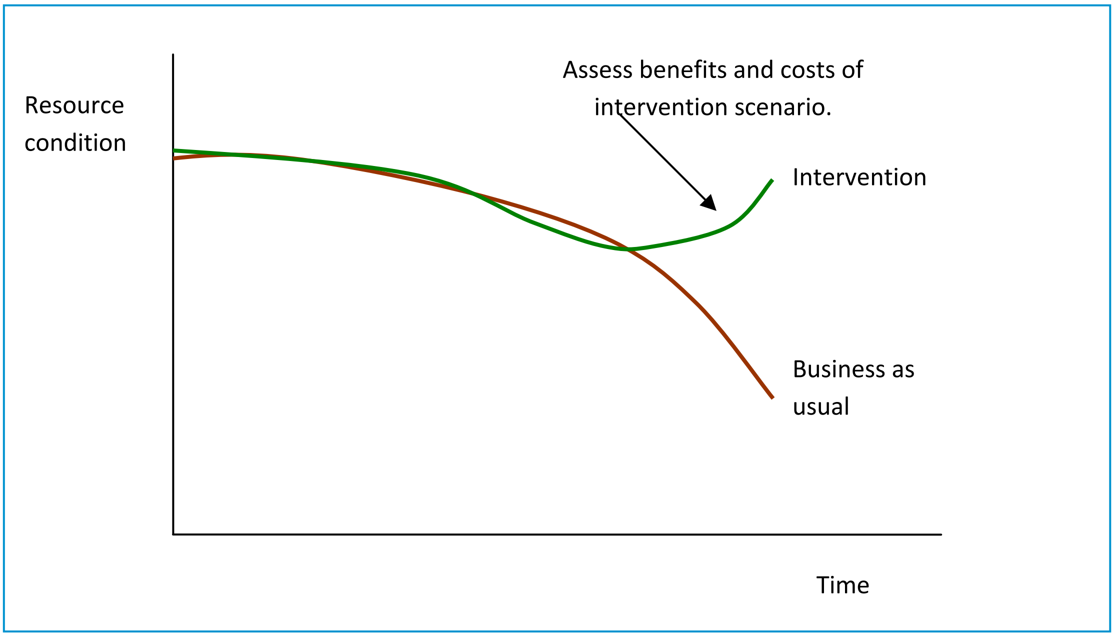
A conceptual example of these scenarios is shown in Figure 4.

---

14 Relevant data and models used are specified in each of the regional chapters.

15 Queensland Treasury, 2006, Project Evaluation Guidelines and Queensland Treasury Public Benefit Test Guidelines.

Figure 4: Assessment of scenarios



Source: MJA.

2.1.3 Economic and social constraints to MAT implementation

Achieving MATs will create economic and social impacts such as enhanced recreation opportunities, changes in production costs etc. Some of these impacts may form impediments or constraints to achieving the overall objectives of WQIPs.

For example, there may be insufficient private benefits to undertake some actions. This impact reduces the likelihood that individuals will change their behaviour without an external motivation such as regulation or financial incentives. Other potential constraints include:

- the perceived risk and uncertainty of the proposed changes in management actions;
- the complexity of the proposed action and the degree to which it is complementary or compatible with existing practices and the objectives of the business or sector;
- the degree to which the action can be trialled or tested at a small scale before full-scale adoption; and
- the degree to which results of implementing the change in practice can be easily seen and evaluated to reinforce continuation of the practice.[16]

These constraints should be qualitatively identified as part of the individual socio-economic assessments.

[16] Cary, J., Webb, T. and Barr, N., 2001, The *adoption of sustainable practices: some new insights. An analysis of drivers and constraints for the adoption of sustainable practices derived from research*, Land and Water Australia, Canberra.

3. Benefits and costs of enhanced water quality

This section outlines the key drivers of actions that impact on water quality and provides an overview of the benefits of enhanced water quality in the GBR catchments.

3.1 Drivers of actions impacting on water quality

There are a number of physical causal relationships that underpin the relationships between human activity and changes in water quality. These relationships help inform the actions and practices that need to change if policies and programs are to halt or reverse pollutant loads entering the GBR. Key causal relationships include:

- **land clearing**. Within the agricultural and urban land use sectors, land clearing is one of the main drivers of pollutants into water bodies. Approximately half of the GBR catchments are now cleared compared to pre-European settlement.[17] Although broad-scale land clearing of remnant vegetation is no longer legal in Queensland, clearing for urban development and clearing of non-remnant vegetation is still permitted. Land clearing leads to increased erosion and the transport of sediment and associated nutrients in receiving waterways;
- **pastoral land uses**. Pastoral lands are a diffuse source of sediments and nutrients into the GBR. Grazing can lead to land erosion, which in turn leads to increased TSS in nearby waterways. This problem is exacerbated when cattle have access to riparian areas because livestock contribute additional sediments and nutrients to waterways;
- **intensive agriculture**. Intensive agriculture such as sugar cane is another sector that increases nutrient loads into the GBR. In particular, fertiliser use results in higher nitrogen and phosphorus levels in nearby waterways. Pesticides are also a pollutant from this sector. Other intensive agriculture industries that could have a negative impact on water quality in the GBR are aquaculture, horticulture, and intensive feedlots;
- **urban settlements**. Developments along the GBR are also a source of pollutants. Sewage effluent, which is the main form of point source pollution in urban areas, contains nitrogen and phosphorus. Unsewered homes can create similar problems through diffuse sources. In addition to sewage emissions, stormwater runoff from urban areas is a diffuse source of nutrients from sources such as garden fertiliser; sediments, especially from new developments; and toxicants from roads. These emissions are generally related to population growth; and
- **point source industrial loads**. Point source pollutant loads from factories, chemical processing, waste treatment, spray painting, piggeries, and prawn farms are all sources of various pollutants than can ultimately enter waterways. Major sources of point source loads are licensed Environmentally Relevant Activities (ERAs) in Queensland and are regulated through a licensing system managed by the DEHP (formerly by the Environmental Protection Agency).

[17] Reef CRC, 2003, *Land use and the Great Barrier Reef: current state of knowledge*.

3.1.1 Drivers of changes in land use

Changing land uses to more intensive uses such as intensive cattle production, or moving from cattle production to sugar cane can be a major trigger of the size of loads impacting water quality. Changes in land use generally reflect market drivers and opportunities. An analysis of key sectors is provided in Appendix A.

By understanding growth potential of these sectors, predictions can be made on the impact these sectors will have on future water quality in the region. If the sector has constrained growth potential, likely changes to that sector's impact on water quality are also low.

Agricultural developments in the GBR catchments are driven by factors including: international and domestic markets (e.g. exchange rates, competition, market access); demand-pull factors (e.g. population growth, incomes, tastes); supply-push factors (e.g. productivity trends, biotechnology, R&D); institutional factors (e.g. quarantine); farmer knowledge and skills; natural resource management (e.g. best management practices and regulations) and climate variability.[18]

The key points of the analysis in Appendix A are:

- **pastoral.** Price and demand expectations are positive for the sector over the medium term. Changes to vegetation management regulations in recent years are likely to constrain expansion of the sector to areas of regrowth, areas which are probably already under production. Therefore much of the demand for the pastoral sector is likely to be met via an intensification of existing production. This may include further development of feedlots and associated fodder crops, including irrigated fodder. Inappropriately managed pastoral intensification forms a further risk to water quality objectives;
- **sugar**. This sector is essentially a price taker. The current world supply and demand balance for sugar, and medium price expectations suggest that large-scale changes in land use from low-intensity agriculture to sugar production are unlikely;
- **horticulture**. Growth in horticulture production in GBR catchments has generally outstripped demand in recent years, particularly for fruit. Export-dominated strategies are being pursued for further development. However, the perishable nature of products, distances to markets and the significant investments needed for horticulture processing will constrain large-scale changes from low intensity uses to horticulture;
- **aquaculture.** Recent years have seen increases in aquaculture development. Despite significant interest in further aquaculture development, market conditions such as price trends and competition are not favourable enough to trigger widespread expansion; and
- **urban and peri-urban.** Population growth across many of the GBR catchments has been relatively rapid in recent years and this trend is expected to continue. In addition, the bulk of the population growth is concentrated in coastal areas. The exception is growth attributable to mining developments. Changes in land use from agriculture to urban uses can have a positive or negative impact on water quality, depending on the specific circumstances.

In addition, the rapid expansion of the mining sector in recent years has also led to changes in the composition of land use. This has particularly been the case in the Fitzroy, Burdekin and Mackay Whitsunday regions. While mining does not utilise particularly large land areas compared to other land use changes occurring, the intensity of the land use change poses

[18] DPI&F, 2007, *Future drivers of the Queensland food and fibre industry.*

potential risks to water quality in the GBR catchments, if not continued to be sustainably managed. Much of the drive for mining development in the GBR catchments has been the rapid expansion of emerging economies (particularly China) and the rapid expansion of energy demand.

3.1.2 Receiving impacts

Both humans and economics sectors are impacted by a decline in water quality. Broadly, the majority of impacts lie within the water supply, agriculture, aquaculture, commercial and recreational fishing, recreation and tourism sectors, industries (e.g. power generation) and mines, and within cultural and spiritual values:

- **water supply** costs could rise where water quality problems increase the treatment requirements to ensure regulated standards are met (e.g. nutrient, pathogen, sediment, toxicant, salinity, changed pH). Where enhanced catchment management improves water quality, significant cost savings to water supply services can occur;[19]
- **tourism** could suffer from decreased water quality, particularly if corals and fish are negatively impacted. Visitor numbers to the GBR have increased approximately 10% in the past 10 years and data from the Tourism Forecasting Council suggests that if growth in GBR tourism mirrors broader industry expectations, inbound international tourism could be expected to grow around 4.9% per annum for the next 10 years, while domestic visitation would remain relatively stable;[20]
- **recreation** opportunities for locals would be damaged if water quality declined. Providing water quality is maintained, direct recreational use benefits are likely to increase in line with population;
- **commercial and recreational fishing** could be damaged by falling fish stocks resulting from disruption to natural systems; and
- **cultural values** of the GBR for both Indigenous and non-Indigenous communities will be diminished if it is not kept in a healthy condition.

3.2 Identified benefits of enhancing water quality

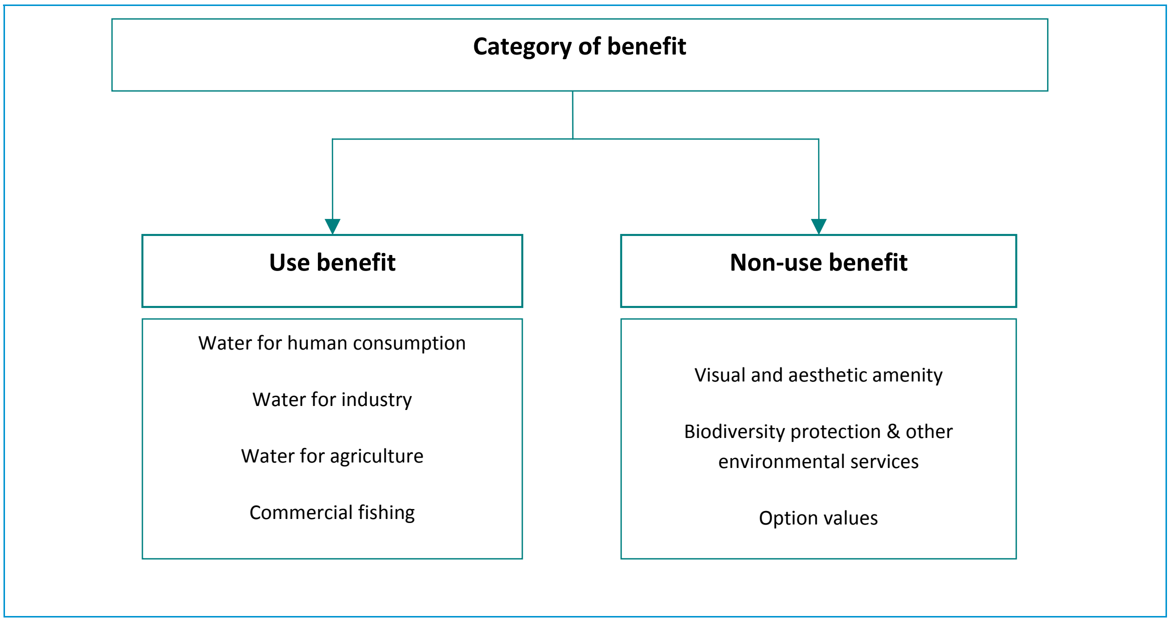
Water quality impacts economic values and economic uses. This section outlines the key benefits of enhancing water quality. As illustrated in Figure 5, the economic benefits of actions to protect water quality can be grouped into ‘use’ and ‘non-use’ benefits, depending on whether the underlying use directly draws on the waterways or not.[21]

19 Weber, T., 2005, *Using a Catchment Water Quality Model to Quantify the Value of an Ecosystem Service.*

20 Tourism Forecast Committee, 2007, *Forecast 2007 Issue 1, Tourism Research Australia, Canberra.*

21 This is a simplified presentation of the total economic value framework.

Figure 5: Benefits of protecting and enhancing water quality



Source: MJA 2006. Business case for investment in healthy waterways in South East Queensland.

These values can be further separated into impacting values — values for activities that impact water quality such grazing — and receiving values — values that rely on water quality such as water for human consumption.

3.2.1 Use benefits

Economic services that use waterways are many and varied and include water for human consumption, water for agriculture and industry, water used for commercial and recreational fishing, aquaculture, recreational swimming, and boating and water-related tourism.

Water for human consumption

The population requires a safe and secure source of potable water. The population of the WQIP regions is growing, placing further pressure on available potable water supplies. As water quality declines, local governments usually make a commensurate investment in increased treatment to meet regulated water quality standards. Some of this investment is 'lumpy' investment as new treatment plants are built; deteriorating water quality can therefore be expected to have a major impact on urban water charges.

Water treatment and environmental management costs that can be attributed to other sectors provides a direct estimate of the benefits, or avoided costs, of maintaining water quality that is closer to potable standards, in addition to benefits downstream for the GBR. The benefits of avoiding water quality-related incidents for the general public are significant.[22] While there are no specific studies on avoided water treatment costs due to enhanced catchment management, studies from overseas indicate significant benefits. For example, a study undertaken in Auburn, Mayne in the US (population 23,000), found $570,000 spent to acquire watershed land is avoiding $30m in capital costs and $750,000 in annual operating costs. [23]

22 For example, NQ Water spent in excess of $3m on environmental management alone in 2005/06 in addition to treatment costs. Source: *NQ Water Annual Report 2005–06.*

23 Ernst, C., 2004, *Protecting the Source: Land Conservation and the Future of America's Drinking Water, Trust for Public Land*, Washington DC.

Avoided or deferred wastewater treatment costs

Enhanced catchment management reduces total pollutant loads into receiving waters, particularly TSS, TN and TP. If wastewater treatment standards are increased, for example from secondary to tertiary treatment to meet water quality objectives, there may be a benefit from enhancing catchment management to delay or avoid upgrades to wastewater treatment plants (WWTP).

Actions in catchments can form a cheaper alternative to a WWTP upgrade. The capital and operation costs of upgrading WWTPs are ultimately borne by the community via increased wastewater treatment charges, increased taxes, or reductions in other government services. Estimates for potential benefits from avoided WWTP upgrade costs are shown in Table 2.[24]

Table 2: Benefits of avoiding WWTP augmentation (load = 1 tonne nitrogen/year)

	Capital expenditure avoided ($)	Annual operating expenditure avoided ($)	Annual customer charges avoided ($)
Low	400,000	31,300	77,000
Medium	850,000	40,800	138,600
High	1,300,000	50,400	200,200

Source: MJA.

Industrial and mining water use

Water use by industry is also significant in GBR regions. Major users include sugar mills and mines, and water is also used as input to other manufacturing and industrial processes such as electricity generation, metals manufacturing and some food and beverage manufacturing. Some industries are highly reliant on good quality water, such as those associated with food manufacturing, or where water must be certain specifications for cooling processes,, whereas water quality is less important to other users such as coal mines.

Water for agriculture

There are a number of primary industries that are a risk to water quality values, but also rely on water quality to maintain production values. Major sectors that fall into this category include:

- **beef.** The beef cattle industry has an impact on water quality via land management and use and is also reliant on water quality as a business input, essentially for stock watering. There are significant potential productivity benefits to producers to maintain water quality and quantity to maintain the health of stock. The beef cattle industry is the largest agricultural producer in Queensland, and is a key industry in the GBR. There are over 4.6 million beef cattle in the WQIP regions, with an estimated value in excess of $1.16b.[25] The Queensland beef industry is forecast to have a gross value of production of $3.5b in 2006/07;[26]

---

24 MJA analysis of capital expenditure of WWTP upgrades from secondary to tertiary standards. Expenditure data source: DLGPSR. Operating expenditure source: Watts, S. & Keller, J., 2005, *Technical review: best management practice for WWTPs and re-use options in SEQ.* Annual customer charges avoided calculated using a simple ‘building blocks’ approach including capital costs (assuming a 20 year operating life), operating and maintenance costs and a return on capital (6.5% discount rate used).

25 *Agcensus 2001*, MJA estimate.

26 DPI&F, 2006, *Prospects for Queensland’s primary industries 2006–07* March edition.

- **sugar.** Cane production represents a risk to water quality, particularly nitrogen and phosphorus associated with fertiliser use and other chemicals associated with pesticides. Cane production also depends on reliable irrigation water supplies and rainfall to ensure production is maintained; and
- **horticulture**. Horticulture is also both a risk to water quality, via particularly nitrogen and phosphorus associated with fertiliser use and other chemicals, as well as depending on reliable water supplies to maintain production. While data for the sector is relatively poor, 2001 agricultural census data indicated an estimated that the value of $860.5m.[27]

The estimated gross value of agricultural production, based on ABS Agricultural Census data is shown in the table below.

Table 3: Estimated gross value of agricultural production ($m)

	Tully	Burdekin	Townsville	MW	Fitzroy	Burnett	Total
Crops	144	382	17	128	316	230	1,217
Livestock	5	274	5	23	756	100	1,163
Total	149	657	22	151	1,072	330	2,380
% of all WQIPs	6%	28%	1%	6%	45%	14%	100%

Source: MJA based on ABS Agricultural Census Data. Note: MW denotes Mackay Whitsunday.

Commercial fishing and aquaculture

The GBR supports commercial fishing operations. Commercial fishing had a gross value (direct and indirect) of $106m in 2004–2005 and supported around 1,000 full-time equivalent jobs. This industry is partially reliant on maintaining water quality in freshwater, estuarine and marine environments. In the year ending June 2004, the Gross Value of Production (GVP) of the Queensland aquaculture industry was $72.5m. Around $57.1m of this production fell in statistical divisions that are partially or fully in GBR catchments.[28] Employment in the same areas equated to in excess of 560 FTEs. Since 2004, the annual value of aquaculture production in Queensland has declined moderately.

Table 4: 2003/04 Queensland aquaculture gate value

Statistical Division	FTE	%	Prod'n (tonnes)	%	Area (ha)	%	Values ($ m)	%
Wide Bay	88	16	268	7	149	14	6.1	11
Fitzroy	16	3	21	1	19	2	0.6	1
Mackay	64	11	516	13	262	25	7.7	13
Northern	174	31	1,748	43	345	33	25.4	44
Far Northern	219	39	1,500	37	262	25	17.3	30
Total	561	100%	4,053	100%	1,037	100%	57.1	100%

Source: Queensland Department of Primary Industries & Fisheries, 2005.

[27] CDI Pinnacle Management and Street Ryan Associates, 2004, *The economic contribution of horticulture to the Queensland Economy.*

[28] QDPI, 2005, *Industry prospects.*

Tourism

Tourism has the second highest GVP in the GBR catchments, second only to mining.[29] Tourism is not an industry in its own right for national accounting purposes. Rather, tourism impacts are measured across several industries. Therefore, estimating the economic contribution of tourism is complex and costly and regional estimates at the WQIP scale are not produced.

Major research undertaken by Access Economics estimated the total economic contribution (Gross State Product) to the GBR catchments from tourism in 2004–2005 at $3.6b. The sector also has significant flow-on effects for the broader economy and the total impact on the national economy (Gross Domestic Product) was estimated at $4.3b in 2004–05.[30]

There were 43,000 FTE jobs associated with the industry in the same period. Approximately 1.9 million tourists visit the GBR each year.[31] There are approximately 840 tourism operators in the GBR with 1,700 tourism vessels.[32]

The distribution of tourism activity is not uniform across the GBR or WQIP regions. Tourism activity is largely concentrated in coastal zones and offshore islands that may not strictly fall within WQIP boundaries. MJA has developed a range of estimates of the distribution of tourism activity across the six WQIP regions. [33]

While this data should be treated with caution, it does provide some indication that tourism activity across the six WQIP regions is concentrated in Mackay–Whitsunday, which accounts for 25–37% of total activity, Fitzroy[34] and Townsville. Note that the region specifically covering Cairns City is not covered by this analysis of WQIPs.

This provides some indication that, if declining water quality does actually have a negative impact on tourism, Mackay Whitsunday, the Fitzroy and Townsville are potentially at the greatest risk.

While Figure 6 provides some indication of the absolute distribution of total tourism activity, the relative importance of tourism-related activity for each WQIP region may be significantly different. It is important to note that the distribution of tourism activity (and economic benefits) is uneven across the GBR. This is outlined by a subset of regions assessed in Figure 6.

29 Hand, T., 2003, *An Economic and Social Evaluation of Implementing the Representative Areas Program by Rezoning the Great Barrier Reef Marine Park.*

30 Access Economics, 2005, *Measuring the economic and financial value of the Great Barrier Reef Marine Park.*

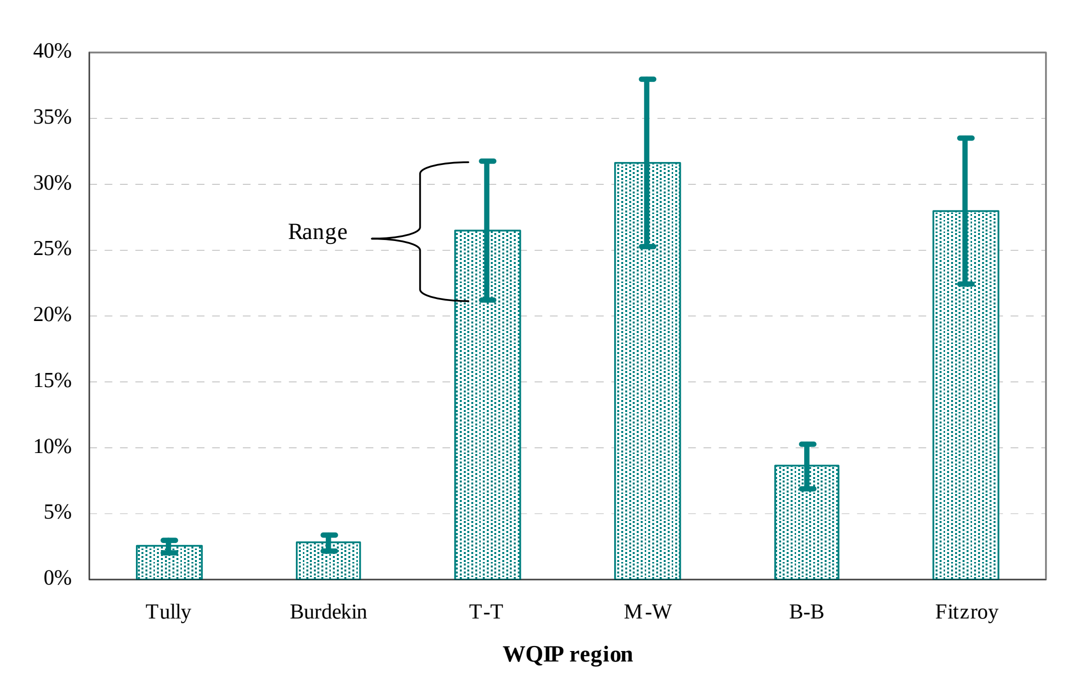
31 http://www.gbrmpa.gov.au/corp_site/key_issues/tourism . Accessed 29 October 2009.

32 http://www.gbrmpa.gov.au/corp_site/key_issues/tourism/tourism_and_recreation_in_the_great_barrier_reef_marine_park . Access 29 October 2009.

33 Based on each WQIP region's proportion of the total of the six WQIP regions' total guest nights and employment in accommodation, cafes and restaurants. Data sourced from ABS *Tourism Accommodation Survey* (Cat. 8645.0) and *2001 Census*.

34 Data for Mackay Whitsunday and the Fitzroy may be overestimates due to miners residing in formal accommodation houses (such as motels) on a semi-permanent basis.

Figure 6: Estimated distribution of total tourism accommodation activity across WQIP regions



Source: MJA.

Table 5 shows the percentage of total employment in each of the WQIP regions in accommodation, cafes and restaurants and retail trade. These are all industries that are heavily reliant on tourism activity. The data indicates that, despite only a small proportion of the total tourism activity for the WQIP regions occurring in the Tully and the Burdekin, the relative importance of the tourism sector in the Tully is similar to other WQIP regions.

Table 5: Proportion of total employment in accommodation, cafes and restaurants and retail trade

Tully	Burdekin	Townsville	Mackay Whitsunday	Burnett–Baffle	Fitzroy
19%	16%	20%	23%	20%	19%

Source: ABS Census of Population and Housing.

There have been virtually no studies that explore the relationship between water quality, tourism activity and economic benefits. This is a major gap in knowledge. However, a relatively recent study undertaken in Port Douglas indicated that recreational diving and snorkelling visitors would reduce annual visits to the reef by around 60% given a combined 80% decrease in coral cover, a 30% decrease on coral diversity and a 70% decrease in fish diversity. If this impact occurred across the GBR, and the relationship with visits held, the report estimated that tourism expenditure could drop by almost $140m per annum.

Recreation

Recreation is an important use value of the GBR. Recreational activities include boating, camping, diving, snorkelling, swimming, camping, bird and wildlife watching.

The gross value (direct and indirect) of recreational activities to the GBR catchment area, excluding tourism, was estimated to be $461m in 2004–2005, with 7,000 FTE jobs generated by the industry. [35]

In October 2006, there were 67,485 recreational vessels registered in the coastal communities along the GBR coastline.[36] Time series analysis of this data indicates the proportion of the population in WQIP regions that own a registered boat has increased from around 7.5 boats/100 people to 9.0 boats/100 people (up 20%) since 2000.[37]

At a localised scale, the implementation of policy responses such as WSUD in urban areas can provide significant amenity and recreational benefits in local creek and river systems. While WSUD may only provide a minor contribution to reducing loads into the GBR, the localised benefits can be significant.

Recreational fishing

The most recent and comprehensive source of data on recreational fishing in Australia is the *National Recreational and Indigenous Fishing Survey*.[38] The results of this survey indicate that in the twelve months to April 2001, 3.3 million Australian recreational fishers spent an estimated $1.85b on participating in recreational fishing. This involved 20.6 million fishing days of effort and a harvest of 1.36 million aquatic animals. [39]

In the GBR, recreational fishing expenditure was approximately $100m in 2004.[40] This indicates the importance of the recreational boating and fishing industry in the GBR. Many studies show that catching fish is not the only, or even primary reason, for people to go fishing. In one survey in Queensland, participants valued being outdoors, enjoying nature and rest and relaxation more importantly than for fishing alone.[41] This suggests that if there were less fish in the GBR due to poor water quality, recreational fishers might still enjoy their experience. However, it seems likely that the satisfaction of recreational fishers would eventually decline if there were consistently low odds of catching fish.

Research of the willingness-to-pay of Queensland recreational fishers for a 20% improvement in catch rates at inland waterways show that values range from $19 per angler at the Fairbairn Dam to $43 per angler at the Boondooma dam.[42] Similar benefits may be evident across the WQIP regions.

Data relevant to the specific WQIP regions is not available. However, data on recreational fishing activity for each relevant Queensland Economic Fishing Zone is outlined in Table 6.

---

35 Access Economics, 2005, *Measuring the economic and financial value of the Great Barrier Reef Marine Park.*

36 http://www.gbrmpa.gov.au/corp_site/key_issues/tourism/management/gbr_visitation/rec_vessels . Accessed March 2009. Ormsby, 2004, *A review of the social, motivational and experiential characteristics of recreational anglers from Queensland and the Great Barrier Reef Region.*

37 Queensland transport registrations database.

38 Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

39 Campbell, D., Murphy, J., 2005, *The 2000-01 National Recreational Fishing Survey: Economic Report*, Department of Agriculture, Fisheries & Forestry, June.

40 Queensland Transport, 2007, www.transport.qld.gov.au .

41 Ormsby, 2004, *A review of the social, motivational and experiential characteristics of recreational anglers from Queensland and the Great Barrier Reef Region.*

42 Rolfe, J., Prayaga, P., Long, P. & Cheetham, R. 2004, Estimating *The Value Of Freshwater Recreational Fishing In Three Queensland Dams*, Report prepared for the Queensland Department of Primary Industries.

Table 6: Recreational fishing expenditure by regions

	Far Northern	Northern	Mackay	Fitzroy	Total
Estimated expenditure ($M.)	24.1	16.6	22.7	35.1	98.5
Estimated expenditure (%)	24.5	16.9	23.0	35.6	100.0

Source: The National Recreational and Indigenous Fishing Survey: Economic Report, 2005
Note: .Initial results of a 2010 survey indicate declines in the estimated absolute numbers of recreational fishing in all GBR regions except Far North Queensland and declines in participation rates right across the GBR. This is likely to result in a reduction in overall real levels of expenditure.[43]

Research

Another important non-extractive use value for the GBR is research and education. The combined annual expenditure of research- and education-related activity to the GBR for James Cook University, the Australian Institute of Marine Science and the Cooperative Research Centre for the GBR was $25m in 2003.[44] If water quality declines further, it is likely the R&D sector may expand.

3.2.2 Non-use benefits

There are several types of non-use benefits associated with maintaining or enhancing water quality outcomes. These broadly relate to:

- visual and aesthetic amenity;
- ecosystem functions and services; and
- option, existence and bequest values.

Option values are where individuals value retaining the option to use the resource in the future, bequest values are where individuals value a resource for future generations, and existence values are where individuals value a resource simply because it exists. This section briefly summarises some of the more relevant studies undertaken to estimate non-use values.

Only a limited number of studies have been undertaken directly in WQIP regions.[45] Therefore, in order to demonstrate the likelihood of non-use benefits and value, key studies from outside the WQIP regions were also summarised.

Visual and aesthetic amenity

The economic value of improving the visual and aesthetic amenity of the region's waterways is difficult to ascertain. One approach is to gauge the effect of water quality and water scenic amenity (i.e. views and proximity) on residential house prices. There is evidence that properties with waterfront access command market premiums. KPMG[46] report that water frontage residential allotments had an average 97% premium on unimproved capital value compared with

43 http://www.daff.qld.gov.au/documents/Fisheries_RecreationalFishing/SWRFS-Phase-1-factsheet-May.pdf

44 Hand, T., 2003, *An Economic and Social Evaluation of Implementing the Representative Areas Program by Rezoning the Great Barrier Reef Marine Park.*

45 There are several methods to estimate non-use values such as revealed preference methods, the travel cost method, and stated preference methods like contingent valuation and choice modelling. Applying these techniques is both complex and expensive, often in excess of $100,000 for a contingent valuation study.

46 KPMG 1998, *Brisbane River and Moreton Bay Wastewater Management Study: Preliminary Economic Analysis of Proposed Expenditures and Strategies, Report prepared for the Queensland Government, Brisbane.*

non-waterfront properties. More recent reports confirm that prices in waterfront areas command substantial premiums.[47]

Value of protecting ecosystem function and services

The Ecosystem Services Project[48] describes ecosystem services as the services that people obtain from their environment. They include:

- pollination;
- fulfilment of people's cultural spiritual and intellectual needs;
- regulation of climate;
- insect pest control;
- maintenance and provision of genetic resources;
- maintenance and regeneration of habitat;
- prevention of soil erosion;
- maintenance of soil health;
- maintenance of healthy waterways;
- water filtration;
- regulation of river flows and groundwater levels; and
- waste absorption and breakdown.

There is evidence to suggest that residents highly value maintaining ecosystem function and ecosystem services. Given the large number of ecosystem services and functions provided by waterways and water quality, it is expected that individuals would be willing to pay to maintain waterway health to retain the option of using them in the future. A number of studies have been undertaken about managing riparian vegetation and river health; and wetland, river and estuary health. Relevant studies relating to riparian vegetation and river health include:

- Rolfe et al. (2002) estimated the value of protecting 1% more floodplain vegetation was $1.30/household in the Fitzroy and $1.74 in the Dawson, Comet and Nogoa catchments;[49]
- Robinson et al. (2002) estimated the value of a 1% change in the appearance of water in Moreton Bay at $0.37 per household per year;[50] and
- Rolfe and Windle (2005) estimated Brisbane households were willing to pay $22.80 per year to preserve fifteen per cent of water resources in the Fitzroy Basin despite the fact that the cost would be borne in Brisbane and the benefits accrued in the Fitzroy.[51]

---

47 Rolfe, J., Donaghy, P., Alam, K., O'Dea, G., and Miles, R., 2005, *Considering the economic and social impacts of protecting environmental values in specific Moreton Bay / SEQ, Mary River Basin / Great Sandy Strait Region and Douglas Shire waters*, Institute for Sustainable Regional Development, Central Queensland University, Rockhampton.

48 Ecosystems Services Project consortium at www.ecosystemservicesproject.org/html/overview/index.htm . Accessed 29 October 2009.

49 Rolfe, J., Loch, A., and Bennet, J., 2002, *Tests of benefit transfer across sites and population in the Fitzroy Basin, Valuing Floodplain Development in the Fitzroy Basin Research Report No. 4*, Central Queensland University, Rockhampton.

50 Robinson, J., Clouston, B., and Suh, J., (2002), 'Using a citizens' jury to estimate preferences for water quality improvements: A Case study on the Bremer River catchment, South East Queensland', Paper presented in the River Symposium. 2002, Brisbane.

Relevant studies relating to wetland, river and estuary health include:

- Windle and Rolfe (2004) reported significant community values for the protection of estuary in the Fitzroy catchment. Water quality has a direct effect on the health of waterways as well as estuaries. Their study indicated that Brisbane households were willing to pay an amount of $0.08 for a one-kilometre improvement of waterway health and $3.17 for a one per cent improvement in the health of the river estuary;[52]
- Clouston (2002) estimated values held by Brisbane residents for wetland protection in Moreton Bay of between $11 and $19 per household;[53]
- Robinson et al. (2002) reported protection values for the Bremer River, where households were willing to pay $36 per year for a moderate improvement in water quality;[54] and
- Rolfe et al. (2002) estimated that Brisbane households were prepared to pay $0.02/km/household to improve waterway health in the Fitzroy and $0.08/km/household in the Dawson, Comet and Nogoa catchments.[55]

In an attempt to determine tradeoffs and priorities in natural resource management, a 2005 survey of Toowoomba, Brisbane, Rockhampton and Mackay ascertained the marginal values for water, soil and vegetation protection, while another survey asked populations in Toowoomba, Brisbane and Mackay to value resources in the GBR coastal and inland regions.[56] These values are outlined in Table 7.[57]

Table 7: Marginal Values for water, soil, vegetation protection, and GBR

Soil conservation	Water quality improvement	GBR coastal soil	GBR coastal water	GBR inland soil	GBR inland - water
4.64	6.62	4.60	7.82	3.70	6.69

Source: Windle and Rolfe, 2006, Non-market values for improved NRM outcomes in Queensland.

These values capture both use and non-use values. One of the surveys also asked respondents to rate the importance of various use and non-use values for water, vegetation and land resources.[58] The survey found that non-use values were higher than use values. Bequest and existence values were particularly high. This lends support to the idea of high non-use values for the GBR.

---

51 Rolfe, J. & Windle, J., 2005, 'Valuing options for reserve water in the Fitzroy Basin', *Australian Journal of Agricultural & Resource Economics*, 49, pp. 91–114

52 Windle, J. & Rolfe, J., 2004, 'Assessing the values for estuary protection with choice modelling using different payment mechanisms', Paper presented at the *48th Annual Conference of the Australian Agricultural & Resource Economics Society*, February, Melbourne.

53 Clouston, E., 2002, *Linking the ecological and economic values of wetlands: A case study of the wetlands of Moreton Bay*, Ph.D. Thesis, Griffith University.

54 Robinson, J., Clouston, E. and Suh, J., 2002, 'Using a citizens' jury to estimate preferences for water quality improvements: A case study on the Bremer River catchment, South East Queensland', Paper presented at the River Symposium, Brisbane.

55 Rolfe, J., Loch, A., and Bennet, J., 2002, *Tests of benefit transfer across sites and population in the Fitzroy Basin, Valuing Floodplain Development in the Fitzroy Basin Research Report No. 4*, Central Queensland University, Rockhampton.

56 Windle and Rolfe, 2006, *Non-market values for improved NRM outcomes in Queensland.*

57 Windle and Rolfe, 2006. The figures for the GBR coastal region are the same as Mackay–Whitsunday, and the figures for GBR inland are the same as Rockhampton, as indicated in the text p.39.

58 Windle and Rolfe, 2006, *Non-market values for improved NRM outcomes in Queensland.*

While a number of studies have investigated non-market value and benefits, these studies do not allow for a detailed economic analysis of the benefits and costs of enhancing water quality in the GBR catchments. Different approaches for measuring and reporting benefits mean that estimates cannot be aggregated for a single estimate of the benefits of protecting and enhancing waterways and water quality in WQIP regions. In addition, quantitative estimates of change in resource condition attributable to the WQIPs are still lacking. However, there is significant evidence to suggest that the benefits are substantial. Waterways and water quality are significant environmental assets that the community relies on for commercial (use) and non-commercial (non-use) benefits. The studies reviewed indicate the community is willing to invest heavily in the protection and enhancement of waterways and water quality in GBR catchments.

3.2.3 Social and cultural benefits and values

In addition to the use and non-use benefits and values, there are significant social and cultural benefits and values that are not formally valued in monetary terms:

- the GBR is intrinsically associated with the Queensland identity, as indicated by its place as a Queensland icon in 2006;[59]
- cultural values of the GBR include historic sites such as lighthouses and over 30 historic shipwrecks;[60]
- there are significant Aboriginal and Torres Strait Islander social values for the GBR. There are over 70 Aboriginal and Torres Strait Islander Groups along the Queensland coast in the GBR region that have Native Title or other interests in the GBR.[61] These groups have a deep cultural connection with the GBR. For example, research with the Nywaigi Traditional Owners in Far North Queensland showed that there were intrinsic links between the 'connection of Nywaigi people to country and culture, the spiritual health of individuals and the social health of the Nywaigi community';[62] and
- uses of the reef include hunting for traditional foods such as turtles and dugongs. Islands in the GBR contain significant historical and cultural sites including fish traps, middens, rock quarries, story sites and rock art.[63]

3.3 Summary of benefits and costs

Table 3.7 summarises the benefits and costs of the WQIPs identified as part of this study. Some data sources are incomplete and do not allow for a formal benefit–cost analysis of the WQIPs.

59 http://www.nationaltrustqld.org/qldicons.htm . Accessed 29 October 2009.

60 Australian Government, 2006, *Review of the Great Barrier Reef Marine Park Act 1975.* An 'historic shipwreck' is defined as one that has been sunk for 75 years or more.

61 http://www.reefed.edu.au/home/explorer/hot_topics/gbr_traditional_owners . Accessed 29 October 2009.

62 Greiner et al., 2005, *Wellbeing of Nywaigi Traditional Owners — The contribution of country to wellbeing and the role of natural resource management.*

63 Australian Government, 2006, *Review of the Great Barrier Reef Marine Park Act 1975.*

Table 8: Summary of economic and social benefits and costs

Benefits	Estimated values	Distribution and comments
Benefits		
Water for human consumption	Not quantitatively estimated.	Benefits will accrue across GBR catchments broadly in line with population. Availability of sufficient quantity and quality water is vital for human consumption. WQIPs will enhance water quality, potentially reducing health risks associated with poor water quality, and reduce treatment costs by local governments. The financial benefits of quality water for human consumption are not quantitatively estimated, but will largely accrue to the State Government (via lower health expenditure) and the local government sector (via lower water treatment costs).
Avoided or deferred WWTP upgrades	Approximately $77,000–200,000 p.a. per tonne nitrogen removed.	Benefits accrue across WQIP regions. The magnitude and timing of benefits are unknown, but will be driven by individual WWTP augmentation timing and costs. Within systems where pollutant loads, particularly nitrogen and phosphorus, are already at, or near, assimilative thresholds, WWTP augmentation could be avoided or deferred where water quality is improved by WQIPs. Benefits will accrue to the State Government and the local government sector via avoided capital and operating costs and to the community via lower water charges.
Industrial and mining water use	Not quantitatively estimated.	Benefits accrue across WQIP regions. The magnitude of benefits is reliant on the specific water quality requirements of industrial plants — higher for food processing and manufacturing requiring pure water. Water quality for industrial use is likely to become more critical as agriculture, particularly horticulture, moves towards greater levels of product processing. Specific regions of interest include the Burdekin where the State is considering expanding horticulture (Water for Bowen project) and where a horticulture processing strategy is being implemented.
Benefits	Estimated values	Distribution and comments
Agriculture — crops	Approximately $1.22b in 2001	Cropping, particularly sugar cropping, is a significant industry in most WQIP regions. Of the WQIPs considered in this report, the Burdekin and the Fitzroy are the dominant regions for gross value of production. There is significant water use for irrigation across the WQIPs including: Burdekin 730,000 ML p.a.; Mackay Whitsunday 144,000 ML p.a; Fitzroy 255,000 ML p.a; Burnett 285,000 ML p.a; Tully 17,000 ML p.a; Townsville 9,000 ML p.a. (based on ABS water use in agriculture data). Maintaining water quality is vital some crops and direct and indirect benefits will accrue to producers, while cropping is also a major source of diffuse loads.

Benefits	Estimated values	Distribution and comments
Agriculture — pastoral	Approximately $1.16b in 2001	The pastoral sector is significant in some WQIP regions. Of the WQIPs considered in this report, dominant regions in terms of the gross value of production were the Burdekin and the Fitzroy. Water quality is vital to the sector to ensure production is maintained and direct and indirect benefits accrue to producers. However, the pastoral sector is also a significant source of diffuse loads, particularly sediments.
Commercial fishing	Approximately $100m + p.a.	Commercial fishing is spread across WQIPs and is partially reliant on water quality to maintain and enhance stocks. The benefits of enhanced water quality will primarily accrue to owners of the commercial fishing fleet.
Tourism	Approximate contribution to Gross Domestic Product of $4.3–4.5b per annum.	Total economic contribution of tourism to the GBR catchments is estimated at around $4.3–4.5b per annum. Much of this tourism is attributable to GBR visits and water quality can have an impact on the attractiveness and visitation levels to some regions. Key WQIP regions covered in this report that are significant beneficiaries of GBR-based tourism activity are the Whitsunday region and Townsville. Tourism in the GBR is a significant contributor to the local economy, creating in excess of 50,000 jobs. Key beneficiaries of enhanced water quality are tourism operators (directly) and much of the accommodation, retail trade and transport sectors (indirectly).
Benefits	Estimated values	Distribution and comments
Recreation	Approximately $460m p.a. +	Expenditure on recreation such as boating and bushwalking (excluding tourism) has been estimated at approximately $460m p.a. Much of this recreation is partially reliant on the maintenance of water quality. Regional data is not available. However, benefits will partly mirror population distribution across the WQIP regions. However, recreational benefits of the WQIPs will primarily accrue in coastal regions where the bulk of water-based recreation occurs.
Recreational fishing	Approximately $100m p.a. +	Expenditure of recreational fishing across the WQIP regions is approximately $100m p.a. Recreational benefits of fishing is partially reliant on water quality outcomes and are concentrated in coastal areas, particularly areas with a higher population. The benefits of recreational fishing primarily accrue to local residents.
Research	Not quantitatively estimated	Research is undertaken across the GBR catchments. However, much of the research efforts are located within the greater Townsville region and Rockhampton where researchers are physically located. The benefits of research are accrued by society in general.
Visual and aesthetic amenity	Not quantitatively estimated	Water quality can have a positive impact on visual and aesthetic amenity, particularly in areas with water views. These values can translate to higher property values.

Benefits	Estimated values	Distribution and comments
Ecosystem function and services	Potentially $2.3m p.a. benefit to locals per 1% enhancement in GBR coastal water quality	Based on non-market valuations of enhanced water quality, a 1% enhancement in GBR coastal water quality is worth approximately $2.3m p.a in enhanced welfare to residents of the WQIP regions. If relative load reductions outlined in WQIPs (some in excess of 25%) translated to similar percentage increases in water quality, the non-market values associated with ecosystem function could be very significant to residents. These benefits would be distributed across the WQIP regions based on population.
Cultural values	Not quantitatively estimated	Significant cultural values across WQIP regions relating to water flows, water quality, culturally significant sites and connections of Indigenous communities to land and seas.

Source: MJA.

3.4 Costs of WQIP implementation

The costs of enhancing water quality in the WQIP regions are significant. These costs will be borne by a mix of governments, consumers and producers, depending on the source of the pollutant and the policy approach chosen. The potential costs of implementing each of the WQIPs are outlined in their respective sections of this report. A summary of the estimates costs of meeting the targets in the WQIPs for the next five years is outlined in the table below

Table 9: Approximate costs of implementing WQIPs for the period 2009 to 2014 ($ millions)

WQIP region	Rural diffuse		Urban diffuse		Total	
	Low	High	Low	High	Low	High
Fitzroy	18	25	27	40	45	65
Mackay Whitsunday	46	116	4	9	50	125
Burdekin	80	165	n.a.	n.a.	80	165
Townsville	1	1	30	30	31	31
Tully Murray	7	15	n.a.	n.a.	7	15
Burnett Baffle	47	77	15	15	62	92
Total	199	399	75	94	275	493

Source: MJA. Note: This table could not be extended to include the Wet Tropics region.

Key points to note regarding costs are listed below:

- the costs of implementing the plans are relatively uncertain as the net costs of many of the management actions required to implement the WQIPs are highly variable. However, the costs could range from around $275 million, up to nearly $500 million;
- estimated costs exceed funding available through the Reef Rescue Package and incentives available to complement the introduction of regulations to mitigate rural diffuse loads in the Burdekin Dry Tropics, Wet Tropics and Mackay Whitsundays catchments in North Queensland;
- the costs represent proactive investment above regulatory requirements. The estimates do not include costs of practices to meet regulatory requirements, specifically the costs of wastewater treatment plants or implementing water sensitive urban design in greenfield development;
- analysis undertaken for individual WQIPs found significant variation in the cost effectiveness of investments in reducing loads. Generally investments in reducing loads from sugar and grazing are the most cost effective means to reduce rural diffuse loads. In addition, investments in abating rural diffuse loads are generally significantly more cost effective than investments in urban diffuse load abatement (e.g. retrofitting WSUD); and
- the relative cost effectiveness of different load abatement alternatives indicates a need to ensure the design and delivery of WQIPs that specifically target the most cost effective actions first.

4. Policy and program options

Once an informed decision to implement a MAT has been made, economic and social assessment can be used to design the most cost-effective policy, program or project to achieve it. Efficient policy should be designed to overcome any impediments to changing practices that negatively impact on water quality and provide cost-effective outcomes. This section outlines key economic and social impediments to change. Understanding these impediments can set the context for policy development. This section also outlines key policy and program approaches, considers the appropriate intervention points and identifies key gaps in knowledge that may constrain the use of the most effective policy options within WQIPs.

4.1 Impediments to change

There are a number of key economic impediments that can hinder adopting changed practices to reduce risks to water quality. Key impediments include:

- **market failure**: Market failure relating to the 'public good' nature of water quality, where markets fail to incorporate the full social and economic costs or benefits of actions that impact on water quality into prices. This creates distorted market signals on the true benefits and costs of many land-use activities. Often, there are insufficient private benefits for landholders to justify actions that enhance water quality; and
- **financial capacity:** Landholders may not have the financial capacity to fund natural resource management activities. Landholders are unlikely to carry out conservation activities if they do not have sufficient financial resources or if the conservation activities do not contribute sufficiently to farm profitability. Financial constraints to improved natural resource management are consistently self-reported by landholders.[64] For example, in 2003, landholders in the Burdekin Dry Tropics reported that some of the main impediments to implementing improved natural resource management practices include climate variability leading to profit swings, high initial costs for some changes, lack of government incentives and high ongoing costs.[65] Key pressures on Central Queensland natural assets have also been identified as including the capacity to pay for natural resource management and the cost-price squeeze.[66] There is also some evidence to suggest that landholders may require a specific minimum income before they are able to participate in natural resource management activities. For this reason, larger farms may have greater financial capacity to devote to conservation.[67]

Key social impediments to change include:

64 For examples of these publications, please see Stanely, J. et al, 2004, *Understanding social and economic drivers of natural resource management decision-making.*

65 Greiner et al, 2003, *SOCIO-ECONOMIC* report.

66 *CQSS2*, 2004.

67 Black and Reeve, 2002, *Participation in Landare groups: the relative importance of attitudinal and situational factors.*

- **landholder and community attitudes:** Collective and individual attitudes towards reef values and changing practices to reduce risks to reef values can affect the uptake of actions; and
- **social capital:** social capital can impact on a community's ability to implement changes consistent with WQIP objectives.[68] Social capital is made up of 'norms', networks, trust and systems of reciprocity that underlie social interaction and contribute to community cohesiveness and coordinated action.[69] Changes in NRM practices are less likely to occur when individuals or groups feel excluded or unable to change their behaviour without social censure. However, there is not a great deal of evidence supporting or contradicting this theory. A contrary example is that a lack of skills or leadership was not considered an important constraint to improved land management in the Burdekin Dry Tropics.[70]

Other key impediments include:

- **practice attributes**: The attributes of the particular change proposed can influence uptake. For example, considerations include the relative advantage, the associated risk, the complexity, the compatibility, the 'trialability' and the observability of recommended practices;[71] and
- **institutional and legal impediments**: Policies and policy instruments must match both institutional requirements and the intended outcome. For example:
  - regional natural resource management bodies are unable to implement policies or programs of a regulatory nature, such as licences on emissions. Nor can they generally enter into long-term contracts beyond their current external funding time horizon, for example National Heritage Trust 2;
  - new planning controls cannot apply retrospectively to existing developments; and
  - while some policy and regulatory options may prove to be highly cost-effective in addressing water quality, some options may entail significant political costs that outweigh the potential benefits.

4.2 Policies and approaches

There are a number of potential policy approaches and tools available to governments and the broader community to enhance water quality. This section provides a brief overview of the key approaches and tools available including:

- regulatory approaches;
- other government approaches;
- market approaches; and

68 Stanley, J., Clouston, B. and Binney, J., 2005, *Understanding social and economic drivers of natural resource management decision-making.*

69 Stanley, J., Clouston, B. and Binney, J., 2005, *Understanding social and economic drivers of natural resource management decision-making.*

70 Greiner, R., Stoeckl, N., Stokes, C., Herr, A., and Bachmaier, J., 2003, *Natural resource management in the Burdekin Dry Tropics: social and economic issues*, a report for the Burdekin Dry Tropics NRM Board, CSIRO, Townsville.

71 Cary, J., Webb, T., and Barr, N., 2001, The *adoption of sustainable practices: some new insights. An analysis of drivers and constraints for the adoption of sustainable practices derived from research,* Land and Water Australia, Canberra.

- suasive and social approaches.

These approaches are considered within the hypothetical context that a WQIP is already in place.

One of the major challenges for managing water quality is decision making with imperfect information. This creates difficulties for policy makers to determine the most appropriate mix of policies and tools to enhance water quality. No particular policy approach is best across all circumstances and generalisations can be difficult to apply.

While improved information will enhance the choice and design of policies and programs, improving information is not a costless exercise. The benefits of improved information must be weighed up against the costs of accessing that information.

4.2.1 Regulatory approaches

Any level of government that applies regulatory approaches to water quality must use ‘command and control’ techniques to regulate actions that are inconsistent with public interests. Regulatory approaches include prohibitions, limits, standards, and permits to undertake certain activities that impact water quality.

Regulation is typically applied consistently across a jurisdiction, or a particular management region.

Regulatory approaches are often considered most appropriate where there are environmental thresholds beyond which environmental damage is catastrophic or irreversible. In the absence of perfect information, regulation can provide a means of applying the ‘precautionary principle’ to remove the risk of reaching these threshold points. Common identified advantages of regulatory approaches include:

- simple and universal application, such as prohibiting activities that create a risk to water quality in certain geographical areas;
- low administrative costs of implementation, with broad and immediate effect on the targeted action; and
- providing some certainty to affected parties by providing clear information on legal requirements and specifying property rights and obligations.

Despite the potential advantages of regulation as a policy tool, a number of disadvantages of regulatory approaches have been identified including:

- regulation often involves high opportunity costs, usually development opportunities foregone, together with a lack of flexibility in application and the potential for higher cost solutions. Regulation may not allow for opportunity costs to be minimised. By providing a ‘one size fits all’ approach, regulation often does not provide incentives to find lower cost solutions or to go beyond the compliance standards set by regulators;
- there is a high cost to governments of ongoing monitoring and enforcement to ensure compliance with regulations. Monitoring is often insufficient and enforcement of regulations is limited;
- potential for perverse outcomes from regulations, for example a prohibition on land clearing from a certain date could result in substantial clearing prior to the date of the regulation, triggering greater levels of erosion than would otherwise have occurred; and

- regulatory approaches often do not have clearly specified objectives and lack good regulatory practice, particularly transparency, accountability and better targeting of ecosystem service provision.

Most jurisdictions now apply a test of regulatory 'best practice' to ensure that regulation is both necessary and appropriate, and that alternatives to regulation have been considered.

Regulatory approaches are often a prerequisite for alternative approaches (e.g. market creation for ecosystem services where volume-based market mechanisms are to be used) as regulations establish the underlying property rights and minimum obligations with respect to natural resource management and use. [72]

4.2.2 Other government approaches

Other government approaches such as providing information, unregulated duty of care, voluntary 'best practice' codes, and removing impediments to conservation tend to provide less certain outcomes than regulated approaches. However, they are often used in conjunction with regulation or in some cases such as cotton, industry self-regulation.

Approaches such as taxes and subsidies can provide incentives for continuous enhancement of water quality. However, there are substantial theoretical and practical problems associated with establishing an efficient level of taxation or subsidy, particularly given the significant variation in environmental values and financial circumstances of landholders impacted by these policy tools. In weighing-up these approaches, governments are also able to implement the full range of market approaches, which are outlined in the following sections.

4.2.3 Market approaches

Given the possible lack of effectiveness and efficiency of regulatory approaches to achieving natural resource management objectives, there has been a significant focus in recent years on market approaches, including changes in land management practices that reduce risk to water quality outcomes. [73]

Market approaches harness the ability for polluters (e.g. landholders, developers, wastewater treatment facilities) to achieve gains from trade by participating in markets that enhance the provision of ecosystem services and enhance water quality outcomes. To make gains from trade through market approaches, it is vital to have variation in at least one of the following:

- the biophysical characteristics of the areas to be managed;
- management actions; or
- landholder or enterprise characteristics, particularly financial private benefits and costs of actions that deliver ecosystem services.

Market approaches typically fall under three broad categories:

- **price-based approaches** that set or modify prices to reflect the cost of providing or enhancing ecosystem services. The most common form of these approaches is auctions or

[72] Whitten, S., Coggan, A., Reeson, A., and Gorddard, R., 2007, *Putting theory into practice: market failure and market based instruments (MBIs)*. Working Paper 2 in the Socio-Economics and the Environment in Discussion CSIRO Working Paper Series Number 2007-02. May 2007.

[73] Grafton, Q., 2005, *Evaluation of Round One of the National Market Based Instrument Pilot Program*.

tenders to purchase ecosystem services above minimum regulated requirements on private land;[74]

- **quantity-based approaches** that set binding targets to achieve ecosystem services. The most common approaches are cap and trade mechanisms, for example water trading and tradable pollution licences;[75] and
- **market friction approaches** that remove impediments to the provision of ecosystem services.

Market approaches offer an alternative to regulatory approaches and some approaches, particularly price and market friction approaches, can be implemented by a broader range of organisations including non-statutory regional natural resource management bodies and other non-government organisations.

Market approaches generally work best in situations where the costs and benefits of targeted management actions differ substantially between different landowners or enterprises. Identified advantages of market approaches include:

- discovery of the supply curve, or price discovery, for ecosystem services is a result that would not otherwise be observable to 'purchasers' of environmental services;
- flexibility in applying market approaches can result in lower cost outcomes when compared to regulatory approaches. This is perhaps the key advantage of market approaches. Many market approaches are specifically designed to provide the most cost-effective outcomes — that is the greatest change at the lowest cost;
- they create positive, and often continuous, incentives to enhance water quality outcomes that can drive innovation;
- market approaches can reveal the realistic split between private and public benefits from actions to enhance water quality;
- voluntary participation of these approaches can result in lower monitoring and enforcement costs;
- fairness and equity results as all participants gain from trade and transacted prices are determined by market participants;
- the use of commercial contracts (and sometimes covenants) can sometimes result in greater certainty than regulatory or suasive approaches; and
- most market mechanisms do not require explicit monetary valuation of ecosystem services to function. The need to use expensive and often controversial non-market valuation techniques can be avoided. By using well-designed metrics, benefits can be measured in biophysical terms. Well-designed metrics can simultaneously incorporate site characteristics and values, the impacts of management actions, risks and financial considerations simultaneously.

Identified disadvantages include:

- market approaches are not suitable for all circumstances. For example, where there is very little variability between potential market participants, there will be limited gains from trade;

---

74 Stoneham, G., Chaudhri, V., Ha, A., and Strappazzon, L., 2003, 'Auctions for conservation contracts: an empirical examination of Victoria's BushTender trial', *Australian Journal of Agricultural Economics* 47(4).

75 Murtough, G., Aretino, B., and Matysek, A., 2002, *Creating Markets for Ecosystem Services.*

- while market approaches such as tenders reveal the split of public and private benefits from management actions, the use of the mechanisms is criticised in some circles due to the need for budget or program funding. While market approaches may be more economically efficient than regulations, they can be more costly to government as governments may be required to pay for the public benefits directly as opposed to imposing the cost on private landholders under typical regulatory approaches. This has happened in most tender mechanisms to date;
- information and transaction costs for market mechanisms can be relatively high compared to some other policy approaches. These costs must be weighed up against any efficiency gains from using market approaches. Advances in information technology are helping to reduce these costs in many instances; and
- inadequate data and knowledge base to provide confidence in expected water quality outcomes can erode agency confidence in the environmental benefits that market approaches can deliver.

Market approaches provide an important and often complementary tool to regulation for achieving water quality objectives. However, market approaches require significant consideration before they are implemented to ensure their appropriateness to the environmental problem. In addition, significant care must be taken in their design to ensure they will lead to enhanced ecosystem services.

4.2.4 Suasive and social approaches

Poor environmental outcomes can sometimes occur through a lack of awareness, minimal information or through negative perceptions. As a result, suasive and social approaches aim to change perceptions and affect decision-making through providing information, training and education services, and other strategies to enhance social capital.

There has been a particular focus on suasive approaches to land management by fostering a conservation ethic for private landowners in Australia, involving, for example, awards for achievement and education campaigns.

Measurement of the impact of suasive and social approaches is very difficult as the approaches are typically used in conjunction with other approaches and attribution of benefits to particular approaches is difficult. In the long term, changing landowners from ‘users’ of the land to ‘stewards’ with a duty of care could have a large impact on environmental outcomes, especially in combination with other approaches.

A key outcome from the use of suasive and social approaches is the level of volunteerism by citizens to enhance water quality outcomes from organizations such as CoastCare and LandCare programs. Volunteers are central to many environmental programs in Australia and internationally and policies and programs that harness volunteerism can be highly effective.

The drivers of volunteerism are complex and not particularly well understood. However, social capital, individuals’ personal attributes, circumstances and social pressure all play a part. Measham and Barnett (2007) identify five modes of environmental volunteerism: activism, education, monitoring, restoration and sustainable living. In addition, they identify key motivations including: helping a cause, social interaction, improving skills, learning about the environment, a desire to care for the environment or a particular place.[76] Identified advantages of suasive and social approaches, including volunteerism, are:

- these approaches can be relatively cheap to run as time and resources are often donated; and
- the approaches can lead to significant changes in attitudes and practices for land and water management, particularly over the longer term.

Despite the obvious advantages, social and suasive approaches do have some disadvantages including:

- outcomes from social and suasive approaches can be highly uncertain and difficult to verify, or there may be significant time lags before benefits in the form of changed attitudes and practice are realised;
- many environmental works and services are of limited durability and resilience;
- some programs may result in misdirected or ineffective actions, for example a desire to volunteer to protect some iconic species or locations, despite the fact they may be less important from a broader conservation or ecosystem services perspective; and
- volunteers can often suffer from burnout, risking the continuity of programs.

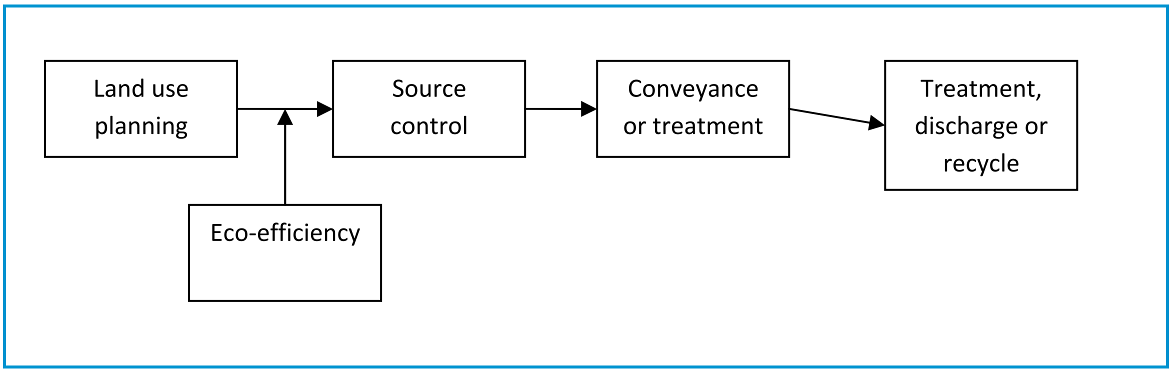
Social and suasive approaches form an important component of any policy and program approach and can have an important impact on the acceptance, uptake and compliance with other government, regulatory and market approaches.

4.3 Efficient intervention points

In determining a cost-effective suite of policies and programs, it is also strategically important to consider the most effective intervention points to reduce risks to water quality. The pollutant treatment train framework (PTTF) provides a useful start in identifying differing intervention points that could be addressed by different management actions. Key elements of the PTTF are outlined in Figure 7.

[76] Measham, T.G., and Barnett, G.B., 2007, *Environmental volunteering: motivations, modes and outcomes. Socio-Economics and the Environment in Discussion (SEED).* CSIRO Working Paper Series Number 2007-03. May 2007.

Figure 7: Pollutant treatment train framework



Source: Source: MJA adapted from NCSU (2000). National Management Measures to Control Non-point Source Pollution from Agriculture DRAFT. North Carolina State University, Raleigh, NC.

There are a number of points to note within the PTTF:

- land use planning enables consideration of the capabilities of land systems and the risks to water quality associated with different land uses. Land use planning can operate at a series of scales. At the State or regional scale, for example minimum State-wide performance standards for new development, directing relatively more risky land uses into areas that pose a lower risk to water quality. At a catchment or local scale, for example land use planning in a statutory local government planning scheme to reduce risks associated with urban development. At a property scale, for example a farm plan that provides riparian buffer zones;
- eco-efficiencies enable the reduction of inputs to production processes that create risks to water quality, for example excessive fertiliser use. Many eco-efficiencies can also deliver some economic efficiencies'
- source control measures retain pollutants at the point of application;
- conveyance and transmission processes trap pollutants on site. Best management practices, such as closed system aquaculture practices, provide a good example of this approach; and
- treatment and discharge measures trap or assimilate pollutants before discharge into waterways. Recycling wastewater to land can significantly reduce volumes discharged.

Economic and social assessment can assist in determining where along the PTTF the most effective interventions can be, taking into account a policy or program’s certainty in delivering change. For example, discharge from an aquaculture enterprise, such as a prawn farm, can have a major impact on water quality in receiving environments. The potential financial benefits of two alternative aquaculture developments may be identical, but the costs to the environment of each option may differ significantly depending on the assimilative thresholds of their receiving waterways. Well-designed land use planning can result in a very cost effective policy tool for ensuring the aquaculture development only occurs in the lower cost area.

Where possible, policy options to implement each broad suite of MATs will be discussed in the regional chapters.

4.4 Recommended policy approaches

Sections 4.1 to 4.3 provided an overview of the policy issues, policy approaches and intervention points. In developing each of the specific regional WQIP chapters, MJA has considered the most appropriate set of policy arrangements for addressing water quality in the GBR catchments, given current institutional arrangements. There are significant similarities in the policy approaches proposed across most of the individual WQIPs. The table below outlines the recommended policy and program approaches to address the key pollutants relevant to the WQIPs.

Table 10: Recommended policy approaches

Pollutant source and policy tools	Comments
Rural diffuse	
Suasive	Suasive approaches by industry and regional natural resource management boards to raise awareness of water quality issues, emphasising the win-win opportunities within a commercial agricultural framework. Note: The efficacy and certainty of suasive approaches are uncertain.
MBIs	Need to implement MBIs that are specifically designed to overcome economic or financial impediments to changing practices, including transitional funding requirements and funding capital equipment. MBIs could be targeted at contractors where appropriate. Variability in private costs of reducing loads and variability of reductions in loads entering GBR suggest the use of competitive tenders to allocate all or part of incentive funds available from Reef Rescue and other funding sources. Given the fact management actions are likely to be similar within sectors, for example within the grazing sector, it may be more appropriate to develop common assessment frameworks or metrics for each sector and adjust to better match regional characteristics if necessary. Given the scale of potential investment under Reef Rescue, institutional delivery arrangements that enable administrative efficiencies would be prudent, for example a single organisation to manage ongoing contracts, payments and monitoring. Some WQIPs have identified capital equipment funding (e.g. hooded sprayers) that enhance longer term profitability. In such cases structural adjustment loans should also be considered in conjunction with competitive tenders. Where actions are identified to have sufficient private benefits, but land attitudes towards risk or a lack of capital availability are the key impediments to change, consideration of tools such as 'insurance-like' products to underpin risks or loads to overcome capital availability should be considered.

Pollutant source and policy tools	Comments
Urban diffuse	
Suasive	Establish and promote best practices for the building sector based on regulatory requirements. Implement information programs for households to reduce risks. Note: The efficacy and certainty of suasive approaches are uncertain.
Performance-based regulation	Establish performance-based regulatory requirements, such as water sensitive urban design, for new developments specifically developed to reduce risks of urban diffuse loads. Regulatory requirements should be commensurate to the risk associated with development, considering location, scale, soil types, and slope.
Market-based	Market-based approaches could also be used in conjunction with well designed performance based regulation. For example, the potential for offsets to offset residual increases in urban loads that cannot be managed via WSUD.
Point source (industrial and mining)	
Suasive	State and local governments to continue to provide appropriate information on risks attributable to point-source loads. Note: The efficacy and certainty of suasive approaches are uncertain.
Regulation	State to continue to enhance regulatory approaches and invest in WWTPs. State to implement recent changes to regulation of environmentally relevant activities, including charges.
MBIs	Where there are multiple WWTPs within the same discharge zone, consider the use of a 'bubble licence' to enable the most cost-effective upgrades and to reduce the financial burden on the government and households.

Source: MJA.

4.5 Other policy issues

In addition to considering the suite of policy approaches and their associated tools, there are a number of other issues that require consideration when developing water quality policies and programs:

- there is a need for quality information and data to understand water quality issues (risks; appropriate management actions; impediments to change; and heterogeneity in environmental, social and financial characteristics of areas) and to develop effective and efficient policies and programs. Information needs include new and emerging threats and associated risks;
- there is a need to understand public versus private benefits when developing policies and programs;
- there is a need to realise that benefits and costs of actions that enhance water quality outcomes are not uniform and analysis of the marginal benefits and costs and, where possible, the consideration of thresholds is vital to robust policy and program design.

- there is a need to consider the synergies and complementarities of different policy and program approaches. There are no ‘silver bullets’ and a single policy approach is rarely likely to be optimal;
- there is a need to consider whether policies and programs should target single or multiple water quality and other environmental policy objectives;
- there is a need to be aware of prevailing institutional arrangements and the most appropriate entity (e.g. State or regional natural resource management body) and scale to implement policies and programs;
- administration and transaction costs associated with different policy and program approaches must be taken into account; and
- monitoring and evaluation requirements must be considered, as should the need to use an adaptive management framework for policy and program design and delivery.

4.6 Information and knowledge gaps

The project has identified several gaps in information in the areas of environmental, social and economic knowledge. This lack of information can reduce the likelihood of optimal policies and programs to address water quality issues being adopted. However, the development of better information is not a costless exercise and the benefits of enhanced information enhancing decision making must be weighed against the cost of information development.

Key gaps in physical science information include:

- good policy design requires and understanding of the biophysical aspects of water quality. While the environmental benefits and costs of managing for water quality outcomes are generally understood and the general direction of impacts are known, the quantification of the relationships (magnitude and variation) between the managed areas, management practices and the provision of ecosystem services is not well understood. This lack of knowledge significantly constrains the ability to assess the likely outcomes of WQIPs; and
- the focus of much of our scientific research is at the catchment scale, yet the effect of policies and markets, and management decisions occur at the farm and enterprise scale. Therefore, a greater understanding of the impacts of management actions at the property and enterprise scale is required to better inform policy and program development.

Key gaps in social information and knowledge include:

- the social impediments to enhancing practices are not well enough understood at a landholder level to design efficient policies and programs. Often, our understandings of social aspects of land management are based on broad generalisations that can lead to misinformed policy and program development. These information gaps are potentially most acute in peri-urban areas. However, there are examples of research that is designed to overcome some of these gaps;[77]
- the effectiveness (uptake and lags to behavioural change) attributable to social and suasive policies and programs is still largely unknown; and

[77] For example, the Bureau of Rural Science (Social Science Group) have undertaken a number of comprehensive landholder surveys for regional natural resource management bodies that provide an enhanced understanding of the drivers, impediments and variance of natural resource management practices.

- little is known about the supporting nature that social policies and programs play in enhancing the effectiveness of regulatory and market approaches.[78]

Key gaps in economic information and knowledge include:

- the split of public and private benefits of many proposed management actions;
- the relationships between changes in water quality and the economic value of industries in receiving waters, particularly tourism;
- sufficient understanding of the variability of benefits and costs of management practices to underpin policy choice and development;
- the need for metrics used to estimate benefits of management actions and to facilitate market approaches; and
- the understanding of the values of ecosystem services is generally poor and targeted studies that value ecosystem services would be prudent to show the ‘public good’ value of ecosystem services that are provided by improving water quality.

In all three areas, considerable uncertainty exists about the future. Therefore, it can be beneficial to consider the major drivers and trends that may bring new and emerging threats to water quality, and to develop future scenarios accordingly. This information will enable planning that can better accommodate future contingencies.

[78] For example, a recent LWA funded study undertaken by Charles Stuart University investigated the social impediments to the uptake of market-based instruments.

Part B: Regional chapters

5. Burnett Baffle

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- The Burnett Baffle region's population is expanding at a slightly faster rate than the GBR catchment population as a whole. With the exception of some areas where population growth is driven by mining, the bulk of the future population growth is likely to occur in the coastal zone.
- Social conditions in the Burnett Baffle region are notably lower than the GBR as a whole. This poses a challenge to the adoption of management changes to improve environmental values. Relatively speaking, social conditions are less favourable in the Burnett Baffle than for the State as a whole.
- The high reliance on agriculture, particularly beef and sugar production, as a source of employment and income within the Burnett Baffle and the associated water quality risks from production are not likely to decline without policy intervention.
- There are significant economic and social constraints to changing agricultural practices and these have implications for policy and program design and implementation.

Scenarios assessed

Two scenarios were assessed: a do nothing more scenario; and a scenario of actions to accelerate uptake of better soil, better soil, nutrient and pesticide management practices across a number of rural (cane, horticulture and grazing) and urban (land development) industries. The potential for WWTP upgrades is also considered.

Impacts

Impacts of the do nothing more scenario are likely to be a further decline in water quality and increasing risks to the GBR; negative impacts on sectors reliant on water quality, particularly GBR tourism drawcards such as boating, diving and snorkelling; negative impacts on recreation, particularly recreational fishing; and a general loss in ecosystem function.

Impacts of the second scenario include:

- a reduction in suspended sediments (4% by 2013, and 40% by 2058), principally from grazing activities;
- reductions in dissolved inorganic nitrogen loads by 8% by 2013, and 80% by 2058, principally from sugarcane and horticultural areas;
- reductions in the concentration of residual pesticides (diuron, atrazine and hexazinone) in waterways by 5% to 2013, and pesticides of concern by 25% to 2058;
- reductions in urban diffuse and point source loads by 5% to 2013 and 25% to 2058; and
- significant benefits in terms of risk mitigation to the growing tourism industry.

Implementation issues

The implementation costs for the WQIP were estimated by the Burnett Mary Regional Group at around $47m. MJA found most costs to meet RCT and MAT targets set by the WQIP for 2013 were reasonable, with the following exceptions:

- reducing sediment loads: using the costs of sediment reduction from the Mackay WQIP, the costs of meeting a 4% reduction in the total suspended solids load through changing grazing practices could be as high as $48m, compared to the $18m stated in the WQIP; and
- urban load reduction: if the urban RCTs (5% reduction in key pollutants by 2013) are to be met primarily though retrofitting a WSUD stormwater management program, the cost would be approximately $15m.

A key issue affecting implementation is the lack of high quality data on diffuse source pollutants from major land uses, as well as a lack of detailed financial and economic data on individual properties from grazing, sugar cane and horticultural activities.

The cost-effectiveness of rural diffuse source programs could potentially be enhanced by two main initiatives:

- careful design of incentives to ensure the most cost-effective use of public funds. This includes: using competitive tenders to select the most cost-effective proposals from landholders; potential use of structural adjustment loans to meet some up-front capital costs that result in sufficiently increased gross margins in subsequent years to cover repayments; and careful consideration of who is eligible for incentives provided, for example should landholders or contractors be targeted for some incentives; and
- primarily concentrating actions on the grazing and sugar industries.

In addition, given the relatively high costs of abating urban diffuse loads, strategies such as WSUD retrofitting programs can be questionable, particularly where resources could be used more effectively by investing in rural best management practices.

5.1 Introduction

The Burnett Baffle region includes the Baffle, Kolan, Elliott and Burnett catchments, covering freshwater systems as well as the associated estuaries and receiving waters adjacent to the southern GBR and the northern Great Sandy Marine Park. The area includes the Regional Councils of Bundaberg, North Burnett, South Burnett and Cherbourg Aboriginal Council and parts of Gladstone, Gympie and Dalby Regional Councils. The resident population of the area was 128,385 in 2005, of which more than half were located in the Bundaberg Regional Council.[79]

Much of the land use in the region is dedicated to grazing, with irrigated cropping, dominated by sugarcane, concentrated in the Bundaberg irrigation area. Horticulture is largely restricted to irrigated orchards in the Gayndah and Mundubbera areas, and to vegetable and tree crops within the Bundaberg irrigation area.

Mining of black coal, gold, kaolin and limestone occupies a very small land area in the region, but makes a strong contribution to the economy. Eco-based tourism has grown strongly in recent decades, especially the backpacker market, focused on Bundaberg and Gayndah. Ten per cent of land use in the Burnett Baffle region is dedicated to conservation.

5.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the Burnett Baffle WQIP.

5.2.1 Demographic makeup

Population

The estimated resident population of the Burnett Baffle region was 128,385 in 2005 of which more than half were located in the Bundaberg Regional Council.[80] Figure 8 shows the historic and forecast population growth for the Burnett Baffle WQIP region compared to all of the WQIP regions assessed in this report.[81] It indicates that:

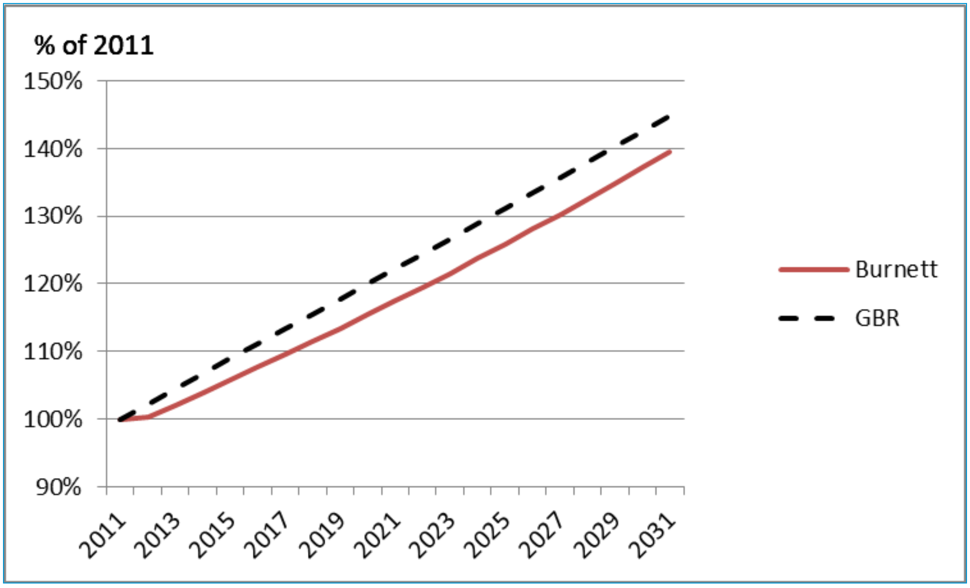
- significant population growth is expected in both the Burnett Baffle and across the WQIP regions over the next 20 years; and
- the Burnett Baffle's rate of population growth is likely to be slightly higher than for the GBR as a whole.

79 Planning Information and Forecasting Unit, Queensland Government, 2006.

80 Planning Information and Forecasting Unit, Queensland Government, 2006.

81 Based on DLGPSR Population Forecasting Unit's mid estimates for each relevant LGA concorded to WQIP boundaries.

Figure 8: Population growth projections Burnett Baffle and all GBR WQIP regions



Source: MJA based on DLGPSR and ABS 2011 Census.

Analysis of the population growth forecasts for smaller regions within the Burnett Baffle show that population growth is likely to concentrate in coastal areas, with Bundaberg growing steadily and Burnett doubling in population over the next 20 years. Miriam Vale is expected to more than double in this time, due primarily to mining activity. Other population and demographic statistics of note include:

- unlike much of the GBR, the population of the Burnett Baffle WQIP region is slightly skewed to females (50.3% of the population);
- 4.7% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Burnett Baffle WQIP region compared to around 3.6% for the whole of Queensland; and
- approximately 11% of people in the WQIP region were not born in Australia and around 2% of the population do not speak English at home.[82] To the extent that these people are targeted for programs under the WQIPs, there may be difficulties in effective engagement.

Community capacity

A community's capacity to participate in natural resource management is often indicated by a number of issues, briefly outlined:

- approximately 20% of adults (>15 years old) participate in voluntary work, potentially indicating reasonable levels of social capital. Females had higher levels of participation in volunteer work at 23%, compared to males (at 18%). However, the ABS census data does not indicate what type of volunteer work (e.g. environmental management) was undertaken;
- the relative financial impact of projects or policies that impact on costs must be considered, as the burden may be relatively greater for lower-income families. The Burnett Baffle has a significantly higher incidence of low-income families than the State

82 Based on analysis of 2006 ABS census data.

as a whole. Approximately 31% of families in the Burnett Baffle WQIP area were on low incomes in 2011 (i.e. < $600/week) compared to 3.2% for the State. However, reported household incomes are often lower in regions with higher proportions of agricultural enterprises. This is likely to be the case in the Burnett Baffle, albeit offset by higher incomes in the mining sector; and

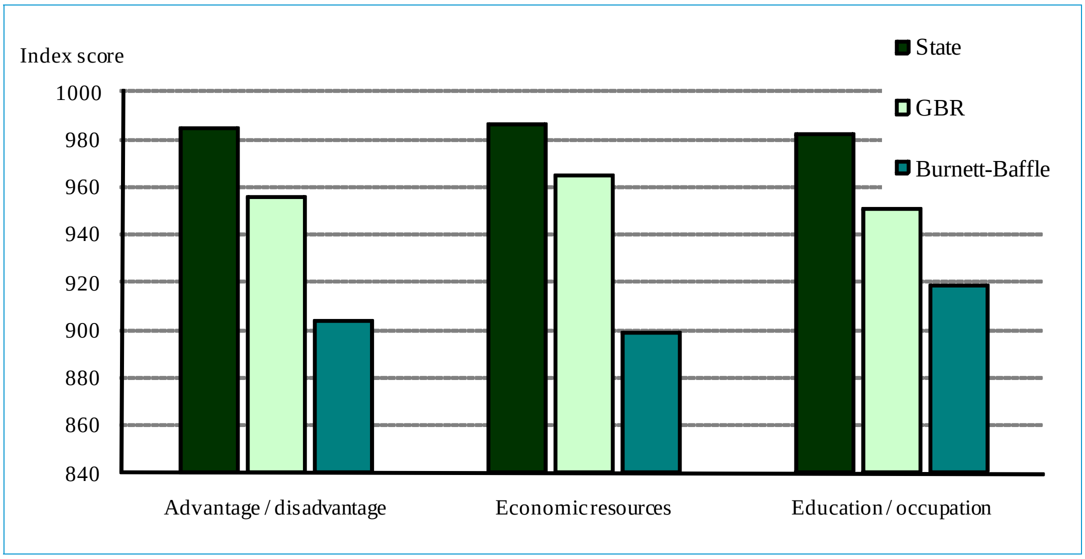
- household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In the Burnett Baffle, approximately 67% of homes are owned or are being purchased. This compares to a State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad means to make relative comparisons of social and economic resources between regions. The three indices of most relevance are: [83]

- the Index of Advantage–Disadvantage is a continuum of values on which low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation includes all education and occupation variables only.

These indices were concorded to the WQIP regions to enable comparisons of each WQIP region to all of the regions assessed in this report and Queensland as a whole.[84] Results are shown in Figure 9.

Figure 9: SEIFA indices



Source: MJA based on ABS 2001 census SEIFA indices.

[83] ABS, 2001, 2039.0, *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas*, Australia, 2001.

[84] MJA estimated concorded index scores for each WQIP region using concorded population figures to derive each LGA's SEIFA score to the overall WQIP SEIFA score.

Analysis of the data indicates:

- relative to the rest of the GBR, the Burnett Baffle is at a relatively significant disadvantage, which is even more pronounced compared to the state as a whole;
- economic resources in the Burnett Baffle are significantly below the rest of the GBR and the State as a whole; and
- education and occupation data also shows that the Burnett Baffle is significantly worse off than the State as a whole and worse off than the GBR as a whole, which may indicate lower resilience to change.

This broadly implies that the Burnett Baffle region's lower social and economic wellbeing may make it more difficult to implement the WQIP here than in other regions, especially where changes come at a financial cost to landowners. This is particularly due to the low levels of diversity in industry and occupations compared to other WQIP regions. A relatively low level of diversification of occupations indicates a potentially lower capacity of the community to adapt to change. Measures to address this constraint may be necessary.

Education levels in the Burnett Baffle are broadly on par with the rest of the GBR catchments, but are lower than the State as a whole as shown in Table 11.

Table 11: Educational attainment

Highest education level completed	Burnett Baffle (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	24.8	21.3	19.8
Year 12	24.0	30.1	37.2
Certificate or diploma	21.1	22.2	21.9
Undergraduate degree	5.2	6.6	9.3
Postgraduate degree	0.7	1.1	2.2

Source: ABS Census of Population and Housing.

5.2.2 Employment and labour force

Labour force statistics shown in Table 12 shows the dominance of primary industries in the Burnett Baffle, compared with both the GBR as a whole and Queensland.

The significant employment in primary industries is more than double the GBR average, and four times the state average. Compared to the broader GBR, there is less of the population engaged in mining, and the lack of a major administrative centre means the Burnett Baffle population is less engaged in public administration.

Manufacturing is slightly more important than for the rest of the GBR, and retail trade is higher than both the GBR and State averages. Despite being a significant contributor to the regional economy, mining is a comparatively small employer in the Burnett Baffle region. Health care and social assistance are higher than the GBR and the State average, perhaps reflecting relatively high social disadvantage in the Burnett Baffle region.

Table 12: Labour force statistics

	Number			Percentage		
	Burnett-Baffle	GBR	Qld	Burnett-Baffle	GBR	Qld
Agriculture, forestry and fishing	5,829	23,546	54,563	12	5	3
Mining	1,453	27,793	51,656	3	6	3
Manufacturing	4,153	34,978	169,025	8	8	8
Electricity, gas, water and waste services	873	6,962	24,764	2	2	1
Construction	3,895	40,558	179,947	8	9	9
Wholesale trade	1,383	13,561	73,377	3	3	4
Retail trade	6,020	46,833	214,617	12	11	11
Accommodation and food services	3,146	32,649	140,036	6	7	7
Transport, postal and warehousing	1,950	24,591	104,924	4	6	5
Information media and telecommunications	374	3,588	25,282	1	1	1
Financial and insurance services	732	6,317	53,833	1	1	3
Rental, hiring and real estate services	657	7,086	36,875	1	2	2
Professional, scientific and technical services	1,461	18,497	131,921	3	4	7
Administrative and support services	1,395	12,383	64,185	3	3	3
Public administration and safety	2,679	30,251	135,586	5	7	7
Education and training	4,095	33,080	160,241	8	7	8
Health care and social assistance	6,814	47,500	240,017	14	11	12
Arts and recreation services	321	4,210	28,418	1	1	1
Other services	1,836	17,688	78,157	4	4	4
Not Stated	1,283	10,814	22,913	3	2	1
Total	**50,349**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS 2011 Census of Population and Housing.

5.2.3 Economic structure

Detailed data specifically on the economy in the Burnett Baffle WQIP region is limited. However, Queensland Treasury estimates of the value of gross regional product for the Wide Bay Burnett Statistical Division (SD) for 2005–06 were $7.8b, or about 4.2% of the total Queensland economy.

Between 2000–01 and 2005–06, the average annual economic growth rate for the Wide Bay Burnett SD was 3.6%, compared to 4.8% for Queensland as a whole. Economic growth in Wide Bay Burnett is relatively faster than in the Fitzroy and Northern Queensland SDs (averaging 3.2% and 2.6% respectively), but slower than Mackay (averaging 5.5%).

Queensland Treasury also estimated the gross value-added by industry for the Wide Bay Burnett SD, which provides an indication of the economic structure and sources of economic growth in recent years. This is shown in Table 13.

Key points to note include:

- while agriculture, forestry and fishing are important industries, accounting for about 9.7% of gross value-added in the region, the relative importance of these industries to the region is declining and these industries have not made a material contribution to regional economic growth in recent years;

- manufacturing, including sugar manufacturing, is declining in relative importance as other sectors grow at a faster rate. But it is still an important sector for regional economic growth; and
- sectors typically associated with tourism, such as retail trade, accommodation, cafes, and restaurants are growing at the same rates as the regional economy as a whole, suggesting that tourism is not a major driver of accelerated regional growth.

Table 13: Key economic structure statistics

Sector	Proportion of Gross Value Added 2000–01 (%)	Proportion of Gross Value Added 2005–06 (%)	Proportional contribution to growth 2000–01 to 2005–06 (%)
Agriculture, forestry and fishing	11.6	9.7	0
Mining	2.4	3.0	5
Manufacturing	10.9	10.4	10
Electricity, gas and water	5.5	4.1	-5
Construction	6.3	8.4	13
Wholesale trade	4.4	3.8	3
Retail trade	9.2	9.2	10
Accommodation, cafes and restaurants	3.5	3.5	5
Transport and storage	4.6	4.5	3
Communication services	2.6	2.2	3
Finance and insurance	3.0	3.4	5
Property and business services	6.0	6.4	10
Government admin and defence	3.7	3.9	3
Education	6.3	6.1	3
Health and community services	7.4	7.9	8
Cultural and recreational services	0.8	0.7	0
Personal and other services	2.0	2.2	3
Ownership of dwellings	9.9	10.6	13
Gross value added	100.0	100.0	100

Source: OESR, 2008, Experimental Estimates of Gross Regional Product.

Agriculture in the region has changed significantly in recent years, with declines in the contribution of traditional industries such as sugar and dairy, with much of the expansion being concentrated in horticulture and beef. Horticultural development is a major focus for future growth. For example, the potential expansion of production assessed for the Baffle Creek Water Resource Plan forecast the value of production in that catchment alone increase sixfold. This scale of development would not occur without water quality implications.[85] In addition, at least

[85] MJA, 2008, *The economic and social implications of the Baffle Basin Water Resource Plan.*

some of the growth in manufacturing has been for food processing and manufacturing, particularly value-adding to horticultural production.[86]

5.3 Proposed changes in practice under the WQIP

The draft Burnett Baffle WQIP[87] outlines a number of proposed changes in practice designed to address pollutants across the spectrum of land use activities. MJA has assessed the impacts of the changes in practice outlined in the WQIP against a 'do nothing more' base case. Current modelled pollutant loads for main land uses in the Burnett Baffle region are shown in Table 14. Grazing dominates land use and pollutant loads, including suspended solids, phosphorus and nitrogen loads.

Table 14: Current modelled pollutant loads in the Burnett Baffle region

	Forest	Grazing	Sugar	Other crops	Other	Total
Area (ha)	695,770	3,241,851	47,821	80,537	42,790	4,108,769
Total Suspended Solids (kt/yr)	93	719	28	9	8	856
Dissolved Inorganic Nitrogen (t/yr)	123	609	43	12	20	808
Dissolved Organic Nitrogen (t/yr)	135	693	19	12	9	869
Total Phosphorus (t/yr)	251	1,699	30	40	14	2,034
Total Nitrogen (t/yr)	1,124	6,875	146	150	73	8,368
Dissolved Organic Phosphorus (t/yr)	7	35	2	1	0	45
Filterable Reactive Phosphate (t/yr)	21	134	3	2	1	161
Particulate Phosphorus (t/yr)	222	1,531	26	37	13	1,828
Particulate Nitrogen (t/yr)	867	5,573	84	124	43	6,691

Source: MJA based on Burnett Baffle WQIP.

5.3.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the WQIP to address rural diffuse sediment and nutrient loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point source loads.

5.3.2 Scenario Two: A suite of practice changes

Water quality issues for the Burnett Baffle region were explored under the WQIP, and separated into land management zones. Inland catchments, inland alluvial and coastal plain areas have different water quality issues associated with geology, hydrology and land management use:

- inland catchments are dominated by grazing with some rain-fed cropping, with erosion exacerbated by vegetation clearing;

86 DIP, 2007, *Wide Bay Burnett Regional Plan 2007–2026*.

87 Burnett Mary Regional Group, *Burnett Baffle Draft Water Quality Improvement Plan*.

- inland alluvium areas have grazing in the upland areas where stream bank and gully erosion contribute sediment to waterways, and irrigated cropping on alluvial flats adds soluble nutrients to waterways and groundwater; and
- coastal plains are predominantly used for irrigated cropping and intensive horticulture, which can increase sediment and nutrient loads to waterways, while expanding urban areas on the coastal fringe result in stormwater runoff and contribute to acid sulphate soil risks.

While monitoring of water quality has been undertaken in the region, it has not identified pollutant entry points following rainfall events:

> *These studies and current monitoring programs are not sufficient to clearly determine the condition of freshwaters in the Burnett Baffle WQIP and can only conclude that water quality is variable throughout the catchments.*[88]

The relationship between land uses and priority pollutants has been established for the Burnett Baffle region, and can be is summarised as follows:

- grazing activities are associated with high regional and localised impacts involving sediment and particulate nutrients;
- coastal sugarcane and horticulture is associated with high regional and localised impacts involving dissolved nutrients and pesticides;
- alluvial cropping has localised impacts involving dissolved nutrients and pesticides;
- inland cropping has minor local impacts involving dissolved nutrients and pesticides;
- developing urban areas have high localised impacts due to sediment and particulate nutrients; and
- existing urban areas have high, localised impacts due to dissolved nutrients and pesticides.

Targets

Resource condition targets and management action targets have been established for the WQIP. These were underpinned by research and modelling[89] and through a rigorous consultation process. Key targets are outlined in Table 15 on the following page..

5.4 Potential impacts of WQIP

The WQIP is likely to have a number of positive environmental, social and economic impacts. Key impacts are briefly outlined in Table 16.

---

88 Burnett Baffle Draft WQIP, p.14.

89 Particularly, Brodie, J. et al., 2003, *Sources of Sediment and Nutrient Exports to the Great Barrier Reef World Heritage Area*, Australian Centre for Tropical Freshwater Research; Fentie, B. et al., 2006, 'Sediment and nutrient modelling in the Burnett Mary NRM region. Volume 6', in Cogle, A.L., Carroll, C. and Sherman, B.S. (eds) *The use of SedNet and ANNEX models to guide GBR catchment sediment and nutrient target setting*, Department of Natural Resources, Mines and Water, Queensland.

Table 15: Modelled end-of-catchment loads

	Management actions	Management Action Targets (MATs)	Resource Condition Target (RCT)
Nutrients (particularly DIN)	Actions such as awareness, education, extension, incentives	Growers to complete Farm Management Systems, attend workshops, adopt nutrient and irrigation and drainage management practices.	Reduce annual estimated DIN loads at end of catchment by 80% in 50 years.
Sediment	Actions such as awareness, education, extension, incentives	Graziers to complete Property Management Planning, attend workshops, adopt management practices to prevent erosion.	Reduce annual modelled end of catchment sediment loads by 38% in 50 years.
Pesticides	Actions such as awareness, education, extension, incentives	Growers that apply pesticides to complete FMS, attend course, adopt pesticide and irrigation and drainage management practices.	Reduce pesticide concentrations by 25% in 50 years.

Source: Burnett Baffle Draft Water Quality Improvement Plan. DIN: Dissolved inorganic nutrients.

Table 16: Potential benefits of WQIP

Key benefits	Key elements and values
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive.
Wastewater treatment	Where actions up the catchment avoid or defer future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[90]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector by maintaining the region's attractiveness to visitors, particularly given the region's growing reef-based tourism activities.
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is valued at around $7.82 per household per year. This translates to around $400,000 per annum for local residents in the Burnett Baffle region.

Source: MJA.

[90] Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey, Commonwealth Department of Agriculture*, Fisheries and Forestry, Canberra.

5.4.1 Potential costs

Some cost estimates of management action targets are provided in the WQIP, for overall costs including those borne by landowners as well as administrators. However, these costs are not separated between the groups, meaning impacts of actions on individual landowners are not provided. Total costs of all costed management action targets in the WQIP are estimated at $47.5m to 2013. While there is insufficient data to estimate these costs with great accuracy, an analysis of the costs undertaken by MJA found most costs to meet RCT and MAT targets for 2013 were reasonable, with the following exceptions:

- reducing sediment loads: using costs of sediment reduction from the Mackay WQIP, the costs of meeting a 4% reduction in the total suspended solids load through changes to grazing practices could be as high as $48m, compared to the $18m indicated in the WQIP; and
- urban load reduction: if the urban RCTs (5% reduction in key pollutants by 2013) are to be met primarily though retrofitting a WSUD stormwater management program, the cost would be approximately $15m. [91]

The WQIP focuses on initiatives that have no direct financial cost to affected parties and focuses on providing incentives and management programs to farm owners. A recent survey of 1,000 farm owners in the Burnett Baffle region revealed that less than one per cent of respondents were part of a benchmark or best practice group, suggesting that large returns may be available from encouraging best practice management.

Only a fraction of the costs of implementing the WQIP should actually be covered by specific WQIP government funding. Clever policy design should ensure the cost to government in achieving the WQIP objectives is both cost effective and equitable.

5.5 Economic and social considerations for implementation of the Burnett Baffle WQIP

There are a number of economic and social considerations to take into account when implementing the WQIP. Key considerations are outlined below.

5.5.1 Impediments to changes in practices

Surveys of landholders in 2006 provide valuable insight into the impediments to changing practice. The importance of key impediments is outlined in Figure 10. Key points to note include:

- with the exception of water availability and soil suitability, the majority of the major constraints and drivers of practice change are financial, for example impacts on cash flow and impacts of profitability. This indicates that suasive approaches such as information provision are unlikely to trigger significant changes to practice on their own; and
- environmental sustainability of practices was only the 11th most important reason for practice change and was generally considered less important than most economic, social and resource availability issues.

[91] This assumes WSUD reduces loads by 70% as per the performance guidelines being established for the State Planning Policy for Healthy Waters; retrofitting 3,300 homes to meet the 5% load reduction; and a cost of $3,000 per household. Estimates are based on the effectiveness and costs outlined in, Healthy Waterways, 2009, *Meeting the Proposed Stormwater Management Objectives in Queensland: A Business Case.*

Figure 10: Impediments and drivers of land use and agricultural practice change

Source: BRS, 2006, Providing social and economic data to support regional natural resource management in the Burnett Mary.

5.5.2 Priority sectors

The design of any program under the WQIP and prioritising sectors to target should consider the number of participants that would need to be engaged to achieve the desired levels of change. Program administration costs are likely to be similar between landholders, irrespective of their actual property size or contribution to reduced pollutant loads. Given the limited resources likely to be available to run programs, there is a need to effectively target sectors and landholders that are more likely to provide the most cost-effective reductions in pollutant loads.

Within the Burnett Mary region, there are approximately 5,800 farming establishments, of which over 4,000 participate in grazing activities, around 560 are solely or partially sugar producers, and around 1,000 are solely or partially involved in horticulture production.[92]

When targeting nutrients from all cropping practices under the WQIP, it should be noted that horticulture accounts for around 18% of producers (by number), but only 0.5% of the area under crops. The likelihood of success from programs, including uptake and absolute and relative changes in practice to reduce nutrients from the horticulture sector need to be significantly higher than from grazing and sugar to justify any investment in programs targeting horticulture.

The dominant land use in the Burnett Baffle region is grazing, which has not only high local impacts, but also high regional impacts on sediment and nutrients. Focusing on grazing, especially targeting larger grazers in strategic locations, may achieve comparatively high returns.

However, while the importance of addressing sediment loads in the Burnett Baffle is vital, particularly where regional impacts may be significant, the smaller average size of pastoral holdings in the Burnett Baffle compared to other WQIP regions could result in administrative inefficiencies for some programs, compared to other regions. Data from 2006–07 indicates that the average grazing enterprise in the Burnett Baffle region is only 25% and 15% of the average enterprise sizes for the Fitzroy and Burdekin respectively.[93] Targeting efforts to reduce sediment loads from grazing on areas that pose the greatest risk to the GBR will be vital.

The structure of the agriculture sector, for example the number of enterprises and the areas under management, suggest program management efficiencies could be obtained by concentrating WQIP efforts primarily on grazing, for sediments, and sugar, for nutrients. Major investment in other sectors such as horticulture and cropping could only be justified where the relative effectiveness of investment in those sectors was significantly higher than for sugar and grazing. This is generally consistent with the development of the WQIP to date.

In addition, the relative cost of pollution abatement between sectors and sub-regions needs careful consideration. Abating urban diffuse pollution loads appears to be very costly compared to abating rural diffuse loads. The cost-effectiveness of actions such as WSUD retrofitting programs is questionable.

5.5.3 Policy choice

Like all other WQIPs, a suite of policy tools is required to meet the MATs outlined in the WQIP. Specific recommendations for choosing policy tools are listed below:

- information and suasive measures: the WQIP outlines a comprehensive suite of information and suasive measures to promote voluntary change. This should assist landholders determine their ability to implement change;
- avoiding fixed price incentives and using flexible price mechanisms: there is evidence of significant variance in the costs of changes to practice in sugar farming and grazing across all WQIP regions. Therefore, fixed price incentives create a risk of overpayment in

92 ABS, 2008, *Agricultural Census.*

93 ABS, 2008, *Agricultural Census.*

some circumstances where the incentive rate exceeds the cost of changes to practice, or low levels of participation where the incentive rate is less than the cost of changes in practice. Flexible price mechanisms such as competitive tenders to distribute incentive funding overcome these risks well and generally lead to more efficient finding allocations;

- develop metrics to assist in prioritisation: because of the variability in the contribution to load abatement and costs between and within industries in the Burnett Baffle WQIP region, there is a need to establish metrics to enable transparent and repeatable prioritisation of incentives. This could build on the work being undertaken in better-resourced WQIP regions; and
- target correct section of industry: because some business inputs are typically outsourced, particularly in the sugar industry, it is important to ensure that incentives are targeted at the section of the industry that is likely to provide the most cost-effective change. The key example of this is the increase in the use of hooded sprayers in the sugar industry where incentives to contractors to convert to hooded sprayers may be extremely cost effective.

6. Fitzroy

Key points

Social and economic profile

- The region's population is expanding, but is not expected to expand as quickly as other GBR catchments. When compared to most other WQIP regions assessed in this report, population growth is also less concentrated in coastal zones, reducing population-based pressures on water quality.
- Social conditions in the Fitzroy are generally more favourable than for the GBR as a whole, but this is partially driven by higher incomes in mining centres. Social conditions are relatively less favourable than for the State as a whole.
- There is a high reliance on agriculture, particularly beef production, within the Fitzroy Basin as a source of employment and income. Water quality risks from grazing are not likely to decline without policy intervention.
- Within the farming sector, off-farm income is important, particularly for smaller enterprises.
- Smaller enterprises are less likely to have knowledge of natural resource management practices and are less likely to undertake natural resource management on farms.
- There are significant economic and social constraints to changing practices and these have implications for policy and program design and implementation.

Scenarios assessed

A formal WQIP was not developed in the Fitzroy. Rather the Central Queensland Strategy for Sustainability developed in 2006 was expanded to include more in-depth analysis and management of water quality issues. This additional analysis, planning and implementation is outlined in the Water Quality Improvement Report (WQIR), or the Plan.

Two scenarios were assessed:

- do nothing more; and
- a scenario of proactive actions including changing grazing practices. These are the key actions from the Water Quality Improvement Report. In addition, implementing water sensitive urban design (WSUD) in greenfield developments and the potential for wastewater treatment plant (WWTP upgrades) are assessed.

Impacts

Impacts of the 'do nothing more' scenario are likely to be a further decline in water quality and risks to the GBR; negative impacts on sectors reliant on water quality, particularly domestic tourism; negative impacts on recreation, particularly fishing; and a general loss in ecosystem function.

Impacts of the scenario of proactive actions include:

- a reduction in sediments of around 750,000 tonnes per annum (16.5%) within 10 years;
- reductions in nitrogen and phosphorus attributable to rural diffuse actions, WSUD and WWTP upgrades;
- significant risk mitigation benefits to the $700m+ tourism industry and the $35m recreational fishing industry. Based on previous studies, the total economic benefits are potentially as high as $88m to $96m over the life of the Plan;
- implementation costs for rural diffuse are in the range of $36m to $51m over the life of the Plan, but options exist to reduce that cost with prudent policy and program design and implementation;
- implementing WSUD would increase housing establishment costs by around 1.1% to 1.3% for a typical new home; and
- WWTP upgrades are expensive to implement. However, the degree to which costs should be attributed to the Plan is questionable.

Implementation issues

Rural diffuse programs could potentially be enhanced by continuing, careful design of incentives to ensure the most cost-effective use of scarce funds, given the current constraints on the availability of funds.

Note: See also May 2011 update at Appendix C.

6.1 Introduction

The Fitzroy region[94] is over 156,000 km^2 and can be separated into six principal catchments. The main land use in the region is agriculture, with almost 90% of the area under agricultural production.[95] Other major land uses include forestry, with approximately 900,000 hectares of land in Central Queensland under State Forestry. Mining and other extractive industries such as quarries use about 56,000 hectares in Central Queensland. Approximately 6% of the region's land is under conservation management.

This section applies the framework outlined in Section Two to the potential actions in the Fitzroy WQIR. The scenarios assessed are based on:

- the Fitzroy Basin Association's (FBA's) interim water quality target for 2007;
- the Central Queensland Strategy for Sustainability 2004 and Beyond;[96]
- consultation with FBA staff;
- potential diffuse urban source actions discussed with EPA officials; and
- application of emerging State policies to increase wastewater standards to tertiary treatment in larger urban centres.

6.2 Profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the Plan.

6.2.1 Demographic makeup

Population

From the 2006 Census, it is estimated that the population of the Fitzroy WQIP region was around 218,500.[97] Figure 11 shows the historic and forecast population growth for the Fitzroy WQIP region compared to all of the WQIP regions assessed in this report.[98] It indicates that:

- significant population growth is expected in both the Fitzroy region and across the WQIP regions over the next 20 years; and

---

94 The SLAs that are fully situated within the Fitzroy region include Fitzroy, Rockhampton City, Gladstone City, Duaringa, Emerald, Mount Morgan, Peak Downs, Calliope Part B, Banana, Bauhinia and Taroom. Others SLAs partly within the Fitzroy region include Livingstone (99%), Calliope Part A (96%), Belyando (91%), Broadsound (91%), Nebo (51%) and Bungil (42%). Shires less than 10% in the region were excluded from the analysis.

95 CQSS2 Regional Profile.

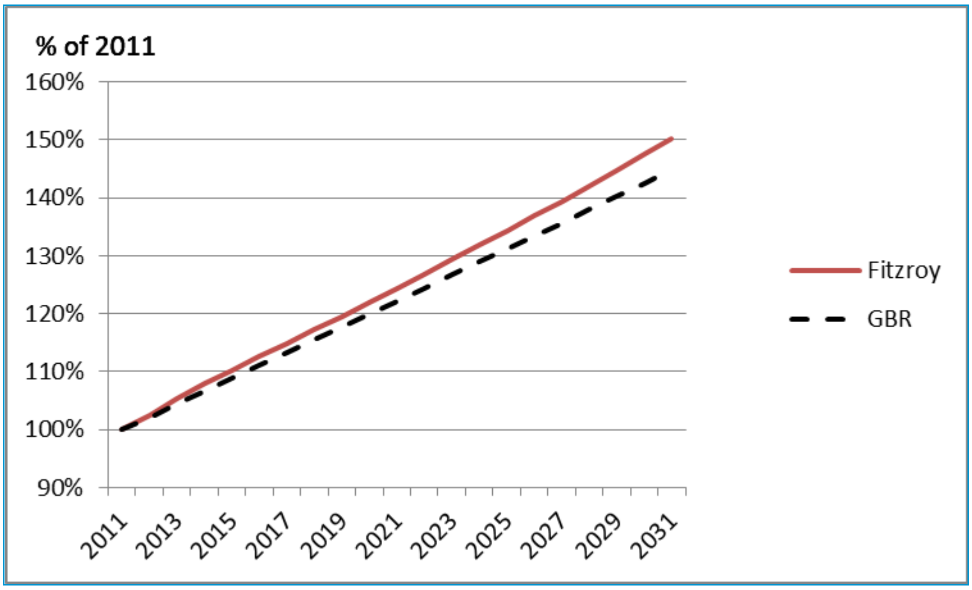
96 Christensen, S. & Rodgers, C., 2006, *Central Queensland Strategy for Sustainability – 2004 and Beyond,* http://www.fba.org.au/investments/regionalplan.html. Accessed 3 November 2009.

97 This estimate is based on ABS census data concorded (best fitted) to the Fitzroy WQIP region by OESR. Population estimates are based on a census participant's usual place of residence.

98 Based on DLGPSR Population Forecasting Unit's mid estimates for each relevant LGA concorded to WQIP boundaries.

- the Fitzroy region's rate of growth is likely to be moderately lower than for the WQIPs as a whole.

Figure 11: Population growth projections



Source: MJA based on DLGPSR and ABS 2011 Census.

Analysis of the population growth forecasts for individual local government areas indicate a slight difference in the population growth patterns in the Fitzroy compared to many other WQIP regions. While all WQIP regions are expected to experience population growth, growth in the Fitzroy is less likely to be concentrated in the coastal zone than for most other regions. This is largely due to expectations for further growth and expansion in the mining sector in the Fitzroy. In effect, the location and nature of future risks to water quality (urban diffuse and point source loads) from urban development in the Fitzroy are likely to differ from many other WQIP regions. Other population and demographic statistics of note include:

- the population of the WQIP region is slightly skewed to males (51.4% of the population);
- in the 2011 census, 4.8% of respondents in the Fitzroy WQIP region identified themselves as being Aboriginal or Torres Strait Islander, compared to around 3.2% for the whole of Queensland; and
- approximately 10% of people in the WQIP region were not born in Australia and around 1% of the population do not speak English at home.[99] To the extent that these people are targeted for programs under the WQIPs, there may be difficulties in effective engagement.

Community capacity

A community's capacity to participate in natural resource management is impacted by a number of issues:

- approximately 20of adults (>18 years old) participate in voluntary work, potentially indicating reasonable levels of social capital.[100] Females had higher levels of

99 Based on analysis of 2006 ABS census data.

100 Levels of participation in voluntary community activities are often used as a proxy indicator of social capital in a community.

participation in volunteer work 23%, compared to males (at 17%). However, the ABS census data does not indicate what type of volunteer work (e.g. environmental management) was undertaken;

- the relative financial impact of project or policies that impact on costs must be considered because the burden may be relatively greater for lower-income families. The Fitzroy has a higher incidence of low-income families than the State as a whole. Approximately 11% of families in the Fitzroy WQIP are on low incomes (i.e. < $600 per week) compared to 8% for the State. However, reported household incomes are often lower in regions with higher proportions of agricultural enterprises. This is likely to be the case in the Fitzroy; and
- household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In the Fitzroy, approximately 61% of homes are owned or are being purchased. This compares to a State average of 55%.

The ABS Social and Economic Indices for Areas (SEIFA) is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad means of making relative comparisons of social and economic resources between regions. Three indices are of most relevance: [101]

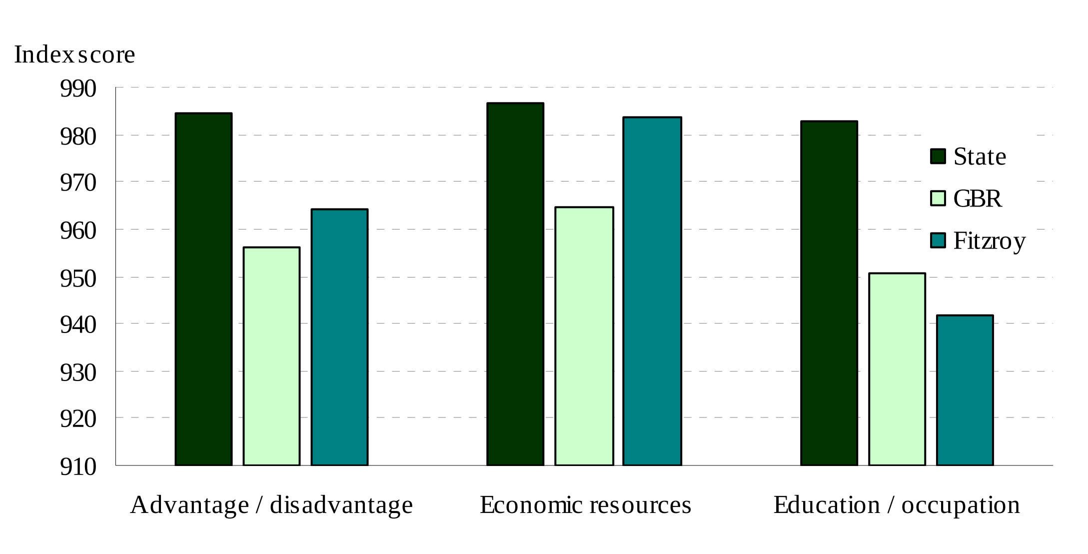
- the Index of Advantage–Disadvantage is a continuum of advantage to disadvantage. Low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation includes all education and occupation variables only.

These indices were concorded to the WQIP regions to enable each WQIP region to be compared with all of the regions assessed in this report and with Queensland as a whole.[102] The results are shown in Figure 12.

[101] ABS, 2001, 2039.0 Information Paper: *Census of Population and Housing — Socio-Economic Indexes for Areas*, Australia, 2001.

[102] MJA estimated concorded index scores for each WQIP region using concorded population figures to derive each LGA's SEIFA score to the overall WQIP SEIFA score.

Figure 12: SEIFA indices



Source: MJA based on ABS 2001 Census SEIFA indices.

Analysis of the data indicates:

- relative to the State, the Fitzroy is at a disadvantage, but generally has better resources than the GBR as a whole; and
- economic resources in the Fitzroy are almost on par with the State and higher than the GBR as a whole, perhaps indicating reasonable economic resilience to change.

This broadly implies that the Fitzroy region's greater social and economic wellbeing may make it less difficult to implement the WQIP here than in other regions. However, a relatively low level of diversification of occupations indicates the potential capacity of the community to adapt to change could be a constraining factor and measures to address this constraint may be necessary.

Education levels in the Fitzroy are broadly on par with the rest of the GBR catchments and the State as shown in Table 17. These ABS figures are broadly consistent with figures obtained for landholders through the 2006 landholder survey.[103]

Table 17: Education

Highest education level completed	Fitzroy (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	24.8	21.3	19.8
Year 12	24.0	30.1	37.2
Certificate or diploma	21.1	22.2	21.9
Undergraduate degree	5.2	6.6	9.3
Postgraduate degree	0.7	1.1	2.2

Source: ABS 2011 Census.

103 Preston, R., Lawson, P. and Darbas, T. 2007, *Landholder practices, attitudes, constraints and opportunities for change in the Fitzroy Basin Region.*

6.2.2 Employment and labour force

Labour force statistics show a high reliance on primary industries, particularly the beef industry as a source of employment. This is similar to much of the GBR catchment, but significantly higher than the State as a whole. Mining and manufacturing is relatively more important than for the rest of the GBR and mining is six times more important to the region.

6.2.3 Economic structure and agricultural practices

The structure of the Fitzroy is characterised by the dominance of mining and agriculture, compared to the GBR catchments and the State as a whole. Key points to note include:

- mining is the major economic activity in terms of values of production and exports, but linkages to WQIP are relatively indirect;
- tourism is estimated to contribute around $716m annually; and
- in 2001, the beef sector was valued at around $730m, while cereal grains were worth around $180m.

Within the agricultural sector, survey data[104] indicates:

- the majority of landholders (66%) have at least 80% equity in their properties, but 8% have less than 40% and are more susceptible to financial stress;
- 43% of landholders derive their incomes predominantly from off-property sources, and 70% of landholders earn some form of off-property income;
- there is an inverse relationship between the size of a property and the likelihood that the majority of income is drawn from off-property sources;
- over 20% of farmers work >60 hours per week, significantly constraining their ability to undertake NRM activities on their properties, while a further 32% of farmers work between 40 and 60 hours a week; and
- only 25% of properties employ two or more persons.

[104] Preston, R., Lawson, P. And Darbas, T., 2007, Landholder practices, attitudes, constraints and opportunities for change in the Fitzroy Basin Region.

Table 18: Labour force statistics

	Number			Percentage		
	Fitzroy	GBR	Qld	Fitzroy %	GBR %	Qld %
Agriculture, forestry and fishing	5,563	23,546	54,563	5	5	3
Mining	13,115	27,793	51,656	12	6	3
Manufacturing	9,915	34,978	169,025	9	8	8
Electricity, gas, water and waste services	2,614	6,962	24,764	2	2	1
Construction	10,300	40,558	179,947	9	9	9
Wholesale trade	3,166	13,561	73,377	3	3	4
Retail trade	10,282	46,833	214,617	9	11	11
Accommodation and food services	7,151	32,649	140,036	6	7	7
Transport, postal and warehousing	6,399	24,591	104,924	6	6	5
Information media and telecommunications	666	3,588	25,282	1	1	1
Financial and insurance services	1,502	6,317	53,833	1	1	3
Rental, hiring and real estate services	1,724	7,086	36,875	2	2	2
Professional, scientific and technical services	4,569	18,497	131,921	4	4	7
Administrative and support services	2,514	12,383	64,185	2	3	3
Public administration and safety	5,666	30,251	135,586	5	7	7
Education and training	8,220	33,080	160,241	7	7	8
Health care and social assistance	9,755	47,500	240,017	9	11	12
Arts and recreation services	688	4,210	28,418	1	1	1
Other services	4,204	17,688	78,157	4	4	4
Not Stated	2,799	10,814	22,913	3	2	1
Total	**110,812**	**442,885**	**1,990,337**	**100**	**100**	**100**

Source: ABS 2011 Census.

In terms of the uptake of land management practices associated with water quality, of the relevant landholders:

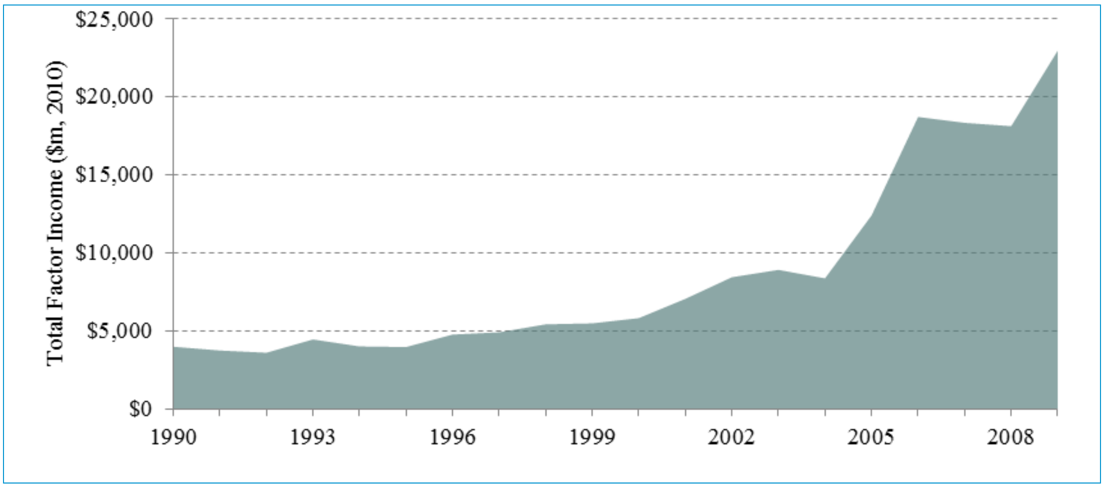
- 44% report undertaking actions to retain appropriate ground cover (only 32% on smaller properties), and generally landholders believe they have knowledge of the issue;
- 15% report undertaking riparian stock management (only 10% on smaller properties);
- 33% report retaining riparian vegetation (23% on smaller properties);
- 47% report farming on contour (lower on small farms, but significantly higher on large mixed enterprises); and
- 52% report minimum till practices.

General conclusions from the survey results indicate that smaller landholders are more likely to derive their principal sources of income from off-farm sources, are less likely to be aware of natural resource management issues and less likely to practice natural resource management on their farms.

Mining and energy development

The principal sources of economic growth in the Fitzroy Basin are the mining and energy sectors and the related support sectors (e.g., transport, water provision, building etc). Growth in these sectors will stimulate flow-on economic activity. The recent growth in the mining sector is shown in Figure 13, expressed in terms of total factor income.

Figure 13: Growth in the mining sector



Source: ABS National Accounts Cat 5220.0 Table 4 - Mining (Total factor income).

Growth in mining and sectors attributable to mining will also create additional water use and may increase dewatering activities and discharges into the Fitzroy Basin. Growth in coal mining, mining water consumption and discharges are shown in Table 19 below.

Table 19: Coal mining production, water use and discharge

Year	Coal production (million tonnes)	Water consumption (ML)	Discharge (ML)
2000-01	139	25,317	6,350
2004-05	172	44,152	8,456
2008-09	191	54,866	14,267

Sources: DEEDI (2010) Queensland's Coal – mines and advanced project; DME (2007) Queensland's world-class coals – mine production and developments; ABS Water Accounts Cat 4610.0 (2000-01, 2004-05, 2008-08 editions); BOM

While there is no direct relationship between coal production, mine water consumption, dewatering and discharge - and the available data is sparse - a number of observations from the data can be made including:

- absolute discharges between 2000-01 and 2004-05 largely grew in line with production. During this period, water consumption grew at a faster rate than coal production;
- however, between 2000-01 and 2004-05, discharges per unit of coal production remained largely unchanged. This may be partially explained by improvements in water and wastewater management by the mining sector where a lower proportion of water consumed is ultimately discharged into receiving waters under relatively normal operating conditions; and
- absolute volumes of discharge increased significantly between 2004-05 and 2008-09. Discharges per unit of tonne of coal production in 2008-09 were in excess of 1.5 times

those in 2004-05. However, discharges in 2008-09 coincided with significantly above average rainfall events, flooding and management responses (e.g. Ensham) that have been documented elsewhere.

In effect, the data provides some indication that the absolute levels of discharges are generally growing in line with production. However, despite significant gains in water and wastewater management, discharges can be significantly higher in very high rainfall years such as 2008-09 and can trigger the need for further management arrangements to be implemented to meet underlying regulatory standards (such as those under Transitional Environmental Programs (TEPs) for Fitzroy Basin coal mines. For this reason, management of water needs to be undertaken within the context of long-term climate sequences that allow for management within climate extremes.

It is likely to be the periods following significantly above average rainfall events that will result in significantly higher volumes of discharge, even under current improved management regimes.

Given the significant data constraints and inherent levels of uncertainty in analyses, it would be prudent to undertake a significantly more detailed and sophisticated analysis to better understand the risks growth in the mining sector poses to environmental values and water quality objectives – particularly under different climatic conditions.

While Basin-wide estimates of loads from mining are not available, it should be realised that while loads attributable to mining and energy development may be growing rapidly, the relative contribution of those sectors to overall Basin sediment and nutrient loads will be relatively minor under any growth assumptions. They have potentially increased in excess of 50% in the past 10 years, but probably still contribute less than 2% of total Basin loads. It is the growth in salinity loads that are likely to create the most significant risks to EVs from mining and energy developments. However, these risks were addressed in revised environmental authority conditions for the release of contaminated stormwater in 2009.

The bottom line is that anticipated growth in sediment and nutrient loads at a Basin scale attributable to land use change is likely to be negligible in the short to medium term (say the next ten years) and the subsequent changes in risks to inland and GBR waters would also be negligible. While the area under urban and mining land use will increase relatively rapidly, it is unlikely to account for any more than 2% of land use in the foreseeable future. These risks will be negligible at the Basin scale, but may create more significant risks to EVs at a more localised scale. Therefore, the existing focus of reducing sediment and nutrient loads from rural diffuse sources is entirely appropriate.

The outlook for other pollutants such as salt is significantly less certain and the risks are relatively poorly understood (particularly cumulative impacts and risks). With respect to contaminated stormwater (high salinity) discharges from coal mining operations, existing regulations and management are already in place to mitigate risks, and the cumulative risks, including coal seam gas waste water emissions, will be assessed in cumulative impact modelling in the near future.

6.3 Proposed and potential actions

This section briefly outlines the two scenarios for assessment. These scenarios are based on information provided directly by FBA and on technical documentation that formed the basis of the FBA interim water quality target 2007.[105]

The focus of the FBA WQIP is primarily sediment loads. However, nutrients will also be targeted as the WQIP is implemented. Prior estimates of sediment loads for the basin range from 2.5 to 10.6 Mt per annum. The base line used for this economic assessment is consistent with the figures used by FBA for the WQIP, developed through the Short Term Modelling Project (STMP). This starting point is 4.5 Mt per annum. Other key findings from the STMP include:

- the sources of erosion are relatively concentrated with 50% of the erosion attributable to 17% of the catchment;
- the influence of the western areas of the Fitzroy Basin account for significantly fewer sediments to the reef, with the majority of loads originating from the floodplains;
- total nitrogen and phosphorus loads are dominated by sediment-bound particulates indicating that actions to reduce sediment loads should also make significant reductions to nitrogen and phosphorus loads; and
- increasing ground cover has the greatest impact on reducing sediment and nutrient loads.

While the STMP concentrated on rural diffuse sediment and nutrient loads, significant loads are also likely to occur due to urban diffuse and urban and industrial point-source emissions. Estimates of the contribution of those loads are currently not available. This section considers the impacts of two scenarios. The first scenario is to do nothing more in terms of policy and programs. The second scenario estimates the impacts of actions proposed by the FBA in addition to a series of actions to address urban diffuse and point sources.

6.3.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the WQIP to address sediment and nutrient loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point-source loads.

This scenario forms the basis against which Scenario Two is assessed.

6.3.2 Scenario Two: A suite of proactive actions

This scenario proposes a suite of proactive actions to reduce sediment and nutrient loads. These actions are outlined in various planning documents developed by the FBA[106] and, where no specific actions are yet proposed by FBA or the State, MJA has assessed potential actions for urban diffuse and point-source loads. Key potential actions include:

---

105 Johnstone, N., 2007, *FBA Interim Water Quality Target 2007.*

106 Christensen, S. & Rodgers, C. 2006, *Central Queensland Strategy for Sustainability — 2004 and Beyond*, http://www.fba.org.au/investments/regionalplan.html, accessed 4 November 2009, and Johnstone, N. 2007, *FBA Interim Water Quality Target 2007*.

- **rural diffuse**: a suite of planning and on-ground actions to reduce hill, bank and gully erosion. For the modelling to underpin target setting, these actions are based on an assumption of increasing average ground cover from around 55% to 70% in project areas. Other actions proposed also involve enhancing cropping practices and wetland management. Based on the STMP, targets of reducing sediments by a further 75,000 tonnes per annum have been established. The aim of the FBA is to cumulatively reduce sediment delivered to in-stream aquatic habitats by 4,100,000 tonnes over 10 years from 2005–06.[107] In 2005–06, the FBA's programs resulted in enhanced management practices over approximately 102,000 ha. This forms the basis of the rural diffuse component of the assessment by MJA;
- **urban diffuse**: there is significant policy and planning development currently underway by the State Government to address urban diffuse sources of sediment and nutrient loads. While policy options are still under consideration, MJA believe the most likely policy outcome is a regulatory requirement to implement enhanced WSUD in future developments, particularly greenfield developments — for example major new developments. In effect, this could be implemented via a new State Planning Policy, where implementing WSUD becomes a performance requirement of new developments. This forms the basis of the urban diffuse component of the assessment by MJA; and
- **urban and industrial point-source pollution**: again, no hard commitments have been made with respect to urban and industrial point sources in the Fitzroy Basin by the FBA because it is outside their jurisdiction. However, based on observed policy developments and investments in other catchments, it is reasonable to assume that potential actions would include an upgrade of existing WWTPs to tertiary treatment and for all new plants and augmentations of existing plants to be to tertiary treatment standards. These would be implemented by the State and by local governments. In addition, regulated point-source polluters (i.e. environmentally relevant activities) would continue to be licensed to current standards, including meeting existing emissions controls. This forms the basis of the point source component of the assessment by MJA.

6.4 Potential impacts

MJA has developed indicative estimates of the potential impacts of these scenarios based on analysis of existing data and previous analysis. The desktop nature of this study does not enable more sophisticated assessment techniques. In addition, this assessment can only be considered as a partial assessment because quantitative estimates have only been established for a subset of all impacts — both loads impacts and economic impacts.

The relevant assessment is to consider the impacts of the proposed suite of actions —Scenario Two - compared to the 'do nothing more' case. Qualitative analysis of a number of considerations show that the do nothing more scenario is likely to result in further increases in sediment and nutrient loads during the life of the current WQIP due to:

- increasing intensity of the beef sector is likely to continue to place pressure on grazing systems resulting in increased erosion;
- continued and lagged loads;

[107] Johnstone, N., 2007, *FBA Interim Water Quality Target 2007.*

- increasing sediment and nutrient loads attributable to population increases, albeit at lower levels per capita due to current minimum development and WWTP treatment standards; and
- mining activity.

While not quantified in this analysis, these increases in loads are likely to have a negative impact on tourism activities reliant on water quality (e.g. snorkelling/diving), recreation (e.g. fishing), water treatment costs borne by local governments, and ecosystem function and ecosystem services.

6.5 Impacts of Scenario Two: A suite of proactive actions

This section summarises MJA's assessment of the impacts of Scenario Two for rural diffuse, urban diffuse and point-source actions outlined in section 5.4.2. There are a number of potential benefits from this scenario. These benefits are briefly outlined in the Table 20.

Table 20: Potential benefits of scenario

Benefits	Key elements and values
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive.
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits in terms of wastewater treatment charges avoided are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector in terms of maintaining the region's attractiveness to visitors. The estimated value of the industry in the Fitzroy for 2005–06 was $716m, which was predominantly domestic tourism.[108] There have been no studies to quantify the relationship between water quality and tourism in the Fitzroy.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing. Estimated annual expenditure is around $35m.[109]
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Maintaining ecosystem function and services	Previous research that indicates that a 1% enhancement in GBR coastal water quality is worth around $7.82 per household per year. This translates to around $760,000 per annum for the Fitzroy. If the WQIP target reduction in sediment loads (down 16.5%) translates to a similar relative improvement in water quality, a rough estimate of the economic benefits of the WQIP are around $12.5m per annum or a present value of around $88m to $96m over the life of the WQIP.[110]

6.5.1 Rural diffuse impacts

The targets established by FBA are to reduce annual loads by 750,000 tonnes per annum (approximately 16.5%) within a 10 year period, excluding lag effects. The modelling from the STMP indicates significant decreases in sediment loads from increasing average groundcover. It was estimated that that strategy would reduce annual sediment loads by 1,450 Mt, and reduce nitrogen and phosphorus loads by approximately one third.

MJA has overlayed the data from the STMP with economic estimates from the economic impacts of changing groundcover estimated by Donaghy *et al* (2007)[111] and using program administration and operating costs provided by FBA.[112] Assuming that FBA are able to target and achieve changes in average cover from 55% to 70%, MJA estimate that the potential cost of

108 Access Economics, 2007, *The economic and financial value of the Great Barrier Reef Marine Park, 2005–06.*

109 Henry, G., and Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

110 MJA estimates based on Windle and Rolfe, 2006, *Non-market values for improved NRM outcomes in Queensland*.

111 Donaghy, P., Rolfe, J., and Gaffney, J., 2007, *Unravelling the economic and environmental tradeoffs of reducing sediment movement from grazed pastures*. Paper presented to the 51st AARES Conference. Queenstown.

112 Johnstone, N., 2007, *pers comm.*

achieving FBA's target reduction in sediment loads of 750,000 tonnes per annum is on the order of $36–51m, or around $48-68 per tonne.[113] This estimate incorporates:

- the opportunity cost (essentially the gross margin foregone) over a 20-year period as a proxy of costs to landholders; and
- program administration costs.

Figure 14 shows the range of costs for achieving the various reductions in sediment loads in the Fitzroy, in present value terms, based on actions to increase groundcover from 55% to 70%.

Figure 14: Indicative cost of reducing sediment loads (present value)

Source: MJA estimates based on Dougall et al, 2006 and Johnson, N. 2007.

The analysis demonstrates a significant cost in achieving the sediment reduction targets. However, analysis by Donaghy et al. indicates that the long term costs and benefits of managing for target groundcover levels vary significantly depending on the starting pasture condition. That research indicated that there was likely to be a potential optimal pasture utilisation rate in the long run. Utilisation rates above that level were actually detrimental to farm financial performance and ultimately the value of the farm asset. Donaghy found that:

> *By lowering the pasture utilization rate from 60% to 50% utilization, the land holder…will achieve a significant reduction in sediment of… 40% over 20 years. This implies an opportunity cost of only $3 per tonne…*[114]

While the work undertaken by Donaghy et al. was essentially a modelling exercise based on a representative enterprise and the results were constrained by the capabilities of the models used, there are a number of key messages relevant to the WQIP including:

- the likely private costs to graziers of reducing sediment loads will differ depending on the current and target groundcover levels;

113 This estimate is broadly in line with indicative estimates from Donaghy et al (2006) of around $56M to reduce sediment exports by 12% in the catchment.

114 Donaghy, P., Rolfe, J. & Gaffney, J., 2007, *Unravelling the economic and environmental tradeoffs of reducing sediment movement from grazed pastures.* Paper presented to the 51st AARES Conference. Queenstown. p.12.

- there are likely to be financially optimal long-term levels of groundcover, depending on farm characteristics;
- increases in cover in the long term can be financially beneficial for some enterprises, while for many graziers there will be private costs in achieving groundcover targets, constraining the likelihood of voluntary adoption of such practices;
- further research into the economic and environmental tradeoffs between pasture utilisation, groundcover and sediment export would enhance policy and program design; and
- given the current levels of uncertainty of the private benefits and costs of achieving enhanced groundcover, providing well-designed incentives is a useful policy tool to achieve targets and to better understand the likely costs of achieving targets.

Constraints and impediments

The costs of reducing sediment export from grazing activities show a significant impediment to achieving sediment reduction targets. This is consistent with findings from a survey of landholders in the Fitzroy (Preston et al., 2007)[115] that indicated cash flow considerations, the costs of inputs and the costs of machinery and equipment were among the greatest constraints to adopting new practices. Cash flow and input costs considerations ranked as the greatest constraints of all resource, financial, social and information constraints considered. Delays in financial returns on new practices were also seen as a significant constraint.

In addition to the financial impediments, the survey revealed a number of land resource, social and information factors also seen as impediments to the adoption of new practices. Key impediments included:

- concerns over climate variability;
- the need for support from family;
- the need to be able to access reliable information on practices;
- stage of life (e.g. approaching retirement) or intentions regarding properties, for example 10% intend to sell the property in the short to medium term, that is next 10 years; and
- general landholder values, where working the land, a rural lifestyle and investment are seen as more important than bush land, habitat and nature conservation.

Interestingly, the need to reorganise a property layout was not seen as a major factor. In effect, it would appear landholders are relatively keen to better configure their properties, but other constraints, particularly financial constraints impede these investments.[116]

These constraints are not of uniform importance across all landholders. This situation should influence the design and implementation of any policy or program to reduce sediment loads.

Policies and programs should be specifically designed to overcome the constraints to changes in land use and management practices.

---

115 Preston, R., Lawson, P., and Darbas, T., 2007, *Landholder practices, attitudes, constraints and opportunities for change in the Fitzroy Basin Region.*

116 Preston, R., Lawson, P., and Darbas, T., 2007, *Landholder practices, attitudes, constraints and opportunities for change in the Fitzroy Basin Region.*

Implementation

An assessment of sediment loads from grazing, using the pollution treatment train framework, indicates that implementation should be targeted at encouraging actions that reduce sediment loads at the source — at the property scale — via:

- enhanced land use planning including consideration of the capabilities of pasture, soils and property layout; and
- reduction of erosion risks via stock management and pasture utilisation that achieve desired groundcover outcomes.

The challenge for policy makers and the WQIP in reducing sediment export from grazing is twofold:

- firstly, the challenge is to develop and manage a program that assists landholders to make a long-term transition from grazing regimes that are both sub-optimal from a private financial perspective and increase the export of sediment, to a more appropriate management regime. The objective should be to manage a transition path that provides long-term private and public benefits. This is likely to require programs such as suasive approaches, and soft forms of regulation in the longer term such as performance requirements under the leasehold land use strategy. Because there is likely to be significant costs in transition, targeted incentives would also be appropriate; and
- secondly, where exports at a catchment scale still exceed targets, the challenge is to develop an effective incentives program that achieves load reduction targets at the lowest cost to landholders. Suasive approaches are unlikely to work under these circumstances and blanket regulatory approaches will impose significant costs on graziers. The most appropriate suite of approaches under these circumstances may be ongoing financial incentives recognising the public stewardship benefits being provided by landholders.

Both strategies must be underpinned by complementary approaches including:

- appropriate information for landholders to understand the private and public pros and cons of practices that reduce sediment loads; and
- appropriate support to enhance the capacity of landholders to manage the transition phase.

These challenges are further complicated by the fact that there is significant spatial variability in the sources and impacts of loads from different parts of the Fitzroy Basin, significant variance in the economic circumstances of properties, and significant variance in the constraints (real and perceived) in implementing new practices.

These approaches could be further underpinned by a review of existing policies and programs that may inadvertently result in unintended water quality outcomes. Where the objectives of these policies and programs can be achieved in other ways, without exacerbating rural diffuse loads, the alternatives should be considered.[117]

The development and implementation of the WQIP, including the Central Queensland Strategy for Sustainability — 2004 and Beyond, indicate a suite of programs and actions consistent with these findings. However, given the current constraints in the availability of funds, rural diffuse

---

117 For example, a review of drought and exceptional circumstances programs undertaken in Victoria found a number of perverse outcomes from the approach that had been adopted. See: Ha, A., Stoneham, G., Harris, J., Fisher, B., and Strappazzon, L., 'Squeaky Wheel Gets the Oil: Incentives, Information and Drought Policy', *Australian Economic Review*, Vol. 40, No. 2, pp. 129–148, June 2007.

programs could potentially be enhanced by careful design of incentives to ensure the most cost-effective use of scarce funds.

6.5.2 Urban diffuse impacts

The development of the WQIP to date has not concentrated much effort on urban diffuse sources of loads. However, future urban development will result in increases in loads and the State is currently considering a number of policy options to address urban diffuse loads.

Typically, these policies have been implemented via WSUD. In the absence of any concrete commitments or Fitzroy-specific modelling, MJA has estimated the potential impacts of implementing WSUD in all future greenfield developments in the Fitzroy using previous analysis of WSUD undertaken in South East Queensland.[118] Based on the load reductions and cost estimates developed in that study, and applying the figures to likely developments in the Fitzroy using estimated population growth as the driver, there are a number of points to note:

- assuming relative reductions from WSUD are around 45% for nitrogen, 60% for phosphorus and 80% for sediments, indicative estimates of reductions in over the life of the WQIP are likely to be in the order of 25 to 53 tonnes of nitrogen, 7 to 10 tonnes of phosphorus and 3,500 to 5,300 tonnes of sediment;
- costs are likely to be around $54–$80m over the next ten years. These costs would translate to marginally higher costs for urban development being passed onto consumers in the form of higher house establishment costs. This equates to around a 1.1 to 1.3% increase in the cost of building a new home; and
- implementing WSUD would not be cost effective as an approach to reduce sediment loads.

Constraints and implementation

An analysis of urban diffuse sources of pollution using a pollution treatment train framework would suggest a suite of considerations and approaches are appropriate including:

- enhanced land use planning to reduce the risks to water quality associated with the location, scale and timing of urban development, which could also involve establishment of buffer zones and other spatial planning requirements;
- localised source controls to contain runoff to source locations as much as practical; and
- enhanced management of runoff conveyance and transmission to reduce risks to waterways.

These approaches would need to be underpinned by appropriate awareness, education and best practice mechanisms relating to both households and, more importantly, the development sector. Institutionally, addressing these issues should be led by the State and local governments.

To avoid potentially inefficient costs of expensive WSUD requirements in regions where the benefits of reducing urban diffuse loads are low, it would also be prudent to consider flexible approaches to developing WSUD requirements based on the relative risks of specific developments, which are a function of location, soil type, and rainfall.

[118] MJA, 2006, *Business Case for Investment in healthy Waterways in South East Queensland.*

6.5.3 Point sources impacts

Similar to urban diffuse loads, point-source loads have not had a lot of attention in the development of the WQIP to date. Sources of point source loads include wastewater treatment plants and mining and energy sector developments.

Point sources - town waste water treatment

The most obvious actions to address point-source loads is via enhanced treatment standards for WWTPs, particularly via a program to upgrade existing secondary treatment plants to tertiary standards and for all new plants to be to tertiary standards.

It is also important to consider the apportionment of costs for WWTPs to meet the objectives of WQIPs. The establishment of new WWTPs is triggered by population growth and is simply a cost of providing infrastructure to underpin population growth. The rationale for WWTPs has historically been to maintain health, with marginal enhancements in water quality to maintain ecosystem function a secondary consideration.

A more likely, albeit untested, assumption is that relevant costs of upgrades attributable to WQIPs should be limited to upgrades from secondary to tertiary (or higher) standards where the WQIP's target loads are already exceeded. This data is not available for the Fitzroy WQIP region.

MJA undertook analysis of expenditure data[119] for recent upgrades from secondary to tertiary treatment for several WWTPs in South East Queensland. Economic impacts were calculated using a simple 'building blocks' approach for tariffs and charges estimations. Our results reflect the financial cost per tonne to the community of reducing a tonne of nutrients from emissions. Estimates range from $76,000 to $200,000 per tonne per annum.

Given these costs, it may be prudent to:

- consider the degree to which costs can be reduced by using flexible mechanisms that allow lower cost upgrades to be exploited;[120]
- consider the extent to which rural diffuse offsets could provide a substitute for WWTP upgrades, which would require a rigorous assessment of the environmental equivalence of offsets and WWTP upgrades; and
- concentrate upgrades in areas where the assimilative thresholds of receiving environments are already exceeded, or are expected to be exceeded in the near future.

Regulatory approaches and subsequent performance standards under WWTP licence conditions are the most appropriate implementation approach, with the costs being shared across the community via wastewater treatment charges.

Point sources - mines and energy development

There are almost 50 operating mines in the Fitzroy Basin and each of these has made a significant investment in the management of water use and associated regulated discharges. There are a plethora of costs involved in the use and management of water, dewatering and discharges including:

119 Data provided by Queensland EPA.

120 The use of 'bubble licences' has significantly reduced the costs of WWTP upgrades in NSW.

- bore fields, pipelines and other supply options;
- overburden dumps, tailings dams and tailings management etc.;
- water treatment (sometimes involving desalination, storage, dosing etc). saline discharge water is an issue for more than 50% of mines, and is becoming a major environmental management issue for the emerging coal seam gas industry;
- waste stream disposal costs;
- mitigation and remediation costs in the event of spillage or illegal discharge;
- rehabilitation costs;
- monitoring, reporting and stakeholder liaison; and
- labour costs associated with all of the abovementioned activities.

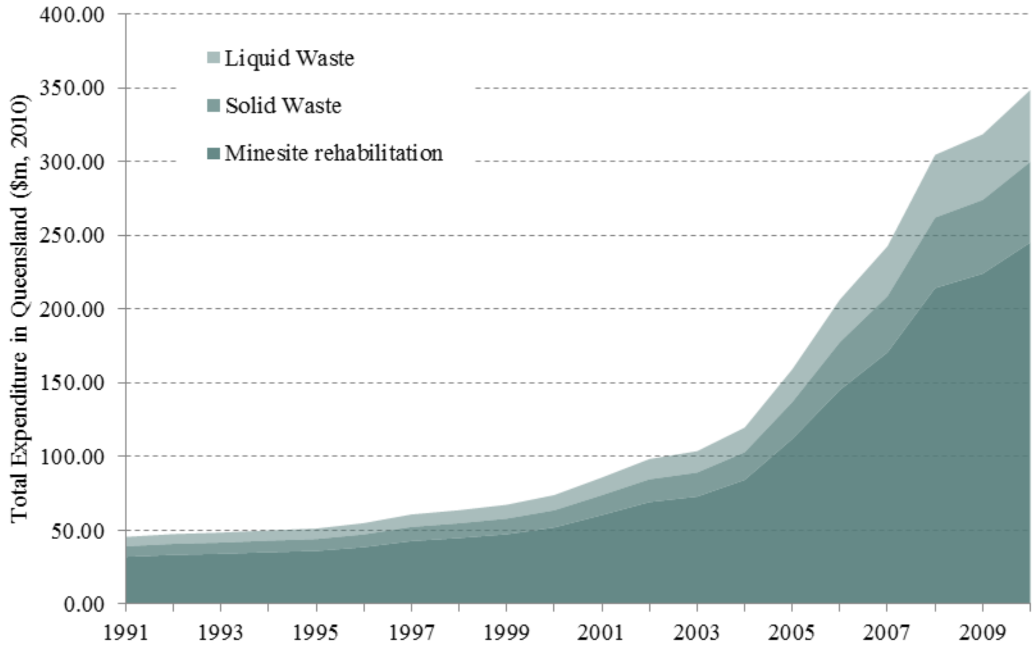
Publicly available information on water treatment costs is both very limited and highly aggregated. For example, ABS data provides an indicative estimate of the yearly expenditure by the mining industry on environmental protection measures in Australia, disaggregated by states. Estimates produced by MJA utilising the most recent data are illustrated in Figure 6 below. When linked with aggregate level production data (by state), the resulting estimates provide an indicative estimate of environmental expenditure and the impost of environmental management on mine costs.

Information on cost structures for mines is not publicly available, although what limited data that is available indicates that while water expenditure in mining is significant in absolute terms (capital and operating costs) it is not one of the most significant cost drivers for the industry in general. Using the last ABS survey of environmental expenditure and ABARE production and price data for the same period, the data indicates that environmental expenditure in the coal industry was less than 0.5% of the value of production.

While the proportion of costs attributable to environmental management would have increased since the time of this data, it is unlikely the changes in environmental regulatory requirements would have had a material impact on the sectors viability except for the most marginal of operations. However, there will be significant variation in the cost attributed to policy-induced costs. Industry sources have provided some anecdotal evidence to suggest that capital expenditure in one mine to meet their amended regulatory requirements was as high as $50 million.

MJA estimate that total environmental expenditure by the Queensland mining industry is now around $250 million per annum. This expenditure has been growing at a faster rate than production growth as environmental management cost increases are driven by multiple factors, including relatively higher regulatory requirements and voluntary improvements in practice as corporate social responsibility initiatives become more mainstream. Of this expenditure, approximately 14% is attributable to liquid waste management, which is of most relevance to the establishments of environmental values and water quality objectives.

Figure 15: Estimated expenditure on environmental management by the Queensland mining industry, 1990-2010



Source: MJA analysis based on ABS 4603.0 Table 2.4, ABS 5220.0 Table 4 and MJA Estimates

Environmental costs vary considerably (depending on site conditions, commodity, loads, regulatory requirements etc), but they rarely likely to exceed more than 2% of total factor income for the mining sector. Liquid waste management, a significant ongoing cost, is typically around 0.2% of factor income. While aggregate level estimates can be produced, region-specific cost estimates remain commercially sensitive to mine operators, as information on potential cost changes may impact on mine viability and potentially on future investment. However, general conclusions include the following:

- the costs of reducing loads/concentrations can be relatively higher for brownfield applications compared with new operations, where higher waste management standards can be incorporated into the mine site design from the outset;
- available ABS data indicates that liquid wastewater management for coal tends to require relatively lower capital inputs (around 60% of total wastewater management costs) when compared to oil and gas (around 85%). However, the trend towards coal seam gas extraction is likely to both increase the overall costs of wastewater treatment for the energy industry in Queensland, and result in a more capital intensive wastewater management cost profile;
- there is significant variability of costs, driven by multiple site characteristics and other physical aspects of mine production, and there are likely to be relatively unique solutions to meeting regulatory requirements for each mine. For example, meeting concentration limits and flow constraints can prove problematic where dilution to concentrations that meet release conditions does not align with favourable low conditions for releases. This will impact on mine configuration and costs; and
- passive water treatment systems generally have lower capital and maintenance costs than active treatment systems. However, it is significantly more difficult and costly to incorporate passive treatment into existing operations.

In addition to cost-related constraints on improving receiving water quality, there are often a number of technological and market constraints that can inhibit voluntary investment in environmental technologies by mining companies, particularly perceived commercial and operational risks of environmental or water management processes. Wastewater management matters have been addressed in the amended environmental authority conditions addressing contaminated stormwater discharge for all coal mines in the Fitzroy Basin, implemented in 2009. They are now a part of the business-as-usual case for future operations and the investment climate.

In addition to the ongoing costs outlined above, also of concern to the mining sector is the potential disruption to production where meeting regulatory requirements restricts the ability of mines to release excess water during flooding (essentially blending with the flood flows) which may result in productions being temporarily halted. This has occurred in some mines as a result of very high rainfall in both the 2008 and 2010 wet seasons. The Queensland Resources Council estimate Queensland coal exports may be 30% lower than expected because of the recent flood events. ABARES have also estimated impacts on production, but have indicated the constraint on exports will be partially offset by an increase in the spot price.

It is estimated that Queensland's coal exports between December 2010 and March 2011 could be around 15 million tonnes lower than previously anticipated. This represents a reduction in export earnings of around $2–2.5 billion. However, it is anticipated that coal prices could be settled at higher levels, partially offsetting the adverse impact on coal industry revenues.

However, while the spot price may partially offset the impacts for the sector as a whole, the impacts will still be felt by mines directly impacted.

The current approach to managing loads from point sources is via regulatory environmental authorities under the Environmental Protection Act 1994 (EP Act). These are specific to each regulated emitter and each has its own requirements (pollutants, loads, discharge location, timing, monitoring, reporting etc). However, the current arrangements may not be sending appropriate economic signals that provide incentives to reduce loads and cumulative risks. Consequently, cumulative impact modelling will be undertaken to refine the current approaches. Specific options worth investigating for both existing and future regulated emitters include:

- **improved information and scheduling of discharges**. DEHP's analysis of the cumulative impacts of mine discharges indicates that discharges from several mines are often undertaken concurrently, increasing the likely of material risks to EVs. While this is largely dictated by the fact multiple mines are impacted by the same rainfall event simultaneously, where climatic conditions allow it, potentially low cost option to partially mitigate the risk of cumulative discharges in some catchments (e.g., the Isaac River) could be to improve information systems to enable individual mines to coordinate the volume and timing of discharges to reduce the cumulative risks of WQOs being exceeded.
- **improved pricing signals**. Current fees for environmentally relevant activities are based on a standardised aggregated environmental score for each activity type. Discounts on fees can be obtained through specific actions that reduce loads. While the current fee structure and discounts provides some form of price signal to reflect environmental damage from emissions, the fees are not an accurate reflection of the environmental risks and costs of emissions at a regional/community scale, particularly where the cumulative impacts may be critical. Significant improvements to pricing signals could be established through approaches such as load-based licence pricing (where fees directly reflect loads – not the business activity). This would then provide a continuous economic signal to

reduce loads where the cost of abatement is less than the licence fee. Fee structures such as inclining block tariffs (e.g., based on concentrations) could also be considered, particularly where the risks of cumulative loads grows exponentially;

- **tradable discharge rights**. Where there are several emitters into the same river system and there are obvious physical thresholds to its assimilative capacity, it would be worthwhile exploring options for tradable discharge rights in some areas (e.g., salinity discharges in the Isaac River for coal mines around Moranbah). This has the potential to simultaneously ensure EVs are protected and to reduce environmental compliance costs. The Queensland Resources Council recently indicated it would consider a feasibility study to investigate a salinity trading approach to salinity discharges. This has proved to be a successful intervention option in some circumstances, such as the Hunter Salinity Trading Scheme in NSW;
- **offsets.** Often the costs of treatment at point sources can be significantly higher than potential actions outside the project site. Therefore, the use of offsets may be possible. Previous analysis by MJA has identified the potential economic opportunities for water quality offsets where enhanced land management actions can substitute for augmentations of treatment standards for wastewater treatment plants. However, it should be noted that current regulatory frameworks do not yet allow for these options. In addition, the current licence fee structure for environmental authorities may create an economic impediment to more sophisticated management approaches such as offsets.
- A variant of an offset approach could include offset-like arrangements where point source emitters establish commercial arrangements to enable the dilution of loads to ensure WQOs are not exceeded (e.g., a mining company purchases water entitlements in the water market and uses the water to mix with mine emissions); and
- **Beneficial reuse to reduce treatment costs**. Water treatment is an expensive exercise for emitters, and opportunities for treatment and beneficial reuse on-site and off-site need to be explored in depth (e.g., reverse osmosis to remove salt and dosing for background quality before using treated water for irrigated tree crops). The coal seam gas sector has already undertaken significant research and application of this option.

It would be prudent to review and assess the abovementioned options to determine what options (and in what catchments) may simultaneously enhance environmental outcomes and deliver cost effective management options. Initially these arrangements could be tested under a pilot arrangement and at a fairly modest scale.

Ultimately, there may be a number of management actions or combinations of actions that can be undertaken to achieve the policy outcome. Consideration of the potential efficient portfolio of arrangements should be made where possible.

7. Mackay Whitsunday

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- The Mackay Whitsunday region's population is expanding at a faster rate than the GBR catchment population as a whole. With the exception of some areas where population growth is driven by mining, the bulk of the future population growth is likely to occur in the coastal zone.
- Social conditions in Mackay Whitsunday are generally on par with the GBR as a whole. The exception is the level of education and the diversity of occupations. Social conditions relatively are less favourable in Mackay Whitsunday than for the State as a whole.
- The high reliance on agriculture, particularly sugar and beef production, as a source of employment and income and the associated water quality risks from production are not likely to decline without policy intervention.
- There are significant economic and social constraints to changing agricultural practices and these have implications for policy and program design and implementation.

Scenarios assessed

Two scenarios were assessed:

- do nothing more; and
- a scenario of actions to accelerate uptake of better soil, nutrient and pesticide management practices across a number of rural and urban industries. The potential for WWTP upgrades is also considered.

Impacts

Impacts of the 'do nothing more' scenario are likely to be a further decline in water quality and risks to the GBR. Negative impacts are likely on sectors reliant on water quality, particularly the GBR tourism drawcards such as boating, particularly fishing; and a general loss in ecosystem function.

Impacts of the scenario of proactive actions include:

- reductions in dissolved inorganic nitrogen loads by 28%, particulate nitrogen loads by 19%, and particulate phosphorus loads by 30%;
- reductions in a number of pesticide loads (ametryn, atrazine, diuron, hexazinone, tebuthirion), most by 25% over seven years;
- reductions in urban diffuse and point source loads;
- a moderate reduction in sediments of about 2% in seven years;
- significant benefits in terms of risk mitigation to the $1.4b tourism industry, particularly given the significance of the Whitsunday sub-region to GBR tourism, and the recreational fishing industry; and
- implementation costs for the WQIP have been estimated at around $165m; however, MJA estimate the cost of public funding to implement the WQIP would be closer to $80m given the significant private benefits of some management practices proposed.

Implementation issues

The cost effectiveness of rural diffuse programs could potentially be enhanced by two main actions:

- careful design of incentives will ensure the most cost-effective use of public funds. This includes: the use of competitive tenders to select the most cost effective proposals from landholders; structural adjustment loans to meet some up-front capital costs that result in increased gross margins in subsequent years to cover repayments; and careful consideration of who is eligible for the incentives provided; and
- actions should primarily concentrate on the sugar and grazing industries.

Urban diffuse and point source loads are best addressed via suasive approaches, particularly information provision, in conjunction with regulatory approaches for new developments and WWTP upgrades. Upgrades to the Cannonvale and Proserpine WWTPs have been committed.

7.1 Introduction

The Mackay Whitsunday region[121] is over 800,000 hectares extending from Eden Lassie Creek south of Bowen to Connors-Clarke Ranges in the west and around Flaggy Creek Rock to the south.[122] Agriculture is a dominant land use within the region, with agricultural production, such as grazing, from relatively natural environments, accounting for approximately 55% of land use, and irrigated agriculture, primarily sugar, accounting for around 18% of land use.

The Mackay Whitsunday region is one of the largest sugar producing regions in Australia. Other significant land uses, based on area, include conservation and natural environments, which account for around 18% of the total area. Areas under intensive use, such as urban development and mining, only account for a small fraction of total land use, but can have significant impacts on the region.[123] This section applies the framework outlined in Section Two to the potential actions in the Mackay Whitsunday WQIP. The scenarios assessed are based on:

- the Mackay Whitsunday Draft WQIP and other information from the Mackay Whitsunday Natural Resource Management Board;
- potential diffuse urban source actions discussed with EPA officials; and
- application of best practice environmental management to waste water treatment plants.

7.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the WQIP.

7.2.1 Demographic makeup

Population

From the 2006 Census, it is estimated that the population of the Mackay Whitsunday WQIP region was around 124,600.[124] Figure 16 below shows the historic and forecast population growth for the Mackay Whitsunday WQIP region compared to all of the WQIP regions assessed in this report.[125] Figure 16 indicates:

- significant population growth is expected in both Mackay Whitsunday and across the WQIP regions over the next 20 years; and
- the Mackay Whitsunday rate of growth is likely to be significantly higher than for the GBR as a whole.

---

121 The SLAs that lie fully within the Mackay Whitsunday region include Mackay City and Whitsunday Shire. Others SLAs situated partially within the region included Sarina (93%), Mirani (92%) and Bowen (60%). SLAs with less than 10% of their area within the region were excluded.

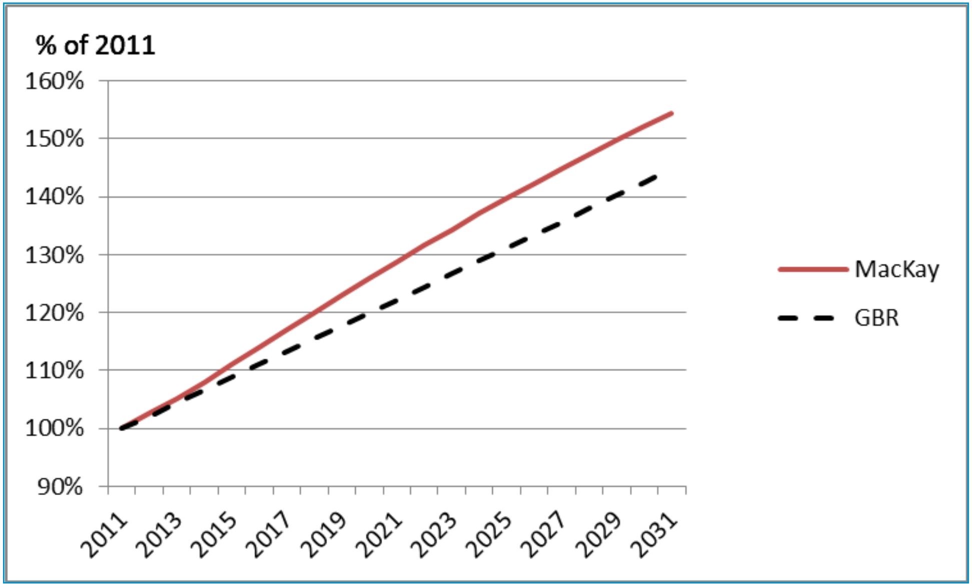
122 Drewry, J., Higham, W., and Mitchell, C., 2008, *Mackay Whitsunday Water Quality Improvement Plan: Final report for Mackay Whitsunday region —draft for public comment.*

123 Based on an analysis of land use data estimated provided by the Queensland Land Use mapping project at NRW.

124 This estimate is based on ABS census data concorded (best-fitted) to the Mackay Whitsunday WQIP region by OESR. Population estimates are based on a census participant’s usual place of residence.

125 Based on DLGPSR Population Forecasting Unit’s mid-estimates for each relevant LGA concorded to WQIP boundaries.

Figure 16: Population growth projections (MW and all GBR WQIP regions)



Source: MJA based on DLGPSR and ABS 2011 census.

Analysis of the population growth forecasts for smaller regions within Mackay Whitsunday indicate that population growth is likely to concentrate in coastal areas with the former Whitsunday Local Government Area expected to grow the fastest, at a rate of approximately 2.6% per annum over the next 20 years. Other population and demographic statistics of note include:

- like much of the GBR, the population of the Mackay Whitsunday WQIP region is slightly skewed to males (51.8% of the population);
- in the 2011 census, 4.3% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Mackay Whitsunday WQIP region compared to around 3.6% for the whole of Queensland; and
- approximately 13% of people in the WQIP region were not born in Australia and around 2% of the population do not speak English at home.[126] To the extent that these people are targeted for programs under the WQIPs, there may be difficulties in effective engagement.

Community capacity

A community's capacity to participate in natural resource management is often impacted by a number of issues:

- approximately 16 of adults (>15 years old) participate in voluntary work, potentially indicating reasonable levels of social capital, although this rate is lower than WQIP regions such as the Fitzroy with greater proportion of the population in primarily rural areas.[127] Females had higher levels of participation in volunteer work (at 19%), compared to males (13%). However, the ABS census data does not indicate what type of volunteer work was undertaken;

---

126 Based on analysis of 2011 ABS census data.

127 Levels of participation in voluntary community activities are often used as a proxy indicator of social capital in a community.

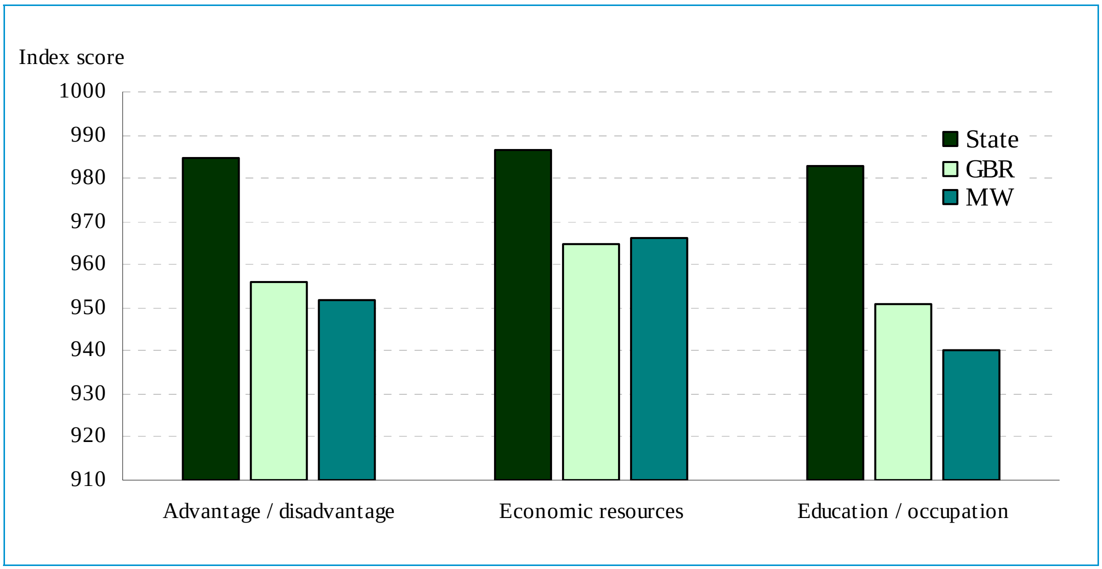
- Mackay Whitsunday has a higher incidence of low-income families than the State as a whole. Approximately 10% of families in the Mackay Whitsunday WQIP area are on low incomes (i.e. < $500/week) compared to 8% for the State. However, reported household incomes are often lower in regions with higher proportions of agricultural enterprises. This is likely to be the case in Mackay Whitsunday, albeit offset by higher incomes in the mining sector; and
- household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In Mackay Whitsunday, approximately 65% of homes are owned or are being purchased. This compares to a State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad way of making relative comparisons of social and economic resources between regions. Three indices of most relevance are:[128]

- the Index of Advantage–Disadvantage is a continuum of advantage to disadvantage. Low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation includes all education and occupation variables.

These indices were concorded to the WQIP regions to enable comparisons of each WQIP region to all of the regions assessed in this report and to Queensland as a whole. Results are shown in Figure 17.

Figure 17: SEIFA indices



Source: MJA based on ABS 2001 census SEIFA indices.

[128] ABS, 2001, 2039.0 *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas, Australia*, 2001

Analysis of the data indicates:

- relative to the State, Mackay Whitsunday is at a relatively significant disadvantage, but at only a slight disadvantage to the GBR as a whole;[129] and
- economic resources in Mackay Whitsunday are below the State, but on par with the whole GBR, while education and occupation data indicates that the region is significantly worse off than the State as a whole and worse off than the GBR as a whole, potentially indicating lower resilience to change.

This broadly implies that the Mackay Whitsunday region's lower social and economic wellbeing may make it more difficult to implement the WQIP here than in other regions. This is particularly due to the low levels of diversity in industry and occupations compared to other WQIP regions. A relatively low level of diversification of occupations indicates the potential capacity of the community to adapt to change could be a constraining factor and measures to address this constraint may be necessary.

Education levels in Mackay Whitsunday are broadly on par with the rest of the GBR catchments, but tertiary education rates are lower than the State as a whole as shown in Table 21.

Table 21: Educational attainment

Highest education level completed	Mackay Whitsunday (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	22.8	21.3	19.8
Year 12	29.0	30.1	37.2
Certificate or diploma	24.1	22.2	21.9
Undergraduate degree	5.8	6.6	9.3
Postgraduate degree	0.8	1.1	2.2

Source: ABS census of population and housing.

7.2.2 Employment and labour force

Labour force statistics in Table 16 indicate the dominance of primary industries and mining.

The significant employment in primary industries is similar to the GBR as a whole, but significantly higher than the State. Manufacturing is relatively more important than for the rest of the GBR and is dominated by sugar processing and machinery manufacturing, often to service the mining sector. Mining is six times more important to the region, compared to the State as a whole. Employment in mining is also growing significantly faster than other sectors within Mackay Whitsunday. [130]

In addition, transport and storage and utilities are both relatively more important than for the GBR and the State as a whole, largely driven by the dominance of the mining industry.

Retail trade and accommodation, cafes and restaurants, often used as a proxy for the tourism industry, are relatively less important in Mackay Whitsunday than the GBR as a whole. However, there is significant variation in the importance of tourism across the Mackay

[129] MJA estimated concorded index scores for each WQIP region using concorded population figures to derive each LGA's SEIFA score to the overall WQIP SEIFA score.

[130] ABS, Census of population and housing — various years. Heather, K., and Clouston, B., 2006, *Regional Agricultural Profile — Mackay Whitsunday Region.*

Whitsunday region. The relative importance of these sectors in the Whitsunday sub-region is very high.

Table 22: Labour force statistics

	Number			Percentage		
	Mackay Whitsunday	GBR	Qld	Mackay Whitsunday	GBR	Qld
Agriculture, forestry and fishing	2,762	23,546	54,563	4	5	3
Mining	7,032	27,793	51,656	10	6	3
Manufacturing	6,245	34,978	169,025	9	8	8
Electricity, gas, water and waste services	665	6,962	24,764	1	2	1
Construction	7,239	40,558	179,947	10	9	9
Wholesale trade	2,925	13,561	73,377	4	3	4
Retail trade	7,232	46,833	214,617	10	11	11
Accommodation and food services	5,542	32,649	140,036	8	7	7
Transport, postal and warehousing	4,820	24,591	104,924	7	6	5
Information media and telecommunications	413	3,588	25,282	1	1	1
Financial and insurance services	949	6,317	53,833	1	1	3
Rental, hiring and real estate services	1,297	7,086	36,875	2	2	2
Professional, scientific and technical services	3,152	18,497	131,921	4	4	7
Administrative and support services	1,941	12,383	64,185	3	3	3
Public administration and safety	2,771	30,251	135,586	4	7	7
Education and training	3,937	33,080	160,241	6	7	8
Health care and social assistance	5,892	47,500	240,017	8	11	12
Arts and recreation services	404	4,210	28,418	1	1	1
Other services	3,538	17,688	78,157	5	4	4
Not stated	1,788	10,814	22,913	3	2	1
Total	**70,544**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS Census of population and housing.

7.2.3 Economic structure

The structure of the economy can provide some indication of a region's capacity to change in response to natural resource management policies or programs. Table 23 indicates the economic structure of Mackay Whitsunday's economy indicated by estimates of gross regional product by industry. Key points to note include:

- the significant dominance of mining must be taken into account when considering the gross value of production. Mining is almost five times as dominant as it is for the State as a whole;

- primary industries are also more prevalent in Mackay Whitsunday than for the State as a whole (4.3% vs. 4.1%). An analysis of the data when the contribution of mining is excluded shows that primary industries are approximately 2.3 times that of the State. This is a better reflection of the relative importance of the primary industries sector, particularly the sugar industry in Mackay Whitsunday;
- despite the significant tourism sector, often indicated by retail trade and accommodation, cafes and restaurants, there is evidence to suggest the tourism sector may be relatively smaller than for the State as a whole. While this result may be somewhat unexpected, it is consistent with lower relative levels of employment in these sectors in Mackay Whitsunday compared to the GBR and State as a whole.[131] Tourism in the Mackay Whitsunday region is concentrated within certain geographical regions, particularly the Whitsundays;[132] and
- generally, Mackay Whitsunday has a much narrower economic base than the State as a whole, with mining and primary industries being disproportionately dominant. Where policies developed under the WQIP impact negatively on these sectors, the impacts could be relatively greater than similar policies in other regions.

[131] It should be noted that the relative importance of tourism is significantly higher when the dominance of the mining sector is removed from the calculations.

[132] GBRMPA tourism group, 2008, *pers comm.*

Table 23: Estimated gross regional product by industry 2005-06

Sector	Mackay Whitsunday		Queensland	
	$m	%	$m	%
Primary industries	572.8	4.3	6,758.0	4.1
Mining	8,081.4	60.7	20,341.0	12.4
Manufacturing	294.2	2.2	14,648.0	9.0
Utilities	208.3	1.6	3,227.0	2.0
Construction	229.8	1.7	13,073.0	8.0
Wholesale trade	328.4	2.5	7,555.0	4.6
Retail trade	297.8	2.2	11,792.0	7.2
Accom, cafes & rest	109.7	0.8	4,754.0	2.9
Transport and storage	701.6	5.3	7,502.0	4.6
Communications	52.1	0.4	3,665.0	2.2
Finance and insurance	202.5	1.5	8,443.0	5.2
Property and business services	623.1	4.7	16,259.0	9.9
Government	142.2	1.1	6,469.0	4.0
Education	299.1	2.2	7,076.0	4.3
Health and community services	401.6	3.0	10,245.0	6.3
Cultural and recreational services	40.3	0.3	1,727.0	1.1
Personal and other services	209.4	1.6	3,422.0	2.1
Ownership of dwellings	350.7	2.6	12,990.0	7.9
General Govt	163.8	1.2	3,672.0	2.2
Total	13,308.8	100.0	163,618.0	100.0

Source: Source: AEC Group, 2007, Economic Baseline Audit of the Mackay Whitsunday region.

The economic structure of Mackay Whitsunday has significant implications for the prioritisation, design and implementation of the WQIP. Of particular importance is the dominance of the sugar industry and the need to target significant effort within that industry if nutrient targets are to be achieved.

Tourism

Along with tropical north Queensland around Cairns, the Whitsunday sub-region is relatively more reliant on reef-based tourism than other WQIP regions. Analysis of GBRMPA's Environmental Management Charge (EMC) data indicates that approximately 1.4 million water-based tourist activities occurred in the Whitsunday region in 2008. This is significantly higher than any other individual GBRMPA management zone. It demonstrates the dominance of the Whitsunday in reef-based tourism and the potential for risks to that industry from any loss in tourism attributable to water quality.[133] The dive and snorkelling tourism market in the Whitsundays has a higher concentration of backpackers and tourists undertaking dive certification as a fundamental focus of their trip. Competition in that market segment is

[133] GBPMA, 2008, unpublished data.

extremely high, particularly with competing locations in South-East Asia.[134] Maintenance of the dive and snorkelling market is vital to the continuation of dive operators and several associated businesses in the Whitsunday sub-region.

Semi-structured interviews undertaken by MJA with approximately 15 dive operators across the GBR (including several in the Whitsundays region) indicated that any deterioration in reef and marine condition has a negative impact in the sector in two main ways. Firstly, operators are often forced to travel further offshore to find quality dive sites increasing operating costs and reducing profits. Secondly, if water quality is poor, dive tourists are less inclined to undertake subsequent dives during their current holiday or return to the region for dive holidays in the future. [135]

Agriculture

The key industry targeted for practice change in the WQIP is agriculture. Table 24 indicates MJA’s estimates of key agricultural land uses and irrigation statistics for Mackay Whitsunday based on the ABS 2005–06 agricultural census and ABS estimates of water use in the agricultural sector for the same period. The analysis shows:

- pasture, primarily for grazing, is the dominant purpose of agricultural land use (at around 65%), followed by sugar cane (around 21%);
- of the area under crops, sugar is by far the dominant crop, accounting for around 97% of the area under broadacre crops;
- horticulture (fruit and vegetables) is a relatively minor land use (around 0.2%);
- of the area under crops, the majority of pasture and cereal crops are not irrigated and around 48% of sugar production is from primarily dry-land production; and
- around 74,000 ha is currently under irrigation, of which around 97% of both the area and water use is for sugar production.

---

134 Tourism Queensland, 2008, *Queensland Scuba Diving and Snorkeling Report — Visitor Activities and Characteristics.*

135 MJA, 2008, *The economic contribution of the dive industry to the GBR.*.

Table 24: Key agriculture sector statistics 2005-06

Land use	Agriculture holdings (ha)	% of area	Est. irrigated area (ha)	Est. irrigation (ML)	Application rate ML/ha
Pasture	429,000	65.1	260	911	3.5
Cereal crops	4,000	0.6	170	562	3.4
Sugar	138,000	20.9	72,000	140,018	1.9
Other broadacre crops	1,000	0.2	50	52	1.1
Fruit	280	0.0	170	278	1.6
Vegetables	1,300	0.2	520	1,040	2.0
Non production areas	85,420	13.0	n.a.	n.a.	n.a.
Total / average	659,000	100.0	74,000	144,367	1.9

Source: MJA analysis based on ABS data.

The significant dominance of sugar for cropping and irrigation has a major significance for the prioritisation and development of programs to address reductions in nutrient loads from the Mackay Whitsunday region. Analysis of other key headline agriculture data indicates:

- Mackay Whitsunday accounts for around 7% of the total cropping area in the GBR and 19% of total irrigated agriculture; [136]
- in terms of gross value of production, approximately 67% of the value of production in Mackay Whitsunday is derived from cropping (mainly sugar), compared to 48% for the GBR as a whole.[137] This indicates a significantly disproportionate reliance on sugar in the Mackay Whitsunday region;
- the value of sugar production in Mackay Whitsunday is estimated to be in excess of 20% of the State's production.[138] Mackay Whitsunday is among the largest sugar producing regions in Australia. Based on value of production figures, sugar accounted for in excess of 95% of the total value of cropping;
- the scale of sugar production in Mackay Whitsunday has resulted in the region being one of the major users of fertiliser in Queensland. It is estimated that the Mackay Whitsunday region accounts for 14% of the State's fertiliser use.[139] This has an impact on nutrient loads entering the GBR;
- the grazing sector is still important in many sub-regions of Mackay Whitsunday, with an estimated 140,000 cattle in the region in 2005. However, this only accounts for around 2–3% of the total cattle in the GBR in both number and value;[140] and
- dairy, other livestock and other primary production, such as eggs, are relatively minimal in the Mackay Whitsunday area.

[136] ABS, *2005 Agricultural Census.*

[137] ABS, *2005 Agricultural Census.*

[138] AEC Group, 2007, *Economic Baseline Audit of the Mackay Whitsunday Region.*

[139] Heather, K., and Clouston, B., 2006, *Regional Agricultural Profile — Mackay Whitsunday Region.*

[140] ABS, *2005 Agricultural Census.*

7.3 Proposed change of practice under the WQIP

The draft MW WQIP[141] outlines a number of proposed practice changes that are designed to address diffuse and point sources of pollutants across the spectrum of land use activities. MJA has assessed the WQIP by assessing the impacts of the practice changes outlined in the WQIP against a 'do nothing more' base case.

7.3.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the WQIP to address sediment and nutrient loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point source loads.

7.3.2 Scenario Two: A suite of changes to practice

Under the WQIP, a suite of actions is proposed to reduce pollutant loads from diffuse and point sources. These actions will enhance water quality in the freshwater and marine environment and enhance relevant environmental values across much of the Mackay Whitsunday catchments and adjacent areas of the GBR. These environmental values are outlined in depth in the WQIP. Through a process of consultation, underpinned by other research[142] and other significant modelling undertaken specifically for the WQIP,[143,144] target changes in sediment, nutrient and herbicide loads attributable to the implementation of the WQIP were established. These loads are shown in Table 25.

141 Drewry, J., Higham, W., Mitchell, C., 2008, *Mackay Whitsunday NRM Group: Water Quality Improvement Plan.*

142 Rolfe, J. et al., 2007, *Effectiveness of Best Management Practices for Water Quality in GBR catchments: sugar cane in the Mackay region*. Centre for Environmental Management. Central Queensland University.

143 Drewry, J., Higham, W., Mitchell, C., and Rohde, K., and Masters B., 2007, *Mackay Whitsunday NRM Group: Modelling sediment and nutrient exports and management scenarios.*

144 Drewry, J., Higham, W., Mitchell, C., Rohde, K., and Masters, B., 2007, *Mackay Whitsunday NRM Group: Turning environmental values into water quality objectives and targets.*

Table 25: Modelled end-of-catchment loads

Key pollutant	Unit	Long-term water quality objective	Current load (2007)	Target load (2014)	Reduction (%)
Sediment	Tonnes/year	n.a.	459,000	449,000	2
Dissolved inorganic nitrogen	Tonnes/year	1,220	1,920	1,320	28
Particulate nitrogen	Tonnes/year	1,380	1,510	1,230	19
Particulate phosphorus	Tonnes/year	120	330	230	30
Ametryn	Kg/year	n.a.	160	120	25
Atrazine	Kg/year	n.a.	1,620	1,210	25
Diuron	Kg/year	3,080	4,680	2,520	46
Hexazinone	Kg/year	n.a.	1,190	890	25
Tebuthirion	Kg/year	n.a.	80	60	25

Source: Source: Drewry, J., Higham, W., Mitchell, C., Rohde, K., and Masters, B., 2007, Mackay Whitsunday NRM Group: Turning environmental values into water quality objectives and targets.

For rural diffuse actions, a suite of classification systems for grazing, sugar and horticulture have been developed in consultation with researchers and industry. These generally cover soil, nutrient and chemical management. Each classification system involves a progression from relatively poor practice (D) to practices that are beyond current best practice (A).

Recognising that any action in isolation may not be prudent and that practice change is likely to involve clusters of complementary changes, each classification system includes a number of on-ground practices, management change and, sometimes, new capital or machinery.[145] In addition to the proposed rural diffuse actions, a number of actions to reduce urban diffuse and point-source loads are also proposed. These include management practices to enhance new urban land development, primarily through water sensitive urban design practices and technologies. An A, B, C, D soil and nutrient classification system is also proposed for these management practices. In addition, the draft WQIP also highlights the potential contribution to reducing loads that would occur from upgrades of WWTPs by council, for example the Bucasia and Bakers WWTPs.

7.4 Potential impacts of WQIP

The WQIP is likely to have a number of positive environmental, social and economic impacts. Key impacts are briefly outlined in Table 26.

145 Drewry, J., Higham, W., and Mitchell, C., 2008, *Mackay Whitsunday NRM Group: Water quality Improvement Plan.*

Table 26: Potential benefits of WQIP

Key benefits	Key elements and values
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive.
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[146]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector to maintain the region's attractiveness to visitors, particularly given the region's high proportion of reef-based tourism activities. Using ABS tourism accommodation data to allocate estimates of the gross value of tourism (as estimated by Access Economics) shows the annual gross value of tourism in the Mackay Whitsunday region could be as high as $1.4b.[147]
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Improved crop yields	Analysis undertaken by DPI&F for developing the WQIP shows potential increases in sugar yields from implementing some practices. This equates to an additional $7.2m to $10.0m per annum in gross margins for the sugar sector in the longer term.
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is worth around $7.82 per household per year. This translates to around $435,000 per annum for the Mackay Whitsunday region for local residents. *If* the modelled reductions in loads outlined in Table 6.5 translate into similar relative improvements in water quality, the annual value of enhanced ecosystems functions and services would be in the vicinity of $10m to $11m.[148]

Source: MJA.

7.4.1 Budgeted costs

In developing the WQIP, estimates of the costs of implementing the WQIP and the required incentive costs were established by DPI&F and the Central Queensland University (CQU). The key on-ground costs, incentives and anticipated effort required to achieve the outcomes are outlined in Table 27.

[146] Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

[147] Access Economics, 2007, *The economic and financial value of the Great Barrier Reef Marine Park, 2005–06.*

[148] MJA estimates based on Windle and Rolfe 2006, *Non-market values for improved NRM outcomes in Queensland.*

Table 27: Estimated on-ground and incentive costs ($m over the period 2007 to 2014)

Industry	Practice change	Est. on-ground costs ($m)	Est. incentives required ($m)	Effort required
Cane & horticulture	Soil management	14.9	5.7	Medium
Cane & horticulture	Nutrients	32.7	13.1	High
Cane & horticulture	Herbicide	32.7	13.1	High
Grazing	Soil management	35.2	14.1	Medium
Urban development	Soil management	4.7	1.9	Medium
Urban (existing)	Nutrients and pesticides	4.7	1.9	Low
Total		**125.0***	**50.0**	

*Note: *This figure is quoted as $115m in the executive summary of the WQIP. However, the correct figure based on the detailed costings is $125m*

Source: Drewry, J., Higham, W., and Mitchell, C., 2008, Mackay Whitsunday NRM Group: Water Quality Improvement Plan.

The estimates indicate total on-ground costs are likely to be around $125m. However, because there are significant private benefits from many practices, the level of incentives required, representing the net cost to landholders, is estimated at $50m over the period from 2007 to 2014. The cost of the incentives is most relevant for any Australian Government funding under the Reef Rescue package. In addition to the required on-ground incentive funding, costs for other elements of the WQIP were estimated. Table 28 indicates the estimated total cost of implementing the WQIP, with the actions currently outlined in it, and MJA's estimation of the funding required under the Reef Rescue package.

Table 28: Estimated WQIP implementation costs ($m over the period 2007 to 2014)

WQIP activities	WQIP estimates ($m)	MJA estimates ($m)	Reason for variation
Rural diffuse (on-ground actions)	125.0	50.0	Government should only fund public benefits
Consultancy / extension	6.0	6.0	N/A
Urban practices	9.6	0.0	Costs borne by consumers
Monitoring and evaluation	14.0	14.0	N/A
Ecosystem health objectives	10.4	9.9	Environmental flows are a responsibility under the *Water Act 2000*
Total	165.0	79.9	

Source: WQIP and MJA.

Only a fraction of the costs of implementing the Mackay Whitsunday WQIP should actually be covered by specific WQIP government funding. Clever policy design could ensure the cost to government in achieving WQIP objectives is both cost-effective and equitable.

While data in Table 27 enables estimation of the cost per unit of reducing specific pollutants, for example the cost per kilo of diuron, calculated costs would be misleading because the suite of management actions deliver reductions in multiple pollutants. Estimating costs on an individual pollutant basis would result in an overestimate of the total costs of meeting targets.

These costs are only indicative. The data underpinning much of the economic modelling undertaken by DPI&F and Central Queensland University and the assumptions made in the economic modelling limit the accuracy of the estimates of actual on-ground costs and incentives required. Section 6.5 explores key economic and social considerations and policy approaches that may influence the final cost to government of implementing the Mackay Whitsunday WQIP.

7.5 Economic and social considerations for implementation of the WQIP

7.5.1 Rural diffuse loads — enterprise numbers and sizes

The design of any program under the WQIP and prioritising the sectors to target should consider the number of participants needed to be engaged to achieve the desired levels of change. Program administration costs are likely to be similar between landholders, irrespective of their property size or contribution to reduce pollutant loads. Given the limited resources likely to be available to run programs, sectors must be targeted effectively and landholders who are more likely to provide the most cost-effective reductions in pollutant loads should also be targeted.

Within the Mackay Whitsunday region, there are approximately 1,660 farming establishments, of which approximately 800 participate in grazing activities. Around 1,160 are solely or partially sugar producers, around 100 are solely or partially involved in horticulture production, and around 75 are solely or partially involved in other broadacre crops, for example irrigated fodder.[149]

When targeting nutrients from all cropping practices under the WQIP, horticulture accounts for around 8% of producers by number, but only 1% of the area under crops. The cost effectiveness of addressing nutrient load reductions through investing in change in horticulture practice may be relatively low, particularly when program administration costs are also considered.

The rationale for administering major programs for the broadacre crop farmers, other than sugar producers, could also be questionable as:

- for programs to reduce nutrient loads, broadacre crop farmers account for 6% of the total number of broadacre enterprises,[150] but only 3% of the area under production;
- for programs to address sediment, broadacre crop farmers account for around 8% of the total number of relevant enterprises, but less than 0.2% of the relevant area under production; and
- the relative effectiveness of interventions need to be very high to justify any significant program, particularly when targeting sediments.

While the importance of addressing sediment loads in Mackay Whitsunday is vital, particularly where regional impacts may be significant, the smaller average size of pastoral holdings compared to other WQIP regions could result in inefficient administration of programs compared to some other regions.

149 ABS, 2005, *Agricultural Census.*

150 Sugar and horticulture are excluded from this analysis.

Data from the 2005 ABS agricultural census indicates that the average grazing enterprise in the Mackay Whitsunday region is only 15% and 5% of the average enterprise sizes for the Fitzroy and Burdekin respectively.[151] Targeting efforts to reduce sediment loads from grazing towards areas that pose the greatest risk to the GBR is vital.

The structure of the agriculture sector, that is the number of enterprises and the areas under management for each sector, suggest that program management efficiencies could be obtained by concentrating WQIP effort primarily on sugar, for nutrient reductions and grazing for sediment reduction.

Major investment in other sectors, such as horticulture and cropping, could only be justified where the relative effectiveness of investment is significantly higher than for sugar and grazing. This is generally consistent with the development of the WQIP to date.

7.5.2 Rural diffuse loads — specific sugar industry issues

Changes in nutrient loads in Mackay Whitsunday will be highly reliant on the prospects and actions of the sugar industry. This section considers a number of economic aspects of the sugar industry and the potential lessons for the design of any efficient sugar program under the WQIP.

Risks to WQIP objectives from potential expansion of sugar production

Economic analysis undertaken for the Whitsunday Water Resource Plan (WRP) identified two district linkages between water management, water use, and the regional Mackay Whitsunday economy:

- maintaining water supply reliability for the sugar industry's viability and longer-term growth prospects; and
- impacts on water quality attributable to the expansion of irrigated agriculture, primarily irrigated agriculture, on the downstream tourism industry, particularly from changes in loads to Repulse Bay.[152]

While the current and foreseeable prospects for growth in the sugar industry indicate a relatively low likelihood of expansion within Mackay Whitsunday, any future growth in the industry could exacerbate risks to water quality. Economic assessments undertaken by MJA for the Pioneer Valley and Whitsunday WRPs show very limited prospects for growth in sugar production within the life of the WQIP. [153,154] However, in some areas of the Whitsunday WRP area, there is evidence of significant under-utilisation of water entitlements. Water entitlements utilisation rates have been at approximately 55% over recent years. Under appropriate market conditions, with current policy settings, expansion could increase considerably, albeit some requiring infrastructure augmentation such as the Lethebrook off-stream storage and a weir on the O'Connell River. Water availability is a significant constraint on expansion in the Pioneer, particularly in coastal areas of the catchment with a greater reliance on groundwater sources within their conjunctive water supply mix.

151 ABS, 2008, 2005 *ABS Agricultural Census.*

152 Water quality impacts were not explicitly considered through the WRP process.

153 MJA, 2007, *Economic and social report on the proposed amendment to the Pioneer Valley Water Resource Plan to include groundwater*.

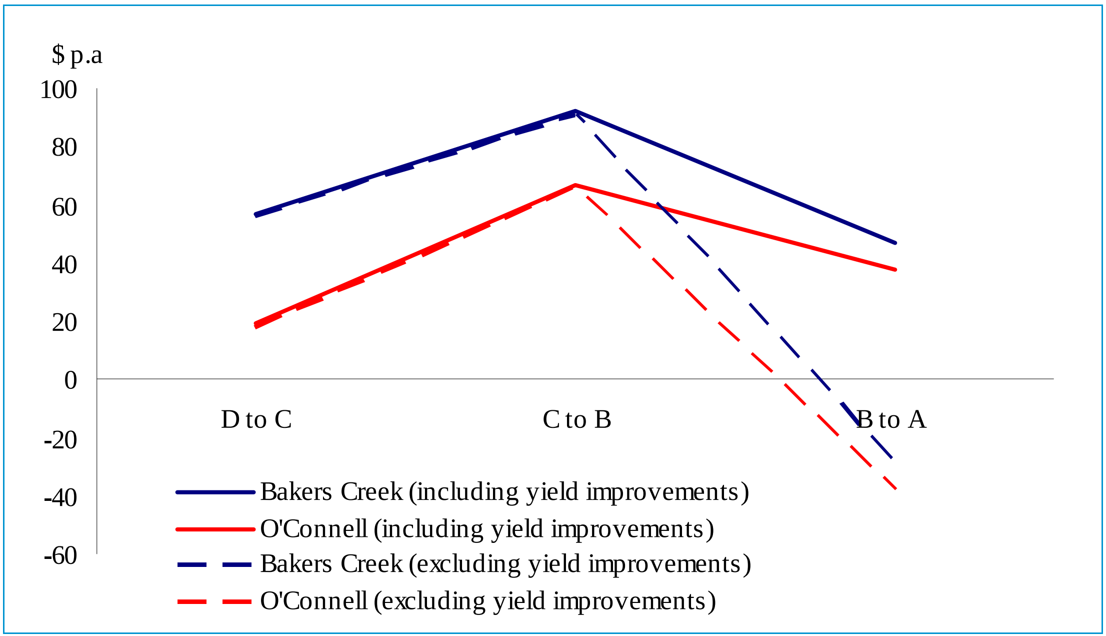
154 MJA, 2007, *Economic and social assessment report for the Whitsunday Water Resource Plan area*.

In implementing the Mackay Whitsunday WQIP, programme managers will need to be aware of the potential risks to the WQIP targets that could result from any improvements in market conditions for the sugar industry. Where expansion may occur in the future, it may be more cost effective to work with producers establishing greenfield sites than working with existing producers, where expensive retrofitting of practices and farm reconfiguration may be required.

Variation in farm size

Detailed economic analysis was undertaken by DPI&F to underpin the design of the Mackay Whitsunday WQIP.[155] DPIF used a representative farm modelling approach (200 ha representative farms for the Bakers and O'Connell catchments) to estimate the economic impacts of practice change in the sugar industry (D to C, C to B, B to A). The results of this modelling are shown in Figure 18.

Figure 18: Annual per hectare benefits of changed practice (200 ha farm)



Source: Strahan R., 2007, Estimating the economic implications for cane farms in the Mackay Whitsunday catchments of practice changes to more sustainable landscapes.

The modelling shows there is likely to be commercial as well as environmental benefits from enhancing practices, particularly where yield improvements can be achieved.

However, the DPI&F analysis also indicated that, even with the reduced costs and yield improvements, most farms would still not be profitable. The studies undertaken by MJA for the WRPs had similar results, identifying that most farms are still reliant on some degree of off-farm income to remain viable.

Farm size can have a significant impact on the economic viability of an enterprise and the ability of that enterprise to invest in changed practices, particularly where up-front expenses are incurred.

In addition, because cane growers often contract out specific aspects of production and harvesting, the size of farms can also have an impact on the degree to which specific tasks are

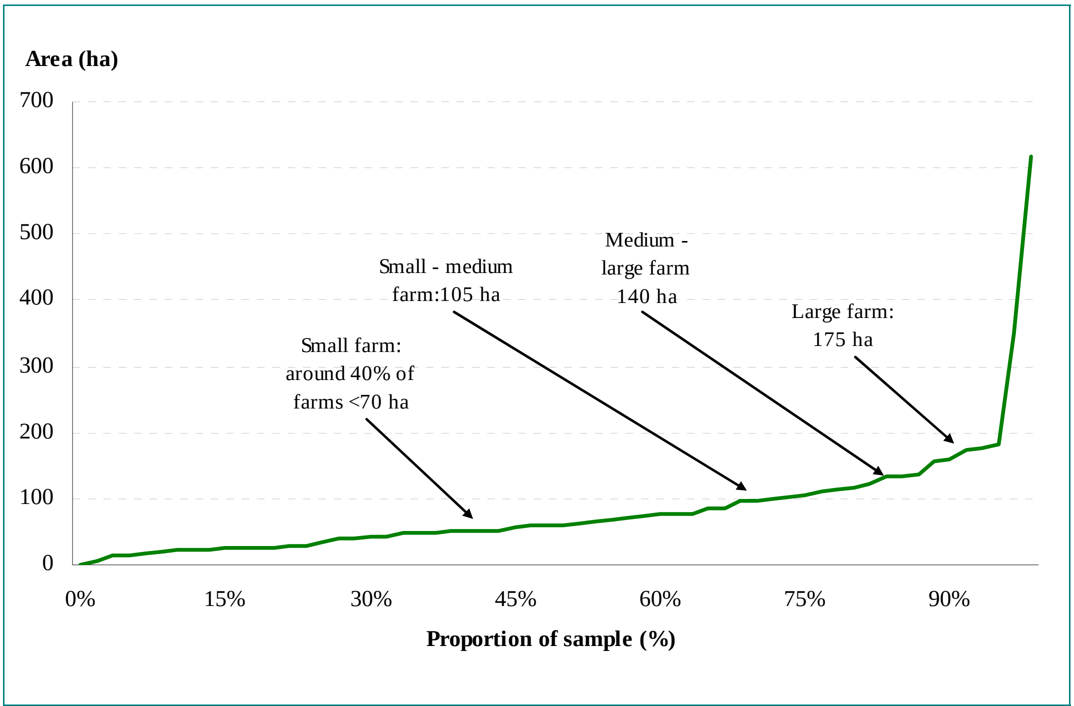
---

155 Strahan R., 2007, *Estimating the economic implications for cane farms in the Mackay Whitsunday catchments of practice changes to more sustainable landscapes.*

contracted out. This is particularly the case where expensive capital equipment cannot be justified or afforded for smaller farms.

The DPI&F analysis assumed a farm size of 200 ha. However, analysis undertaken by MJA found there is significant variation in the size of sugar enterprises across the Mackay Whitsunday region. The spread of farm sizes in the Whitsunday region is shown in Figure 19. In the Whitsunday region, more than 40% of operators are running small sugar enterprises of less than 70 ha.

Figure 19: Variability in sugar farm sizes — Whitsunday WRP region



Source: MJA, 2007, Economic and social assessment report for the Whitsunday Water Resource Plan area.

Many of these enterprises are commercially marginal, at best, and are extremely vulnerable to policy changes that either impose additional costs or reduce productivity.[156] Similarly, average farm sizes in the Pioneer Valley are less than 70 ha. MJA's analysis of the distribution of farm sizes shows that less than 10% of the farms in the Mackay Whitsunday WQIP region are likely to be similar to the size assumed by DPI&F. This may have an impact on the level of practice change uptake and impact on the incentives required to meet WQIP targets.

Economic implications of farm size and physical characteristics

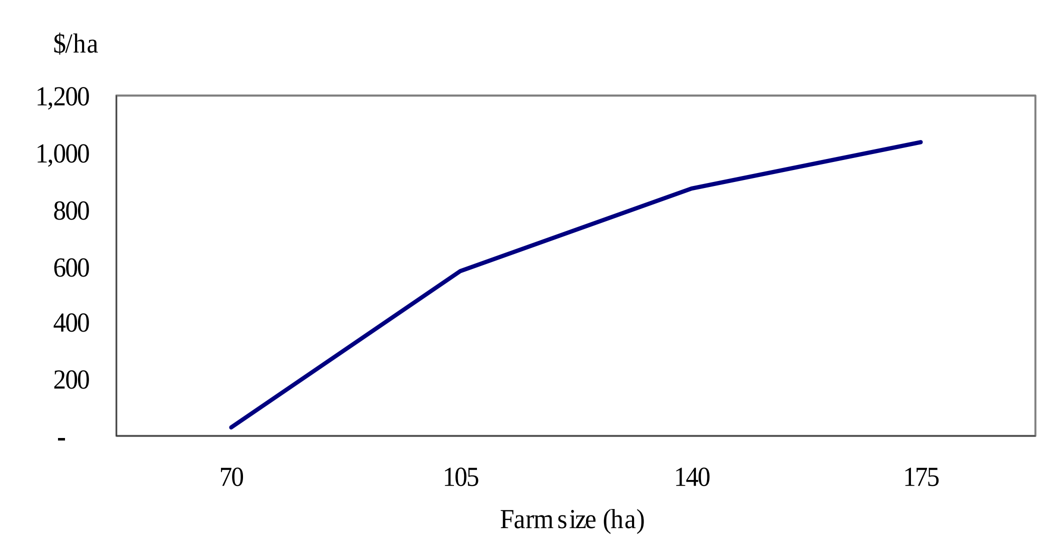
There is evidence of significant economies of scale in sugar production in the Mackay Whitsunday WQIP region. Figure 20 shows MJA's estimates of operating surplus per hectare for the four sizes of cane farms used in the economic analysis to underpin the Whitsundays WRP.[157] The data shows a significant variation in operating surplus per hectare, with larger farms being able to spread fixed costs across a larger production base.

[156] For these WRPs, MJA developed eight representative sugar farm models for the Whitsunday and Pioneer Valley, representing the diversity in size of enterprises and differing cost structures across the WRP area. These models were developed to measure the economic impact of changes in inputs and prices, for example change in water use, change in water entitlement reliability, changes in infrastructure charges and changes in sugar price.

[157] Note: This analysis was undertaken with an assumed price of $320/tonne, significantly higher than the $280 and $300 / tonne assumed by DPI&F to underpin the economic analysis specifically undertaken for this WQIP.

In addition to economies of scale, the economics of differing management practices proposed in the WQIP will also be influenced by farm make up across the WQIP area. In providing advice to the State for amending the Pioneer Valley WRP, MJA found that enterprise makeup (soil type, irrigation practice) has a major impact on an enterprise's ability to change practices.[158]

Figure 20: Economies of scale in sugar farming in the Whitsunday — operating surplus ($ per ha)



Source: MJA, 2007, Economic and social assessment report for the Whitsunday Water Resource Plan area.

Key issues and lessons for WQIP sugar program design

There are a number of key issues and lessons for the development of the WQIP sugar program. These include:

- there is evidence of significant economies of scale in sugar farming. Farm size has specific implications for the transaction costs and effective design of implementation strategies under the WQIP. More effective outcomes may be achieved by contracting fewer, larger operators to reduce program administration costs and to target farmers who are more likely to have sufficient economic resources to invest in practice change. Mechanisms such as competitive tenders to distribute incentives funding cater for these issues well;
- there is significant variability in the size, physical (e.g. soil types, water sources), agronomic and economic characteristics and practices of properties within the WQIP region. The variability within the sugar sector will complicate the development of a robust, transparent and repeatable tool (a metric) to assess the relative contribution of individual landholder's proposals for incentive funding. The metrics developed by Central Queensland University for the tenders being run by the Mackay Whitsunday Natural Resource Management Board and the Burdekin Dry Tropics Natural Resource Management Board form a solid basis for robust assessment of individual proposals;
- DPI&F identified that significant up-front capital investments may be required to implement practice change. These investments could include, for example the purchase and use of hooded sprayers. Cost estimates were $35,000 to move from level C to level B and $62,000 to move from level B to level A.[159] Limited access to capital could

---

158 Based on a sugar price of $320 per tonne and including operators' off-farm income.

159 Strahan, R., 2007, *Estimating the economic implications for cane farms in the Mackay Whitsunday catchments of practice changes to more sustainable landscapes.*

significantly constrain landowners' ability to accelerate adoption of best practice where there are 'up front' capital costs or time lags between implementation and productivity benefits. Some form of transitional funding or risk sharing would, therefore, be appropriate. One option worth considering is to provide financial incentives for capital equipment in the form of structural adjustment loans, with repayments more closely aligned to enhancements in cashflow; and

- because production and harvesting inputs are often outsourced to contractors in the sugar industry, for some practices and capital equipment, it may be worthwhile to target contractors as well as landholders. This may result in practice change across several farms from a single incentive transaction with a contractor.

In combination, these issues indicate that any program to accelerate adoption needs to be both flexible in targeting practice change and recognise the variance of private benefits and costs of different practices for different landholders. In effect, rigid approaches and regulation may prove costly.

7.5.3 Rural diffuse loads — specific horticulture issues

In developing the WQIP, load estimates, practice changes and costs for horticulture are essentially considered to be identical to sugar cane. Where the likely changes in loads implementing a change in practice are the same as for sugar, this would enable a single WQIP program to covers both industries. In effect, horticulturalists would be competing with canegrowers for the same incentives.

However, because of the scale differences between horticulture enterprises and sugar enterprises, the relative administrative costs of any horticulture program are likely to be significantly higher. This needs to be taken into consideration when designing and implementing any program that targets the horticulture sector.

7.5.4 Rural diffuse — specific grazing industry issues

Changes in soil management practices in the grazing sector have the potential to make significant impacts on the long-run sediment loads into the GBR. A series of practices have been clustered to form a relatively intuitive A, B, C, D classification tool for the use by landholders and WQIP program managers. Potential adoption levels have been developed in consultation with industry. The on-ground cost of actions over the life of the WQIP has been estimated at $35.2m, of which $14.1m in incentives would be required, recognising some commercial benefits to farmers from implementing enhanced management practices.[160]

The key costs to the grazing sector were assessed, based on a 200 ha property. These costs include:

- a grazing land management plan, at around $4,500;
- pasture and stock monitoring at three sites, at around $9,000;
- a nutrient management plan, including five soil tests, at around $2,500;
- five kilometres of fencing, at around $18,000; and

[160] Drewry, J., Higham,W., and Mitchell, C., 2008, *Mackay Whitsunday NRM Group: Water Quality Improvement Plan*.

- two watering points, at around $20,000.[161]

While the cost of developing a grazing land management plan and nutrient management plan probably do not vary greatly between landholders, the other costs will vary significantly. In addition, the actual net private benefits and costs of undertaking the other actions will vary significantly between enterprises.

In achieving the objectives of the WQIP, a grazing program needs to be developed.

- a grazing program should be designed to assist landholders make a long-term transition along the classifications (D to C, C to B etc.) using an appropriate mix of suasive approaches and financial incentives where necessary. It is likely that this approach would be reinforced by the light regulatory approach adopted by the State, particularly under the State leasehold land use strategy; and
- in the absence of any additional regulation, competitive tenders could potentially offer the most efficient tool to allocate public money to graziers to increase adoption rates.

These approaches may be further enhanced through complementary policy reform by the State and Australian Governments to ensure 'perverse' outcomes do not occur from other policies, such as exceptional circumstances policies and drought relief policies.

7.5.5 Urban implementation issues

The draft WQIP places less emphasis on urban pollutants, both from diffuse sources and point sources. This is largely a reflection of the institutional arrangements in place and the rural focus of WQIPs in general.

However, the WQIP does include an A, B, C, D classification for reducing loads from greenfield urban development and infill development. The WQIP indicates that these costs should be 'internalised' as part of the development cost and should not be borne by public funding under the WQIP. The WQIP has estimated these costs at around $9.6m over the next seven years, based on a certain uptake of practices.

However, if the practices do form the basis of any regulatory framework, the costs and the impacts on loads could both be significantly higher as compliance would be almost 100%. Based on population forecasts for the Mackay Whitsunday WQIP region and assuming a similar suite of actions to reduce urban diffuse loads as used for the SEQ Healthy Waterways Strategy, the costs could be in the range of $29 to $43m over the seven years. This is reflected in higher costs in establishing new homes equating to an additional 1.1 to 1.3% on the cost of an average new home.

Similar to urban diffuse, point sources have been given little attention in the WQIP development to date, although upgrades to WWTPs are identified as a key implementation action. The costs of WWTP upgrades are driven by the engineering capital and operational costs and are specific to the actual plant.

MJA undertook analysis of expenditure data[162] for recent upgrades from secondary to tertiary treatment for several WWTPs in South East Queensland. Economic impacts were calculated using a simple 'building blocks' approach for estimating tariffs and charges. This reflects the financial cost per tonne to the community of reducing a tonne of nutrients from emissions that

161 Drewry, J., Higham,W., and Mitchell, C., Rohde. K, 2007, Mackay Whitsunday NRM Group*: Modelling* sediment and nutrient exports and management scenarios.

162 Data provided by Queensland EPA.

would be passed onto households via higher charges. Estimates range from $76,000 to $200,000 per tonne per annum.

Given these costs, it may be prudent to consider the degree to which costs can be reduced by using flexible mechanisms that allow lower cost upgrades to be exploited. Where there is more than one WWTP that could be upgraded to meet a reduced load target, the lowest cost option should be exploited, potentially regulated under a ‘bubble license’ arrangement.[163]

Regulatory approaches and subsequent performance standards under WWTP licence conditions are the most appropriate implementation approach, with the costs being shared across the community via wastewater treatment charges.

[163] The use of bubble licences has significantly reduced the costs of WWTP upgrades in NSW.

8. Burdekin

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- With the exception of some areas where population growth is driven by mining, the Burdekin region's population is expanding at a slower rate than the GBR catchment population as a whole.
- The Burdekin is significantly more reliant on primary industries than any other WQIP region, or the State as a whole. The high reliance within the Burdekin on agriculture, particularly sugar and beef production, as a source of employment and income and the associated water quality risks from production are not likely to decline without policy intervention.
- The abundance of water and soil resources for potential expansion of irrigated agriculture poses a significant risk to water quality in the future. Irrigated horticulture development is likely to create the most significant increase of risks.
- There are significant economic and social constraints to changing agricultural practices and these have implications for policy and program design and implementation. Burdekin-specific research indicates financial and economic constraints are dominant.

Scenarios assessed

Two scenarios were assessed:

- take no further action; and
- undertake a range of actions to accelerate uptake of better soil, nutrient and pesticide management practices across a number of rural industries, particularly grazing and sugar cane.

Impacts

Impacts of the take no further action scenario are likely to be:

- a further decline in water quality and risks to the GBR;
- negative impacts on sectors reliant on water quality, particularly GBR tourism drawcards such as boating, diving and snorkelling;
- negative impacts on recreation, particularly fishing; and
- a general loss in ecosystem function.

Impacts of the second scenario of undertaking actions include:

- a reduction in sediment loads of 8% in five years, 15% in 10 years and up to 60% in 50 years from the Burdekin rangelands area;
- reductions of 8–25% in nitrogen loads in five years and 60-80% in the long term from the sugar cane areas;
- a significant reduction of 25–50% in pesticide loads from sugar production in the Lower Burdekin in the short term; and
- significant benefits from risk mitigation to the tourism industry and the recreational fishing industry; however, given the location of the Burdekin WQIP region and the scale of the local tourism and recreation industry, local benefits are likely to be modest.

While the costs of implementing the WQIP are highly uncertain, they are also considerable. MJA estimate:

- annual costs of meeting the five-year targets for the rangelands area are between $14m and $27m. For sugar, the annual cost is significantly lower, at around $2m. The cost of permanent change to achieve the five-year target loads is very significant and substantially beyond the resources available under the Reef Rescue package.
- the annual costs of achieving long-term load targets are substantial. Costs for rangelands are potentially in excess of $115m per annum, while for sugar, costs are in excess of $21m per annum.

Implementation issues

Because of the significant costs in meeting load targets, considerable effort needs to be made to ensure implementation of the WQIP achieves cost-effective outcomes. This can be enhanced by a number of measures:

- incentives must be carefully designed incentives to ensure the most cost-effective use of public funds. This includes: using competitive tenders to select the most cost-effective proposals from landholders; structural adjustment loans to meet some up-front capital costs resulting in increased gross margins in subsequent years to cover repayments; and careful consideration of who is eligible for incentives (i.e. should landholders or contractors be targeted for some incentives?); and
- potentially concentrating on the sugar industry as the results of the Burdekin water quality tender suggest that management actions in the grazing sector may be less cost-effective.

8.1 Introduction

The Burdekin WQIP region[164] includes the majority of lands drained by the Burdekin (including the Belyando and Sutter Rivers), Haughton, Black, Ross and Don River Basins and their tributaries. Agriculture is a dominant land use within the Burdekin, particularly production from relatively natural environments such as grazing. Crops cover an area of around 200,000 ha. The dominant irrigated crop in the region is sugar and the Burdekin is one of the largest sugar-producing regions in Australia. There are also significant areas of irrigated horticulture including perennial tree crops and annual crops, predominantly vegetables. Areas under intensive use from, for example, urban development and mining, only account for a small fraction of total land use, but can have significant impacts on the region. This section applies the framework outlined in Section Two to the potential actions outlined in the Burdekin WQIP to reduce pollutant loads. The scenarios assessed are based on the Draft Burdekin WQIP currently being established by the Burdekin Dry Tropics Natural Resources Management Board.

8.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the WQIP.

8.2.1 Demographic makeup

Population

From the 2006 Census, it is estimated that the population of the Burdekin WQIP region was around 37,200. Figure 21 shows the historic and forecast population growth for the Burdekin WQIP region, compared to all of the WQIP regions assessed in this report.[165] It indicates that, unlike the significant population growth expected across the GBR over the next 20 years (up 157% between 2001 and 2026), the population in the Burdekin WRP area is only expected to increase by around 6%.

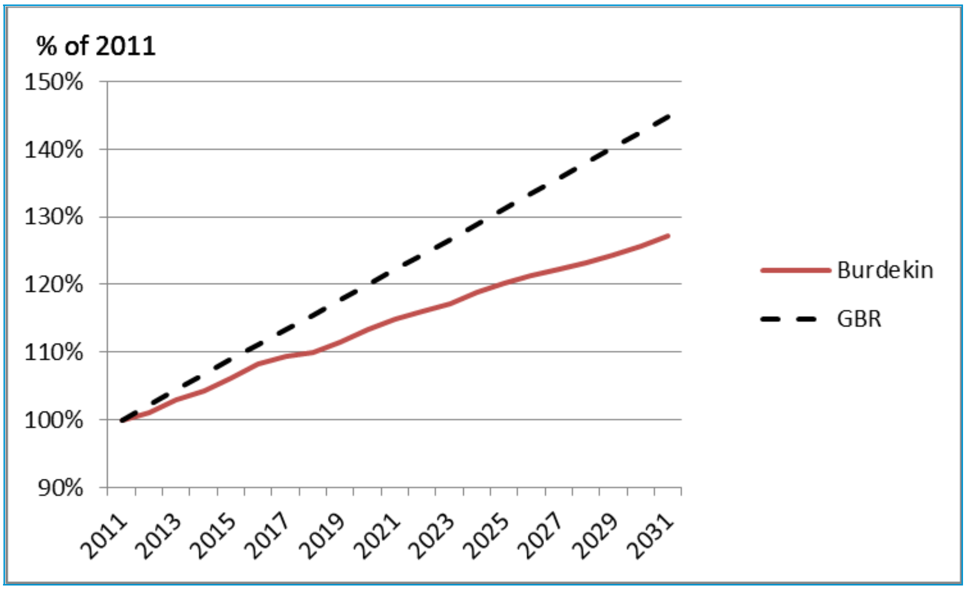
---

164 Census data used in this section is based on the following concordance of Statistical Local Areas (pre- council amalgamation): Burdekin (100%), Charters Towers (100%), Dalrymple (98%), Jericho (70%), Nebo (49%), Bowen (40%), Townsville — Pt B (22%), Belyando (9%), Mirani (8%), Thuringowa — Pt B (2%), Etheridge (1%), Herberton (1%).

165 Based on DLGPSR Population Forecasting Unit's mid-estimates for each relevant LGA concorded to WQIP boundaries.

The lower population growth rates in the Burdekin are primarily attributable to lower levels of urban population growth, which are primarily concentrated in coastal zones. Much of the regional population growth in the GBR catchments is occurring in regions with significant mining development, largely outside the Burdekin WQIP region.

Figure 21: Population growth projections (Burdekin and all GBR WQIP regions)



Source: MJA based on DLGPSR and ABS 2011 census.

Other population and demographic statistics of note include:

- 51% of the population, is male, like much of the GBR;
- 5.8% of respondents to the 2006 Census in the Burdekin WQIP region identified themselves as being Aboriginal or Torres Strait Islander compared to around 3.6% for the whole of Queensland; and
- approximately7% of people in the WQIP region were not born in Australia and around 3% of the population do not speak English at home.[166] To the extent that these people are the target participants for programs under the WQIPs, there may be difficulties in effective engagement.

Community capacity

A community's capacity to participate in natural resource management is often impacted by a number of factors:

- participation in voluntary work. The rate of volunteering is extremely high in the Burdekin WQIP region. Approximately 21% of adults (>15 years old) participate in voluntary work, potentially indicating relatively high levels of social capital. This rate is higher than many WQIP regions, particularly those with a proportionately higher urbanised population.[167] Females had higher levels of participation in volunteer work

[166] Based on analysis of 2006 ABS census data.

[167] Levels of participation in voluntary community activities are often used as a proxy indicator of social capital in a community.

compared to males. However, the ABS census data does not indicate the type of volunteer work (e.g. environmental management) undertaken;

- the proportion of low-income families. The relative financial impact of various projects or policies must be considered as the burden may be relatively greater for lower income families. The Burdekin has a higher proportion of low-income families than the State as a whole. Approximately 15% of families in the Burdekin WQIP area are on low incomes (< $600/week) compared with 8% for the State. However, reported household incomes are often lower in regions with higher proportions of agricultural enterprises. This is particularly likely to be the case in the Burdekin WQIP region where agriculture is so dominant and incomes are often understated; and
- household ownership (owned or being purchased). This factor is sometimes used as a proxy for economic capacity. In the Burdekin WQIP region, approximately 65% of homes are owned or are being purchased. This compares to a State average of 55%.

Table 29: Educational attainment

Highest education level completed	Mackay Whitsunday (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	22.8	21.3	19.8
Year 12	29.0	30.1	37.2
Certificate or diploma	24.1	22.2	21.9
Undergraduate degree	5.8	6.6	9.3
Postgraduate degree	0.8	1.1	2.2

Source: ABS 2011 Census

The ABS SEIFA is a suite of broad, composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad means to make relative comparisons of social and economic resources between regions. Three indices are most relevant to the Burdekin WQIP region:[168]

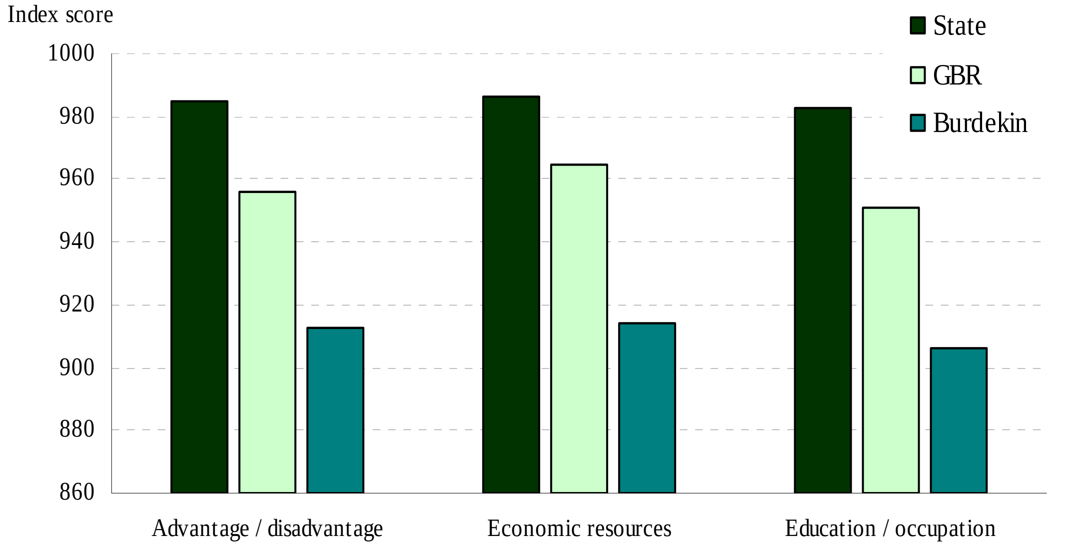
- the Index of Advantage–Disadvantage. This is a continuum of advantage to disadvantage, with low values indicating areas of disadvantage and high values indicating areas of advantage;
- the Index of Economic Resources. This includes variables that are associated with economic resources, including rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation. This includes all education and occupation variables.

These indices were concorded to the WQIP regions to enable comparisons of each WQIP region to all of the regions assessed in this report and Queensland as a whole.[169] Results are shown in.

[168] ABS, 2001, 2039.0 *Information Paper: Census of Population and Housing - Socio-Economic Indexes for Areas,* Australia, 2001.

[169] MJA estimated concorded index scores for each WQIP region using concorded population figures to derive each LGA's SEIFA score to the overall WQIP SEIFA score.

Figure 22: SEIFA indices



Source: MJA based on ABS 2001 census SEIFA indices.

Analysis of the data indicates:

- relative to the State and the GBR as a whole, the Burdekin suffers significantly higher levels of economic and social disadvantage; and
- economic resources in the Burdekin are considerably below the State and the GBR, while education and occupation data indicates the Burdekin WQIP region is significantly worse off than the State and the GBR as a whole, potentially indicating lower resilience to change.

This implies that the Burdekin WQIP region's lower social and economic wellbeing may make it more difficult to implement the WQIP than in other regions.

Further, the low levels of diversity in industry and occupations in the Burdekin WQIP region compared to other WQIP regions indicates the potential capacity of the community to adapt to change could be a constraining factor. Measures to address this constraint may be necessary.

8.2.2 Employment and labour force

Labour force statistics in Table 30 show the dominance of primary industries in the Burdekin. Of the 16,700 workers in the Burdekin WQIP region, around 3,600 (over 21%) work in the agricultural sector, predominantly sugar production. Relative employment levels in primary industries in the Burdekin WQIP region are more than three times that of the GBR as a whole and more than six times that for Queensland. In addition, much of the value-adding and manufacturing in the Burdekin WQIP region is for primary produce including sugar and some horticulture.

Table 30: Labour force statistics

	Number			Percentage		
	Burdekin	GBR	Qld	Burdekin	GBR	Qld
Agriculture, forestry and fishing	3,122	23,546	54,563	18	5	3
Mining	1,731	27,793	51,656	10	6	3
Manufacturing	1,491	34,978	169,025	9	8	8
Electricity, gas, water and waste services	250	6,962	24,764	1	2	1
Construction	1,162	40,558	179,947	7	9	9
Wholesale trade	362	13,561	73,377	2	3	4
Retail trade	1,619	46,833	214,617	9	11	11
Accommodation and food services	953	32,649	140,036	5	7	7
Transport, postal and warehousing	676	24,591	104,924	4	6	5
Information media and telecommunications	83	3,588	25,282	0	1	1
Financial and insurance services	186	6,317	53,833	1	1	3
Rental, hiring and real estate services	167	7,086	36,875	1	2	2
Professional, scientific and technical services	429	18,497	131,921	2	4	7
Administrative and support services	289	12,383	64,185	2	3	3
Public administration and safety	845	30,251	135,586	5	7	7
Education and training	1,411	33,080	160,241	8	7	8
Health care and social assistance	1,524	47,500	240,017	9	11	12
Arts and recreation services	70	4,210	28,418	0	1	1
Other services	582	17,688	78,157	3	4	4
Not stated	450	10,814	22,913	3	2	1
Total	**17,402**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS 2006 Census of Population and Housing.

In addition, mining is relatively more important in the Burdekin region than for the GBR and the State as a whole, while the manufacturing sector is moderately more important in the Burdekin compared to the GBR, largely due to sugar processing.

The professional services and tourism-related sectors are significantly less important than in both the GBR and Queensland as a whole. This is partially a result of excluding Townsville from the Burdekin WQIP region. However, the Burdekin WQIP region is well serviced and has relatively good access to professional and technical inputs from Townsville.

8.2.3 Economic structure

The structure of the economy can provide some indication of a region's capacity to change in response to natural resource management policies or programs. Comprehensive economic data that matches the Burdekin WQIP region is not available. The employment data shows the economic structure of the Burdekin WQIP region is very narrow, dominated by agriculture and associated manufacturing. In terms of the value of production, however, mining may dominate. This is despite mining accounting for a lower proportion of the labour force. There are also significant sub-regional differences, with some smaller regions, such as Nebo, having a very narrow economic base, highly reliant on industries such as mining.[170] The majority of economic and social profiles for the region reinforce the relatively narrow economic base, centred on primary industries (sugar, pastoral, horticulture and an emerging aquaculture sector), mining and associated developments.[171] Because of its relatively narrow economic base, the Burdekin WQIP region is potentially at a greater relative risk from any downturn in the primary industries sector than any other WQIP region.

The economic structure of the Burdekin has significant implications for prioritisation, design and implementation of the WQIP. Of particular importance is the dominance of the sugar industry and the need to target significant effort at that sector if nutrient targets are to be achieved. Given the current and likely medium-term outlook for the sugar industry, programs will need to ensure continued production volumes for the viability of mills in the region. Programs that significantly impact on regional production levels could have major flow-on impacts in the processing industry.

Agriculture

The key industry targeted for practice change in the WQIP is agriculture. Table 31 shows MJA's estimates of key agricultural land uses and irrigation statistics for the Burdekin WQIP region based on the ABS 2005–06 agricultural census and ABS estimates of water use in the agricultural sector for the same period. The analysis shows:

- pasture, primarily for grazing, is the dominant purpose of agricultural land use (approximately 97%), followed by sugar cane (approximately 1%);
- of the areas under irrigated crops, sugar is the dominant crop, accounting for around 79,000 ha or 88% of the area under irrigation;
- horticulture (fruit and vegetables) is also a major irrigated crop but with relatively minor land use (approximately 9,000 ha); and
- of the total area under crops, there are still significant areas of dryland cropping, estimated to be 70,000ha.

Table 31: Key agriculture sector statistics 2005–06

Land use	Agriculture holdings ('000 ha)	% of area	Est. irrigated area ('000 ha)	Est. irrigation ('000 ML)	Application rate (ML/ha)
Pasture	12,340	98.7	3	20.2	2.6
Cereal crops	54	0.4	2	7.9	4.8
Sugar	90	0.7	79	670.8	8.5
Other broadacre crops	5	0.0		1.9	4.3
Fruit	3	0.0	2	7.8	3.3
Vegetables	9	0.1	7	19.7	2.8
Total / average	**12,501**	**100.0**	**93**	**728.2**	**7.8**

MJA analysis based on ABS, 2008, Water use on Australian Farms 2005-06.

[170] Greiner at al., 2003, *Natural Resource Management in the Burdekin Dry Tropics: social and economic issues.*

[171] Burdekin Shire council, undated, Burdekin Regional Profile.

The significant dominance of sugar for cropping and irrigation has major significance for the prioritisation and development of programs to address reductions in nutrient and sediment loads from the Burdekin WQIP region.

8.2.4 Water quality risks from future economic development

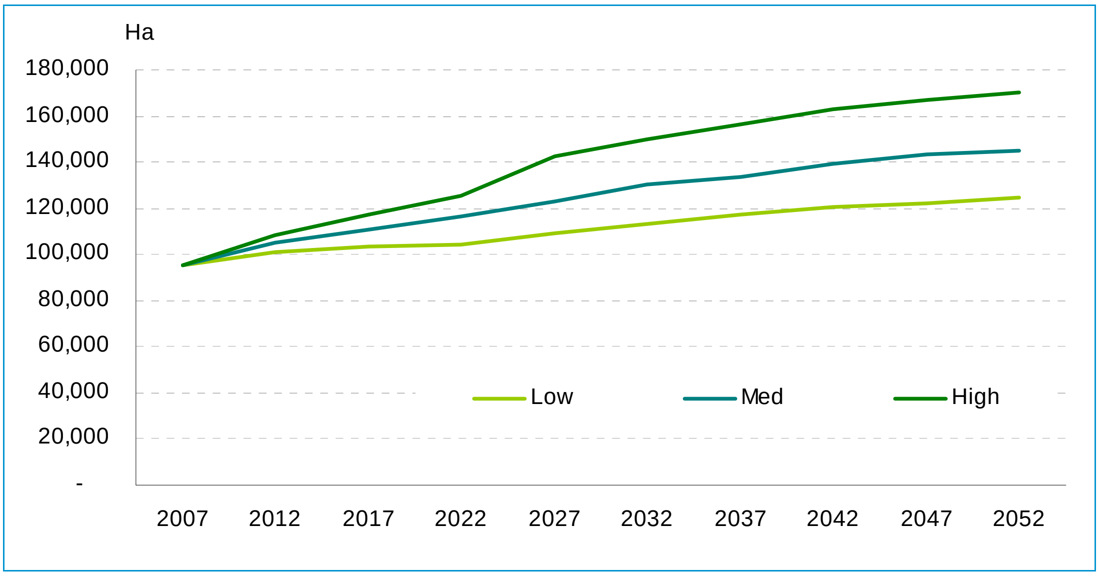
There has been significant interest in the further expansion of irrigated agriculture in Northern Australia with a particular focus on the Burdekin region. There are a number of key drivers of growth in irrigated agriculture including:

- significant growth in demand for products in markets where the Burdekin has a competitive advantage, or where the Burdekin's competitive advantage is likely to increase over time, such as horticulture, including processed horticulture, and beef;
- significantly under-utilised water resources and an expectation that many competing production regions will be more adversely impacted by climate change than the Burdekin, which may trigger a relocation of irrigated agriculture over the medium- to long-term; and
- an expansion of suitable crops in the region, including a significant interest in cotton.[172]

Plans are already well advanced for expansion in areas such as Bowen and a number of feasibility studies have been undertaken on water infrastructure augmentations, including raising the Burdekin Falls Dam.

While there is significant economic uncertainty about the most likely development path for irrigated agriculture in the Burdekin, a recent water demand study undertaken by MJA assessed both economic and agronomic aspects of future development prospects. The report found that significant expansion in the area under irrigated agriculture was likely over the next 50 years. A range of forecasts for irrigated areas is shown in Figure 23.

Figure 23: Potential growth in irrigated agriculture (area)



Source: MJA, 2008, North Queensland Regional Water Supply Strategy: rural water demand. Draft report.

[172] MJA, 2008, *North Queensland Regional Water Supply Strategy: rural water demand*. Draft report.

The most likely growth scenario is closer to the lower end of the range. This is particularly the case in the short- to medium-term as the agricultural sector's international competitiveness is constrained by a high Australian dollar and continued low-cost development opportunities in competing regions.

The distribution of future growth in demand is influenced by a number of agronomic and other factors such as the location of infrastructure. While much of the growth is likely to occur in the Lower Burdekin and Haughton sub-regions in the shorter term, in the medium to longer term, a greater proportion of demand growth will be in the Don Coastal, Belyando and Suttor sub-regions. The growth in these sub-regions is due to faster growth rates in horticulture and other broadacre crops such as cotton and irrigated fodder crops, and because land constraints are beginning to take effect in the Lower Burdekin.

The potential for significant growth in the area under irrigated agriculture has an impact on the likelihood of achieving the WQIP.

8.3 Proposed changes in practice under the WQIP

The draft Burdekin WQIP outlines a number of proposed changes in practice designed to address diffuse and point sources of pollutants across land use activities. MJA has assessed the WQIP by examining the impacts of the changes in practice outlined in the WQIP against a 'take no further action' base case.

8.3.1 Scenario One: Take no further action

Under this scenario, no further actions are undertaken within the auspices of the WQIP to address sediment and nutrient loads.

8.3.2 Scenario Two: A suite of practice changes

Under the draft WQIP, a suite of actions is proposed to reduce pollutant loads from primarily diffuse sources. Through a process of consultation and modelling undertaken specifically for the WQIP, target changes in loads and actions to achieve these loads have been estimated. The draft load targets include:

- **sediment loads**. Attain a 40–50% reduction in mean annual sediment load at the end of the Burdekin catchment (i.e. Inkerman, Clare) by 2058. This equates to a reduction from an estimated level of 4,000 kt/y to 2,000–2,400 kt/y;
- **nitrate loads**. Attain a 60–80% reduction from current levels in nitrate loads entering the GBR attributable to sugar and other irrigated cropping by 2058. This includes a number of shorter-term goals, including an 8–25% reduction by 2013; and
- **pesticide loads**. Attain a 25–50% reduction in pesticide (atrazine, diuron, ametryn, hexaxinone) loads entering the GBR from irrigated sugar by 2013.[173]

Load targets are to be achieved by implementing programs that will result in the adoption of a suite of management action targets. Some of the key management action targets are outlined in Table 32.

[173] BDTB, 2008, Burdekin Water Quality Improvement Plan: Draft Targets.

If adopted, the practices outlined could have a significant impact on loads, as expressed by Brodie et al. (2007):

> *The model findings suggest that catchment-wide improvements in groundcover, gully density and riparian condition in the Burdekin River catchment would reduce end of catchment loads by 60%.* [174]

These actions will enhance water quality in the freshwater and marine environment and enhance relevant environmental values across much of the Burdekin catchments and adjacent area of the GBR. These environmental values are outlined in depth in the WQIP document that is being developed.

Table 32: Key management action targets — % of relevant landholders undertaking actions

Management actions	Target 2013 %	Target 2028 %	Target 2058 %
Minimum end of dry season groundcover in Burdekin Rangelands (7 out of 10 years)	50	60	70
Graziers implementing practices to reduce hill-slope erosion and improve soil and pasture condition in 8 priority sub-catchments	25–45		
Graziers implementing best management practices in frontage country in 8 priority sub-catchments	20–30		
Graziers implementing best management practices to control hill-slope erosion in all sub-catchments		25–45	
Graziers implementing actions to reduce stream-bank erosion in 10 priority sub-catchments	30–50		
Graziers implementing actions to reduce stream-bank erosion in all sub-catchments		30–50	50–70
Undertake enhanced management actions to reduce gully erosion in 4 priority sub-catchments	20–40		
Undertake enhanced management actions to reduce gully erosion in all sub-catchments			20–40
Sugar producers implementing best management practices, for example 'six easy steps' and nitrogen replacement	3–16		
Enhanced nitrogen application rates (plant and ratoon).	2–11		

Source: Brodie et al., 2007, Water Quality targets for the Burdekin Region.

8.4 Potential impacts of WQIP

The WQIP is likely to have a number of positive environmental, social and economic impacts. Key impacts are briefly outlined in Table 33.

174 Brodie et al., 2007, *Water quality targets for the Burdekin Region.*

Table 33: Potential benefits of WQIP

Key benefits	Key elements and values
Water treatment	The benefits in avoided, or deferred, water treatment are not known, but are likely to be positive. The majority of these benefits are likely to accrue to Townsville and other urban and industrial users drawing water supplies from the SunWater system in the Burdekin.
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[175]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector by maintaining the region's attractiveness to visitors. However, while the Burdekin WQIP region does have a modest tourism base, the bulk of benefits would accrue to other regions.
Visual amenity	Limited positive impact on visual amenity and housing prices in relevant areas.
Improved crop yields	Analysis undertaken by DPI&F to develop the WQIP shows potential increases in sugar yields from implementing some practices.
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is worth around $7.82 per household per year. This translates to around $105,000 per annum for local residents in the Burdekin WQIP region.[176]

Source: MJA.

8.5 Economic and social considerations for implementing the Burdekin WQIP

There are a number of economic and social considerations for implementing the Burdekin WQIP. This section draws on the limited research available about the impediments, costs and benefits of different practices to help better understand the potential net cost of achieving the WQIP targets.

These costs have been inferred in the absence of more formalised estimates developed specifically for the WQIP. They should only be considered as broadly indicative of actual costs.

8.5.1 Impediments to uptake of practices

The draft WQIP outlines a number of potential practices and adoption levels necessary to achieve the load targets. However, there are a number of social and economic impediments to

175 Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

176 MJA estimates based on Windle and Rolfe, 2006, *Non-market values for improved NRM outcomes in Queensland*.

the uptake of practices. Actions will require careful design and implementation if water quality objectives are to be achieved at the lowest economic and social cost to the region. Greiner et al. (2007) surveyed graziers, sugar cane farmers and horticulture producers to ascertain the issues that create constraints to the practices shown in Figure 21. Key findings from the analysis include:

- generally, financial impacts (such as reduced profits and increased capital costs) were seen as greater constraints than other factors such as peer pressure or resistance to change. Financial constraints were relatively greater for horticulture producers than cane growers and graziers;
- too much red tape and impacts on productivity were seen as major constraints; and
- social or capacity constraints such as peer pressure and attitudes against change did not feature as highly as many of the financial and commercially orientated constraints.

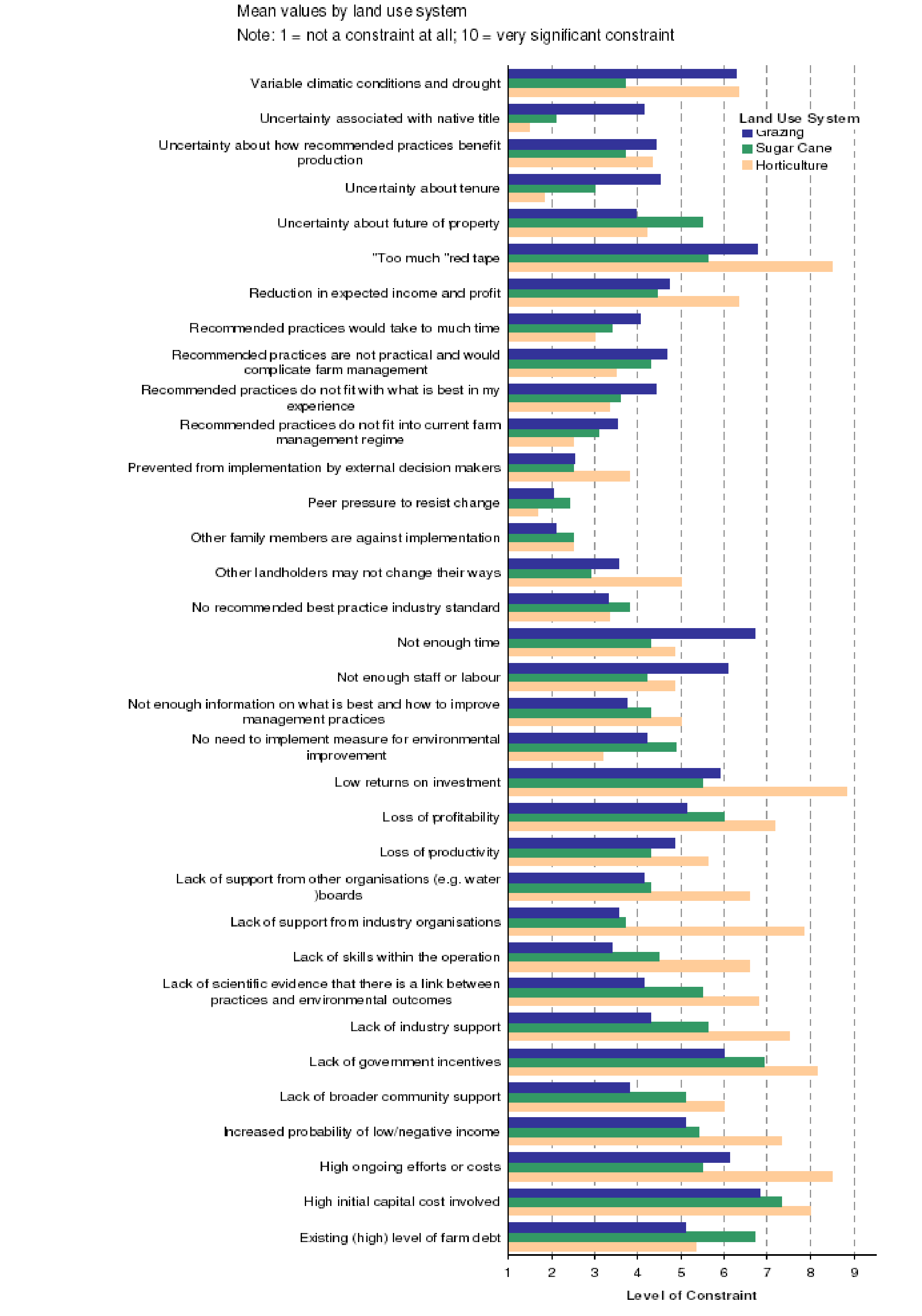
Generally, the findings of the analysis indicate that any WQIP implementation strategy adopted in the Burdekin should be strongly based around developing programs that are specifically designed to overcome these constraints.

Furthermore, the nature and importance of the constraints suggest that programs:

- need to consider the nature of the financial constraints and the impacts on cash flow and capital requirements;
- should fit within an enterprise businesses framework, including consideration of the time available to implement change; and
- focus on minimising red tape and administrative requirements to ensure sufficient participation and compliance.

In addition, given the relatively small contribution to some loads from the horticulture sector and the relatively higher importance of financial constraints, the cost-effectiveness of investing in significant horticulture programs may be very low, particularly where other industries can be targeted for the same pollutants.

Figure 24: Constraints to NRM practice change



Source: Greiner, R., Lankester, A., Patterson, L., 2007, Incentives to enhance the adoption of 'best management practices' by landholders: Achieving water quality improvements in the Burdekin River catchment.

8.5.2 Potential costs of implementation

MJA has assessed two broad sets of costs in meeting the WQIP targets, specifically:

- the costs of meeting rangeland targets; and
- the costs of meeting sugar cane targets.

Meeting rangelands targets

Proposed implementation of the WQIP in the rangelands requires a mix of actions to reduce loads from hill slope and gully erosion and a program for restoring riparian zones. While no formal cost estimates of these actions have been made, an indication of the potential net costs to pastoralists can be obtained by assessing the outcomes of other studies.[177] The net cost provides a reasonable proxy for the level of financial incentives that may be required to achieve the load reduction targets. Based on the net costs to landholders identified from other relevant studies, MJA estimate the level of financial incentives required to achieve the five- year targets is between $14m and $27m per annum. Assuming no real change in costs over time, meeting the 10-year targets could range from $29m to $54m, while for the long-term targets, cost could range from $115m to $214m. These costs exclude any planning or program administration costs. In perpetuity, the cost of meeting the five-year target could be as high as $270m.

These figures indicate the likelihood of meeting even the five-year target is remote if:

- the costs revealed through the recent water quality tender are representative of the incentives needed to achieve changes in practice change;
- financial costs to producers are the major impediment to change, as suggested by the attitudinal surveys; and
- current resources do not change.

Table 34: Rangelands - potential changes in loads and costs

Scenario	Load				Annual cost		
	TSS (Mt)	N (tonnes)	P (tonnes)	Reduction (%)	Low ($m)	Med ($m)	High ($m)
Current	4	6,400	1,400	n.a.	n.a.	n.a.	n.a.
Five- year[178]	3.7	5,900	1,300	8	14	20	27
10-year[179]	3.4	5,400	1,200	15	29	41	54
50-year[180]	1.6	2,600	560	60	115	163	214

Source: MJA based on: Brodie et al., 2007, Water Quality targets for the Burdekin Region; Donaghy et al., Unravelling the economic and environmental tradeoffs of reducing sediment movement from grazed pastures; and Rolfe et al., 2008, Using Conservation Tenders for Water Quality Improvements in the Burdekin.

177 Donaghy et al., *Unraveling the economic and environmental tradeoffs of reducing sediment movement from grazed pastures*; and Rolfe et al., 2008, *Using Conservation Tenders for Water Quality Improvements in the Burdekin.*

178 Hillslope, gully and riparian actions. 70% cover in priority sub-catchments

179 Hillslope, gully and riparian actions. 70% cover in priority sub-catchments, 50% cover in four priority sub-catchments and restoration to 95% in four sub-catchments.

180 Hillslope, gully & riparian actions. 70% cover everywhere, riparian restoration to 95% everywhere.

Meeting sugar cane targets

Reducing nitrogen loads, predominantly from irrigated sugar cane is a major part of the Burdekin WQIP. While at the time of writing definitive estimates of nitrogen loads attributable to irrigated agriculture were not available, a number of studies reviewed by ACTFR[181] indicate estimates for total nitrogen of between 8,600 and 14,200 tonnes per annum for the whole WQIP region. Furthermore, a recent study that considered reducing loads in the Burdekin WQIP region indicates a total nitrogen load of around 5,600 tonnes per annum.[182] In the absence of any concrete estimates of total nitrogen from irrigated agriculture developed through the WQIP, MJA has assumed current loads of around 5,600 tonnes per annum from sugar cane as a starting point for the analysis.

Available data on the likely net cost to landholders from changes in practices in the Burdekin is limited. The most recent and reliable data is the results of the water quality conservation tender run by the Burdekin Dry Tropics Board. While that tender was open to all landholders, bids were dominated by sugar cane farmers and the majority of management actions proposed were similar to those being considered as key actions under the WQIP. The results of that tender provide a proxy estimate for extremely cost-effective investments in nutrient reductions of around $4,550 per tonne per annum.

When capitalised at a 10% discount rate, the cost of meeting the targets in perpetuity ranges between $21m and $64m to meet the five-year targets and between $154m and $206m to meet the 50-year targets.

Table 35: Sugar cane: potential changes in loads and costs

	Load		Cost ($m)	
	N (tonnes)	Reduction (%)	Annual	Perpetuity
Current	5,600	n.a.	n.a.	n.a.
Five- year (low target)	5,100	8	2	21
Five-year (high target)	4,200	25	6	64
50-year (low target)	2,200	60	15	154
50-year (high target)	1,100	80	21	206

Source: MJA based on: Brodie et al., 2007, Water Quality targets for the Burdekin Region; Strahan, R., 2007, Estimating the economic implications for cane farms in the Mackay Whitsunday catchments of practice changes to more sustainable landscapes; and Rolfe et al., 2008, Using Conservation Tenders for Water Quality Improvements in the Burdekin.

If the outcomes of the recent water quality tender are representative of the true cost of practice change, even the five-year targets would likely require more funds than would be available under the Reef Rescue package.

While these costs appear high, even at the high end of these estimates, the costs of reducing nitrogen loads from sugar cane are significantly lower than the costs of treatment to achieve potable water, which range from $0.6m to $1.2m per tonne.[183]

181 ACTFR, 2006, *The Spatial Extent Of Delivery Of Terrestrial Materials From The Burdekin Region In The GBR Lagoon ACTFR Report No. 06/02.*

182 Rolfe et al., 2008, *Using Conservation Tenders for Water Quality Improvements in the Burdekin.*

183 Melbourne Water http://wsud.melbournewater.com.au/content/stormwater_quality_offsets/stormwater_quality_offsets.asp . Accessed 5 November 2009.

8.5.3 Other implementation issues

Analysis of the economic and social impacts of the WQIP that is under development raises a number of key issues vital to the successful implementation of the WQIP and its ability to meet the WQIP targets. These include:

- the need to address the risk of perverse outcomes;
- the need for cost-effective interventions;
- specific rangelands issues; and
- specific sugar issues.

Each of these is briefly discussed.

The risk of perverse outcomes

The future development potential of the Burdekin creates a significant emerging risk for water quality outcomes as the area under irrigated agriculture expands. The majority of pressure from irrigation development is likely to come from irrigated horticulture in the longer term, particularly around the Bowen region.[184] In effect, the land use change risks emerging for the Burdekin are barely covered in the WQIP.

If not managed carefully, future development could either jeopardise the likelihood of meeting the WQIP targets or result in the need for a significant increase in funding required to meet the targets.

Institutional options already exist to partially reduce the risk to water quality from future development, particularly the requirements for land and water management plans for new water entitlement holders under the Water Act 2000.

The need for cost-effective interventions

Given the scale of the practice change proposed under the WQIP, and the limitations of resources available, it is highly unlikely the resources available through the Reef Rescue package will be sufficient to meet the WQIP targets. It is critical to consider both the efficacy and cost-effectiveness of actions implemented under the WQIP.

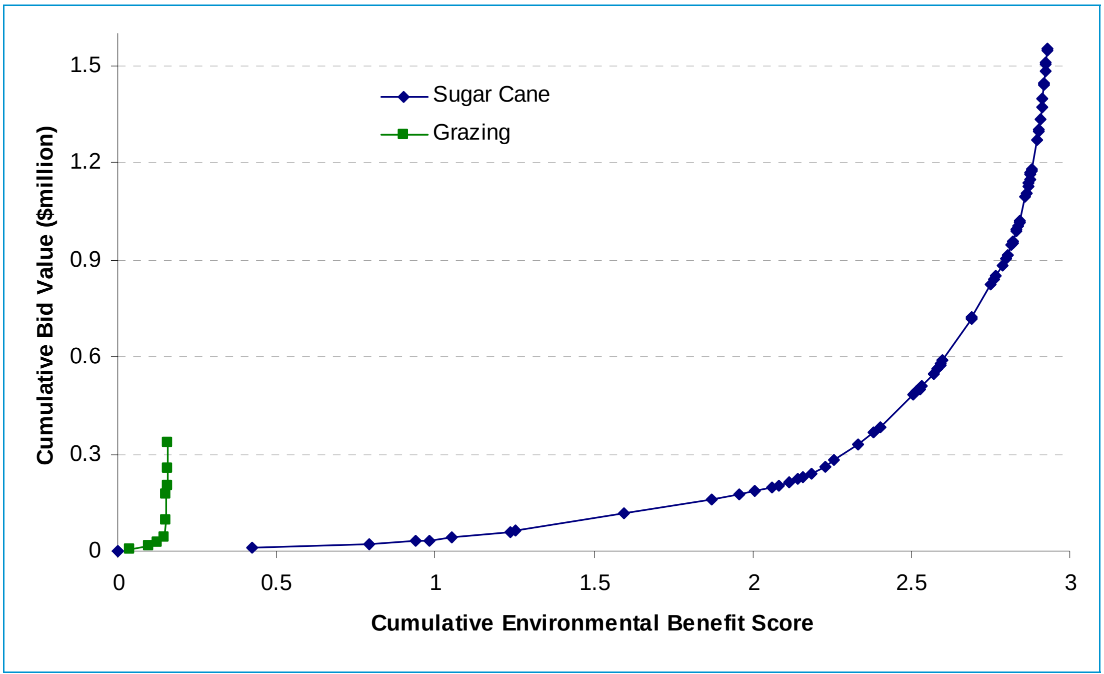
There is significant variance in the costs of changing practices, both between and within the same industry. This was demonstrated by the variance in bid levels for the Burdekin water quality tender that indicated:

- variance in the cost-effectiveness of bids within the sugar and grazing sectors;
- differences in the cost-effectiveness of actions between industries —actions by sugar producers are often more cost-effective;
- differences in the proportion of co-contribution between bids ranging from 0% to 95% of the total cost of actions undertaken; and
- major differences in the cost-effectiveness of bids between regions reflecting both the physical characteristics of a region (location, soil type, etc.) and economic differences between regions.

The variance in bid values for the grazing and sugar industries is shown in Figure 25.

[184] MJA, 2008, North Queensland Regional Water Supply Strategy: rural water demand. Draft Report.

Figure 25: Outcomes of Burdekin water quality tender — cumulative bid curves by industry



Source: Rolfe et al., 2008, Using Conservation Tenders for Water Quality Improvements in the Burdekin.

WQIP implementation mechanisms, such as competitive tenders, provide a means of targeting the most cost-effective actions to achieve the WQIP targets. Where financial inducements to encourage a change in practice are used, tenders are likely to be more cost-effective than other approaches.

Specific rangelands issues

Changes in the grazing sector have the potential to make significant impacts on the long-run sediment loads into the GBR. A series of practices have been clustered to form a relatively intuitive A, B, C, D classification tool for use by landholders and WQIP program managers.[185] In achieving the objectives of the WQIP, a grazing program needs to be developed that:

- assists landholders make a long-term transition along the classifications (D to C, C to B etc.) using an appropriate mix of persuasive approaches and financial incentives where necessary, reinforced by the light regulatory approach adopted by the State, particularly under the State leasehold land use strategy; and
- most efficiently allocates public money to graziers to increase adoption rates; in the absence of any additional regulation, competitive tenders potentially offer the most efficient tool.

These approaches could be further enhanced through complementary policy reform by the State and Australian Governments to ensure ‘perverse’ outcomes do not occur from other policies such as exceptional circumstances policies and drought relief policies.

Specific sugar issues

There are a number of key issues and lessons for the development of the WQIP sugar program:

185 While this classification system has already been developed in other WQIP regions, a similar classification system is yet to be developed for the Burdekin.

- there is evidence of significant economies of scale in sugar farming. Farm size has specific implications for transaction costs and the effective design of implementation strategies under the WQIP. More effective outcomes may be achieved by contracting fewer, larger operators in order to reduce program administration costs and to target farmers who are more likely to have sufficient economic resources to invest in practice change. Larger farms in the WQIP region tend to be in the Burdekin River Irrigation Area. Mechanisms such as competitive tenders to distribute incentive funding effectively cater for these issues;
- because there is significant variability in the size, physical (e.g. soil types, water sources), agronomic and economic characteristics and practices of properties within the WQIP region, metrics are essential to differentiate between alternative funding proposals. The metric developed for the Burdekin water quality tender can form the basis for future investment prioritisation;
- analysis undertaken by DPI&F for the Mackay Whitsunday region identified that significant up-front capital investments may be required to implement practice change, such as the purchase and use of hooded sprayers. For example, costs are in the order of $35,000 to move from level C to level B and $62,000 to move from level B to level A.[186] This is also likely to be the case in the Burdekin. Limited access to capital could significantly constrain landowners' ability to accelerate adoption of best practice where there are 'up front' capital costs or time lags between implementation and productivity benefits. Some form of transitional funding or risk sharing is therefore appropriate. One option would be to provide financial incentives for capital equipment in the form of structural adjustment loans, with repayments more closely aligned to enhancements in cash flow; and
- because production and harvesting inputs are often outsourced to contractors in the sugar industry, for some practices and capital equipment it may be worthwhile to target contractors as well as landholders. With contractors, this may result in practice change across several farms from a single incentive transaction.

In combination, these issues indicate that any program to accelerate adoption will need to be both flexible in targeting practice change and recognise the variance of private benefits and costs of different practices for different landholders. In effect, rigid approaches and regulation may prove costly.

[186] Strahan, R., 2007, *Estimating the economic implications for cane farms in the Mackay Whitsunday catchments of practice changes to more sustainable landscapes.*

9. Townsville (Black Ross)

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- The Townsville (Black Ross) WQIP region's population is expanding at a faster rate than the GBR catchment population as a whole. As the major service centre of the GBR and the largest provider of administrative and health services, this is to be expected.
- Social conditions in the Townsville WQIP region are generally more favourable than in the GBR as a whole, especially for levels of education and diversity of occupations, given the Defence Force presence, public administrative employment and the university presence.
- Low direct reliance on agriculture and mining as a source of employment and income leaves this part of the GBR somewhat uniquely resilient to rural policy change on water quality issues. However, urban pressures and actions are likely to be greater in the Townsville region than in other WQIP regions.

Scenarios assessed

Two scenarios were assessed:

- do nothing more; and
- undertake actions to accelerate uptake of management practices across urban, peri-urban and rural landscapes based on interventions outlined in the Townsville WQIP.

Impacts

Impacts of the do nothing more scenario are likely to be a further decline in water quality and increasing risks to the GBR; negative impacts on sectors reliant on water quality, particularly GBR tourism drawcards such as boating, diving and snorkelling; negative impacts on recreation, particularly recreational fishing; and a general loss in ecosystem function. Impacts on reef-related tourism may be particularly significant for the Townsville WQIP region.

Impacts of the second scenario, undertaking actions outlined in the WQIP, include:

- significant reductions in total nitrogen and total phosphorus made via upgrades of wastewater treatment plants;
- reductions in end-of-catchment sediment loads attributable to urban diffuse loads by 2% through implementing WSUD[187] in greenfield developments. Potentially, a further 8% reduction in sediment loads may be made through the gradual implementation of WSUD in developed areas;
- reductions in end-of-catchment loads from rural sources of up to 44% may be made through the implementation of best management practices in rural production, particularly grazing;
- significant benefits from risk mitigation to the $1.15b tourism industry, particularly given the significance of GBR tourism to the local economy, and the recreational fishing industry.

Estimated costs for the second scenario are as follows:

- the direct implementation costs for the WQIP have been estimated at around $8.8m, including all planning, science and coordination inputs up to 2013
- in addition, a further $240 million is required over the medium term to meet new standards for WWTP. However, these costs are not directly attributable to the WQIP. They are costs associated with meeting

[187] Single Strata Planning Policy.
The Queensland Government is committed to establishing a new approach to state planning policies that simplifies and clarifies the state's interests (including water quality). The new approach means that one single state planning policy will be developed to replace the various current state planning policies in existence. The State Planning Policy will set out policies about matters of state interest in the planning and development assessment system, and forms part of the government's broader commitment to planning reform for finalisation in 2013.

[188] Point source waste water emissions have been addressed with the launching of the $189 million waste water upgrade program in December 2011. The Mt. St. John Waste Water Purification Plant was funded by Townsville City Council ($83.89 million), the State Government ($66.76 million) and the Australian Government ($39 million). As a result of this major waste water treatment plant investment, discharge of treated effluent to the Black River and Saunders Creek has been eliminated and nutrient loads to the Bohle River reduced.

regulated standards for future growth in loads. Major upgrades were completed in 2012.[188]

- the implementation of WSUD in greenfield development is expected to require a capital investment of approximately $4.4m per annum. This is likely be borne by the development community and passed onto purchasers of new homes via increased prices. It is likely that WSUD in new developments will become mandatory under the new State Planning Policy for Healthy Waters. Again, this cost will no longer be attributable to the WQIP. However, the WSUD assets will require ongoing maintenance from local government and the cost of maintaining WSUD assets is expected to be approximately $85,000–$100,000 more per annum than would be the case without the policy
- if retrofitting WSUD is imposed in existing developed areas, the cost of achieving this target, in the long run, could be more than $200m; and
- actions to address rural loads require a relatively modest investment of around $200,000 per annum, if targets are to be met efficiently.

Implementation issues

Addressing end-of-catchment sediment load targets through changes in rural land use practice would appear to be significantly more cost effective than actions in the urban environment such as direct investment in WSUD stormwater management.

If the objective of the Townsville WQIP is to reduce diffuse loads entering the GBR from the Townsville catchment, the rationale for direct investment in WSUD under the WQIP, particularly retrofitting WSUD, is questionable on efficiency grounds.

The cost effectiveness of interventions could be enhanced through the robust assessment and selection of policy tools. The Townsville WQIP has a relatively larger set of intervention options than other WQIPs and all opportunities to use the most efficient set of policies should be examined.

There may also be significant efficiency gains that could be made where the substitutability of actions is recognised and appropriate courses of action are taken, for example increased investment in rural diffuse actions to substitute for costly retrofitting of WSUD in developed areas. However, exploiting these options will require additional scientific effort to establish appropriate metrics and the development of a more flexible policy.

9.1 Introduction

The Townsville WQIP region consists of the greater local government area of Townsville City, with a total land area of around 3,700 km^2. As the largest urban area in the State outside of the south-east corner, Townsville is the primary service centre for a vast catchment.

A key to Townsville's development has been its role as a transport hub for rail and sea, and its post-war population growth has been stimulated by the establishment of heavy industries (cement, copper and nickel) and major government institutions. Defence force populations, university students and Commonwealth and State Government regional offices have also contributed to regional development. Future economic growth is expected to be strong, based on downstream processing and the provision of services to major mineral developments in the Townsville service catchment area, including the North West Minerals Province around Mount Isa. [189]

9.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information available to develop a regional profile. This section summarises some of the key issues relevant to the development of the WQIP.

---

[189] Queensland Government, 2007, *Townsville – Thuringowa Strategy Plan*.

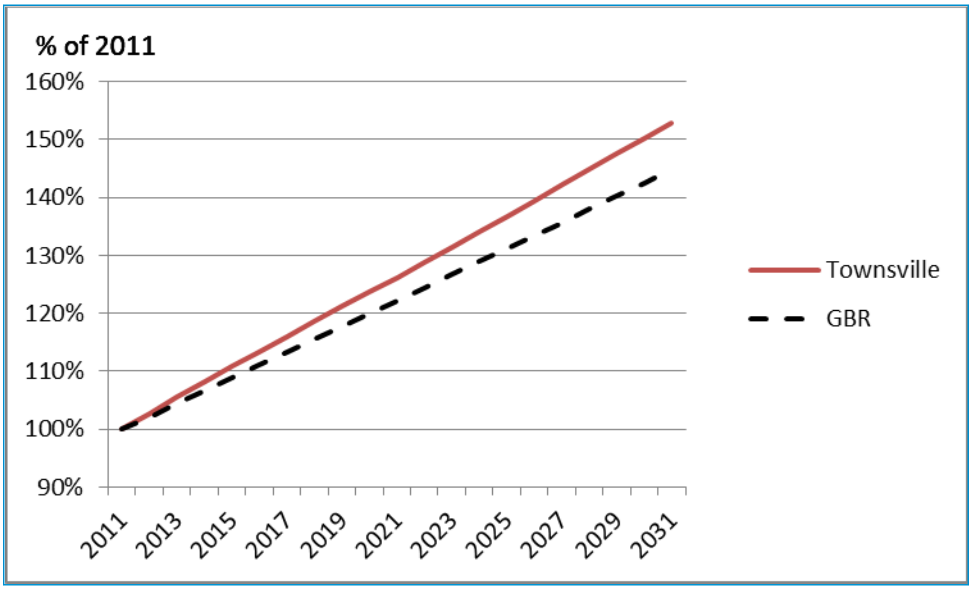
9.2.1 8.2.1. Demographic makeup

Population

From the 2006 Census, it is estimated that the population of the Townsville WQIP region was around 164,550.[190] Figure 26 shows the historic and forecast population growth for the Townsville WQIP region compared to all of the WQIP regions assessed in this report.[191] It shows that:

- significant population growth is expected both in Townsville and across all the GBR WQIP regions over the next 20 years; and
- Townsville's rate of population growth is likely to be significantly higher than for the GBR as a whole — it is the highest of any area in the GBR out to 2026.

Figure 26: Population growth projections — Townsville and all GBR WQIP regions



Source: MJA based on DLGPSR and ABS 2011 Census.

This population growth to 2026 is expected to maintain the Townsville region's status as the State's largest concentration of people outside of South East Queensland.[192] Other population and demographic statistics of note include:

- like much of the GBR, the population of the Townsville WQIP region is slightly skewed to males (51.8% of the population);
- in the 2011 census, 6.2% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Townsville WQIP region, compared to around 3.2% for the whole of Queensland; and
- approximately13% of people in the Townsville WQIP region were not born in Australia and around 3% of the population speak a language other than English at home.[193] .

---

190 This estimate is based on ABS census data concorded (best fitted) to the Townsville WQIP region by OESR. Population estimates are based on a census participant's usual place of residence.

191 Based on DLGPSR Population Forecasting Unit's mid-estimates for each relevant LGA concorded to WQIP boundaries.

192 Queensland Government, 2007, Townsville–Thuringowa Strategy Plan.

193 Based on analysis of 2006 ABS census data.

Community capacity

A community's capacity to participate in natural resource management is often indicated by a number of issues:

- social capital: Approximately 17% of adults (>15 years old) participate in voluntary work, indicating reasonable levels of social capital, although this rate is lower than WQIP regions such as the Fitzroy, which have a greater proportion of the population in rural areas.[194] Females had higher levels of participation in volunteer work (at 19%), compared to males (at 14%). However, the ABS census data does not indicate what type of volunteer work was undertaken (e.g. whether it involved environmental management);
- income status: The relative financial impact of projects or policies on costs must be considered, as the burden may be relatively greater for lower-income families. Townsville has a higher incidence of low-income families than the State as a whole. Approximately 10 of families in the Townsville WQIP area are on low incomes (i.e. < $600/week), compared to 8% for the State; and
- economic capacity: Household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In Townsville, approximately 59% of homes are owned or are being purchased. This compares to a State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad means of comparing social and economic resources between regions. The three indices listed below are of most relevance: [195]

- the Index of Advantage–Disadvantage is a continuum of values, where low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources such as rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation includes all education and occupation variables only.

These indices were concorded (best fitted) to the WQIP regions to enable comparisons of each WQIP region to all of the regions assessed in this report and Queensland as a whole.[196] Results are shown in Figure 27.

Analysis of the data indicates:

- relative to the State and the rest of the GBR, Townsville is at a slight advantage;
- economic resources in the Townsville area are above the State average, and significantly higher than for the whole GBR; and
- education and occupation data shows that Townsville is significantly better off than both the rest of the GBR and the State, indicating a higher resilience to change.

---

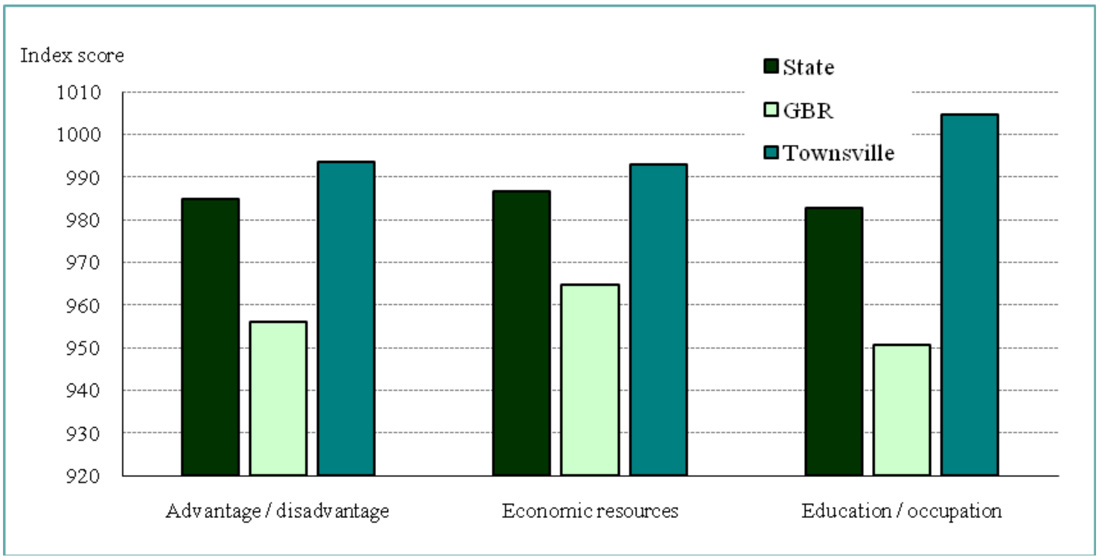
[194] Levels of participation in voluntary community activities are often used as a proxy indicator of social capital in a community.

[195] ABS, 2001, 2039.0, *Information Paper: Census of Population and Housing - Socio-Economic Indexes for Areas*, Australia, 2001.

[196] MJA estimated concorded index scores for each WQIP region using concorded population figures to derive each LGA's SEIFA score to the overall WQIP SEIFA score.

This analysis broadly implies that the Townsville region's significantly higher social and economic wellbeing means the community has a higher capacity to adapt to change.

Figure 27: SEIFA indices



Source: MJA based on ABS census SEIFA indices.

Educational attainment levels in the Townsville region far exceed those in the rest of the GBR catchments, and tertiary education rates are significantly higher than for the State as a whole shown in Table 36.

Table 36: Educational attainment

Highest education level completed	Townsville (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	18.8	21.3	19.8
Year 12	35.7	30.1	37.2
Certificate or diploma	22.3	22.2	21.9
Undergraduate degree	8.4	6.6	9.3
Postgraduate degree	1.7	1.1	2.2

Source: ABS 2006 census of population and housing.

9.2.2 Employment and labour force

Labour force statistics shown in Table 30indicate that the Townsville region has much lower employment in primary industries compared with both the GBR and the Queensland average.

Table 37: Labour force statistics

	Number			Percentage		
	Townsville	GBR	Qld	Townsville	GBR	Qld
Agriculture, forestry and fishing	422	23,546	54,563	0	5	3
Mining	2,479	27,793	51,656	3	6	3
Manufacturing	6,611	34,978	169,025	8	8	8
Electricity, gas, water and waste services	1,314	6,962	24,764	2	2	1
Construction	8,415	40,558	179,947	10	9	9
Wholesale trade	2,681	13,561	73,377	3	3	4
Retail trade	9,158	46,833	214,617	11	11	11
Accommodation and food services	5,800	32,649	140,036	7	7	7
Transport, postal and warehousing	4,350	24,591	104,924	5	6	5
Information media and telecommunications	1,150	3,588	25,282	1	1	1
Financial and insurance services	1,317	6,317	53,833	2	1	3
Rental, hiring and real estate services	1,332	7,086	36,875	2	2	2
Professional, scientific and technical services	4,003	18,497	131,921	5	4	7
Administrative and support services	2,613	12,383	64,185	3	3	3
Public administration and safety	10,172	30,251	135,586	12	7	7
Education and training	6,902	33,080	160,241	8	7	8
Health care and social assistance	10,649	47,500	240,017	12	11	12
Arts and recreation services	1,075	4,210	28,418	1	1	1
Other services	3,210	17,688	78,157	4	4	4
Not stated	1,751	10,814	22,913	2	2	1
Total	**85,404**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS 2011 Census of Population and Housing.

Townsville's role as an administrative and public services centre results in higher employment in public administration and health care and social assistance compared with the broader GBR and the State average. In addition, the university creates employment in education and training above regional and State averages.

In contrast to the GBR region, there is notably lower employment in primary industries and mining. Tourism-related employment (retail, accommodation), while important, is slightly below the average for the GBR and the State.

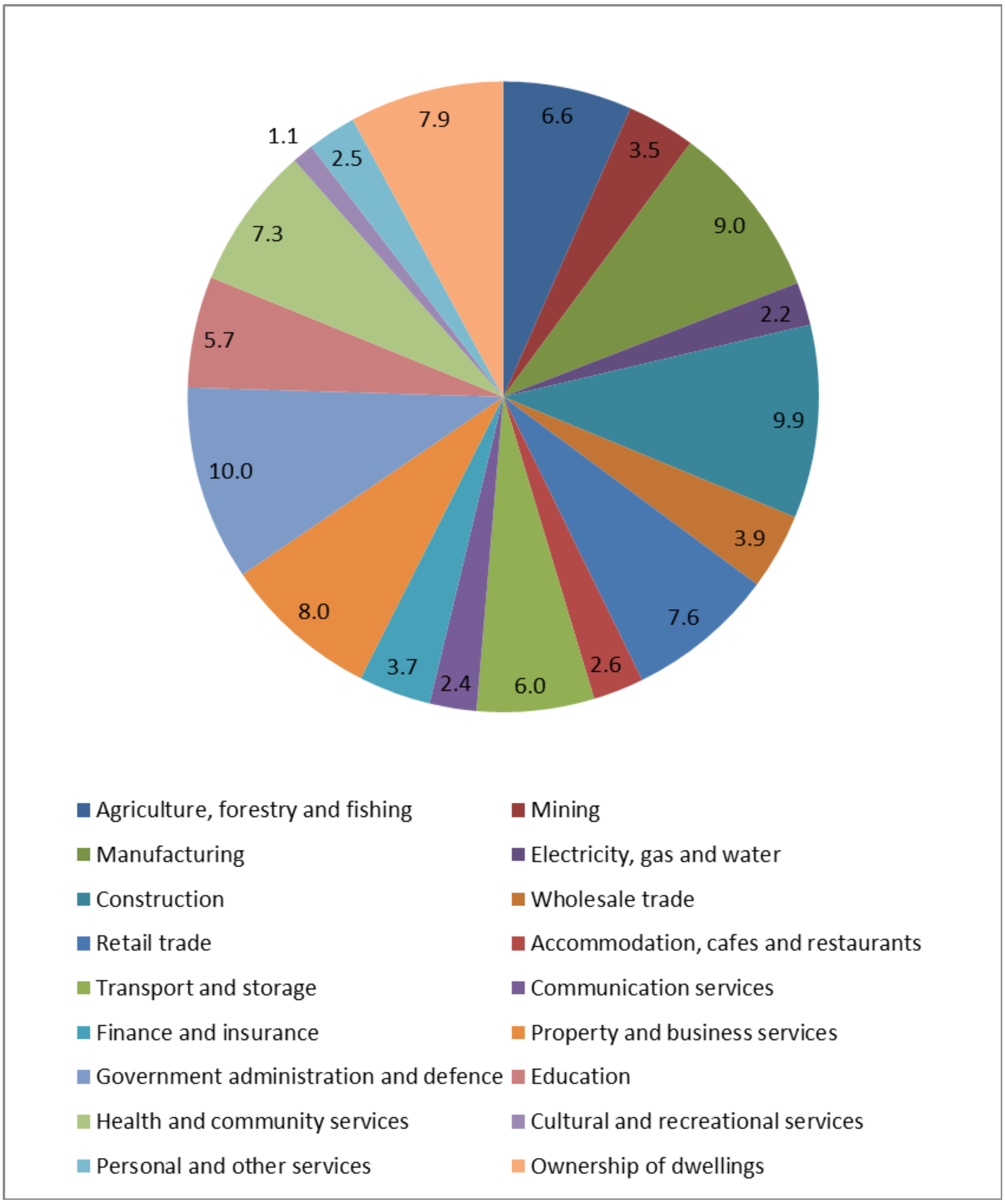
9.2.3 Economic structure

Townsville's role as a major urban centre makes its economy substantially different to other parts of the GBR. Because it is less directly involved in primary production, especially agriculture, the Townsville area has major downstream processing industries that, together with manufacturing and service industries, make up a strong industrial base. Further, the Townsville region is a major transport and service centre for agricultural activities throughout North Queensland. There is also a substantial commercial fishing industry based in Townsville.

The Defence Force and other public sector employers have a significant impact on the economic and employment structure of the region. The Defence Force contribution to the regional economy is estimated at $510m per annum, creating some 8,500 jobs. It is an integral and important component of the region's population. [197]

The main industry sectors in the Northern Statistical Division in terms of contribution to Gross Value Added in 2005–06 are shown in Figure 28. The Public Administration and Defence sector of the economy has been predominant in North Queensland for many years, reflecting the economic significance of the large defence presence in the region. However as other industry sectors become stronger the relative contribution of the Public Administration and Defence sector has declined.

Figure 28: Northern Statistical Division contribution to gross value added 2005/06 (%)



Source: OESR

[197] Queensland Government, 2007, Townsville-Thuringowa Strategy Plan.

The economic structure of the Townsville region makes it more resilient to change than some other areas of the GBR. However, it will nevertheless be indirectly affected by changes to the broader northern Queensland regional economy.

Tourism

The tourism industry contributes to gross value added in the Northern Statistical Division through a number of industry sectors. Tourism is not its own industry subsector in the data obtained from OESR. The wholesale and retail trade sector, the accommodation cafes and restaurants, and cultural and recreational services all rely heavily on the tourism industry. In 2005/06 these categories accounted for a combined total of gross value added of 18.2%.[198] As of June 2011, there were 2,215 tourism related businesses in the Northern tourism region that includes Townsville which directly employed 1,329 people.[199] The tourism sector in the region is likely to be highly susceptible to any significant decline in the condition of the GBR, particularly given the large number of operators based in Townsville.

Townsville's tourism industry offers a diversity of tourism experiences in one region. In recent years, Townsville has experienced a greater growth in visitation than the Queensland average. Townsville's main visitor market is holiday makers, followed by those on business trips and those visiting friends and family. The majority of visitors are self-drive visitors. For the year ending September 2012, 759,000 overnight domestic visitors and 102,015 international visitors chose the Townsville region as their destination, 2.8% and 0.7%, respectively from the previous year.[200] Approximately 24% of international visitors chose Magnetic Island as a destination for the year ending September 2012.

Mining, minerals processing, and transport

Queensland Rail and the Port of Townsville provide a transport hub for the region's mining and agricultural industries, as well as for locally-based Xstrata Copper Refinery, Sun Metals Zinc Refinery, and Queensland Nickel. In 2005/06, for the Northern Statistical Division mining accounted for 3.5% of gross value added and transport and storage accounted for 6.0% of gross value added.

The Port of Townsville is one of the State's fastest growing ports and services both the North East and North West Minerals Provinces of North Queensland. The local resources sector represents approximately 50 % of Townsville's exports and 75 % of imports, with these figures forecast to grow significantly in the coming years.[201]

Manufacturing

In 2011, according to OESR, manufacturing accounted for 8% of employment in the Townsville region. In the Townsville LGA, meat processing is a large employer according to the 2011 ABS census, approximately 18 % of manufacturing employment relates to food product manufacturing.

---

198 OESR, 2005/06, Composition of gross value added, Most recent data.

199 Tourism Research Australia, 2011, Tourism businesses in Australia, June 2009 to June 2011, Appendix D.

200 Tourism Research Australia 2012, 'Visitor numbers to Townsville'.

201 Australasian Journal of Regional Studies, Vol. 16, No. 2, 2010, Les Tyrell, Peter Mellor and Richard Moneypenny, 'Townsville a Regional Development Case Study'.

As a result of the Queensland Sugar Corporation Distribution Centre located in the region there are a number of firms that support sugar processing by manufacturing equipment for the industry. According to the 2011 ABS Census, approximately 11% of manufacturing employment is machinery and equipment manufacturing. [202]

Agriculture

As noted, Townsville's role as an urban centre results in a much lower direct reliance than other GBR areas on primary production, especially agriculture. Townsville does not have an abundance of natural resources. The most substantial natural resources in the area are fisheries and extractive minerals. The predominant agricultural activity is beef cattle grazing.

Agricultural land and forestry are less significant, and Townsville relies on neighbouring regions for these inputs. Less reliable rainfall in the area, compared to other parts of the GBR catchment, makes the Townsville region less suitable for development of intensive agriculture. However, the climate is suitable for aquaculture, which is considered a sunrise industry, although water supply and sustainability issues persist.[203]

9.2.4 Land use

Land use in the Townsville region is dominated by grazing (around 50%), while land use related to urban development (residential, services and utilities, and manufacturing and industrial) accounts for approximately 8% of the area shown in Table 38.

Table 38: Land use

Land use	Area (ha)	Area (%)
Grazing	133,900	49.7
Nature conservation / minimal use	99,800	37.1
Water and wetlands	10,000	3.7
Intensive agriculture	4,100	1.5
Mining / quarrying	400	0.2
Forestry	100	<0.1
Residential	15,200	5.6
Services and utilities	4,000	1.5
Manufacturing and industrial	1,600	0.6
Total	**269,200**	**100.0**

Source: Gunn, J. & Manning, C., 2009, Draft Black Ross (Townsville) Water Quality Improvement Plan: Improving Water Quality from Creek to Coral, Townsville City Council and the Creek to Coral Program, Townsville.

Given the rapid expansion in population expected over the medium- to longer-term and the region's continuing importance as a major regional service provider, it is expected that the land use for residential, services, manufacturing and industrial will expand significantly. Given population growth forecasts, to in excess of 240,000 persons by around 2025, this area could expand by at least 20% over the next 20 years. However, land availability constraints in areas

202 ABS 2011 Census.

203 Queensland Government, 2007, Townsville-Thuringowa Strategy Plan.

such as the Lower Ross sub-catchment, including central Townsville, indicate that future development patterns may differ from historical patterns. **Major land change pressures are likely to occur in the current peri-urban areas, around existing population centres and in the coastal area currently under grazing.**

9.3 Proposed changes in practice under the WQIP

The draft Townsville WQIP[204] outlines a number of proposed practice changes that are designed to address diffuse and point sources of pollutants across the spectrum of land use activities. MJA has analysed the WQIP, assessing the impacts of the changes in practice outlined in the WQIP against a ‘do nothing more’ base case.

9.3.1 Scenario One: Do nothing more

Under this scenario:

- no further specific actions are undertaken with respect to addressing urban diffuse and point source loads; and
- no further actions are undertaken under the auspices of the WQIP to address sediment and nutrient loads from rural diffuse sources.

9.3.2 Scenario Two: A suite of practice changes

The draft Townsville WQIP includes a suite of proposed management actions to address the current and future risks to environmental values. These actions have been developed through a rigorous process of scientific analysis and community consultation at the sub-basin level.[205]

Urban actions

Key urban actions include:

- a continuation of upgrades to WWTP, enhanced management and maintenance of existing infrastructure is proposed. In addition, new and emerging point-source risks will be identified and managed appropriately; and
- in greenfield development, enhanced stormwater management and erosion control, including WSUD, will be implemented. This will be underpinned by appropriate materials, such as guidelines, to assist industry.

In developed areas:

- guidelines and materials will be available to promote enhanced stormwater management and WSUD in areas that are being redeveloped; and
- enhanced stormwater management systems such as stormwater treatment train upgrades, and WSUD may be retrofitted. This action is subject to further investigation, particularly relating to the cost-effectiveness of such an approach.

---

[204] Gunn, J & Manning, C, 2009, Draft Black Ross (Townsville) Water Quality Improvement Plan: Improving Water Quality from Creek to Coral, Townsville City Council/Creek to Coral Program, Townsville.

[205] For a summary of this process see chapters 3-6 of the WQIP.

Peri-urban actions

Peri-urban actions are designed to reduce pollutant loads though a suite of planning, capacity building exercises, and investments, including:

- development of catchment management plans and guidelines — these actions will not contribute directly to load reductions but are vital prerequisites to change;
- enhanced management of septic tanks and other on-site infrastructure impacting on water quality;
- promotion of, and investment in, cost-effective approaches to reducing pollutant loads; and
- additional actions to reduce load risks in the Ross Dam local catchment.

Rural actions

While the Townsville catchment is significantly more urbanised and smaller than other WQIP catchments, there is still a suite of rural actions proposed, including:

- best management practice for grazing based on the programs developed for the Burdekin WQIP;
- best management practice for intensive rural land use (horticulture and sugar) based on relevant programs from adjacent regions; and
- cost-effective erosion management.

Enabling management actions

These actions will be supported and underpinned by further research, continuation of monitoring and evaluation activities, mapping, policy and plan development, wetland and riparian rehabilitation in priority areas, and the enhancement and continued delivery of capacity building activities.

9.4 Impacts on loads

In the absence of further interventions, loads of TSS, TP and TN are expected to increase dramatically from areas under urban land use due to population growth and associated land use change. In addition, TN and TP loads from point sources, primarily WWTPs, are likely to increase despite recent and planned upgrades to reduce concentration loads.[206]

The suite of management actions is likely to reduce pollutant loads and their impacts on environmental values compared to the do nothing more scenario. A summary of modelled end-of-catchment loads is outlined in Table 39. Draft management action targets are set out in more detail in Section 6.7 of the draft WQIP.[207]

One of the key actions being considered in the urban context is the implementation of WSUD for both greenfield development and potentially retrofitting WSUD to the existing urban developed area.

[206] See table 5.14 of the draft WQIP for details.

[207] Gunn, J. & Manning, C., 2009, *Draft Black Ross (Townsville) Water Quality Improvement Plan: Improving Water Quality from Creek to Coral*, Townsville City Council and the Creek to Coral Program, Townsville.

Modelling has been conducted by Townsville City Council as part of the WQIP development to determine the potential contribution of WSUD to reducing sediment loads by 2045, compared to the current TSS base case of 61,400 tonnes per annum. Key results from the modelling are:

- implementing WSUD in greenfield development could reduce TSS by around 1,450 tonnes/ per annum, or 2%; and
- retrofitting WSUD in existing urbanised areas could reduce TSS by around 6,240 tonnes per annum, or 10%.

Table 39: Diffuse end of catchment loads - business-as-usual

Key pollutant	Unit	Current load (2005)	Estimated load (2021)	Increase from 2005 (%)	Estimated load (2045)	Increase from 2005 (%)
TSS	Tonnes/year	42,800	49,300	15.1	61,400	43.3
TN	Kg/year	571,900	613,500	7.3	686,000	20.0
TP	Kg/year	70,600	76,700	8.6	88,400	25.1

Source: Gunn, J. & Manning, C., 2009, Draft Black Ross (Townsville) Water Quality Improvement Plan: Improving Water Quality from Creek to Coral, Townsville City Council and the Creek to Coral Program, Townsville.

A suite of best management practices is also proposed in relation to rural land management that, if implemented, is expected to reduce sediment loads by up to 26,200 tonnes per annum by 2045. This is a reduction of around 44% from business-as-usual.

9.5 Benefits of interventions

The benefits of the interventions are significant, although many of the benefits are non-market in nature, meaning that their economic values cannot be readily determined by market prices. Key benefits are outlined in Table 40.

Table 40: Potential benefits of WQIP

Key benefits	Key elements and values
Water treatment	The benefits in avoided or deferred water treatment costs are not known, but are likely to be positive.
Wastewater treatment	Where actions up the catchment avoid or deferral future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum. For TCC to realise these benefits, a water quality offset scheme would need to be established.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[208]
Tourism	Enhancements in water quality provide benefits to several areas of the tourism sector, particularly given the region's high proportion of reef-based tourism activities. Using ABS tourism accommodation data and Access Economics estimates, MJA estimate that the annual gross value of tourism in the Townsville region is around $1.15 b.[209]
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is valued at around $7.82 per household per year. This translates to around $1.4m per annum for local residents of the WQIP region.[210]

Source: MJA.

9.6 Cost of interventions

The draft WQIP outlines initial estimates of the direct costs of implementing the WQIP. These estimates total approximately $8.8m for 2009 to 2013. Only half of this amount is funded at present. However, much of these works are likely to be Council core business over the coming years. In addition, a total capital investment for point sources of around $240m has been identified within the draft WQIP for WWTP upgrades to meet regulated requirements, an effluent reuse scheme in Cleveland Bay and enhanced sewerage network management. However, these figures do not represent the likely cost of the total practice change being sought. For example, these figures exclude the costs of WSUD in urban areas or practice change for graziers. Table 34 outlines MJA's estimates of the other costs associated with achieving the broad management action targets in the WQIP.

Key points to note include:

- capital costs of WSUD, including rainwater tanks, in greenfield development will be around $4.4m per annum over the life of the WQIP. Capital costs per dwelling range from an estimated $600 for a unit in a large block, to around $5,800 for a detached dwelling or house. However, excluding rainwater tanks reduces this cost by approximately half.

---

208 Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

209 Access Economics, 2007, *The economic and financial value of the Great Barrier Reef Marine Park, 2005–06.*

210 MJA estimates based on Windle and Rolfe 2006, *Non-market values for improved NRM outcomes in Queensland*.

These capital costs will initially be borne by developers and then passed on to consumers via marginally higher prices for new dwellings;

- the growth in ongoing WSUD maintenance costs will be approximately $85,000–$100,000 per annum. Average annual costs per new dwelling will range from around $10–15 for units, up to around $60–80 for detached houses. These costs would typically be borne by local government or body corporate;
- a new State Planning Policy is being developed in Queensland.[211] The State Interest in water quality states that development is planned, designed, constructed and operated to protect the environmental values and support the achievement of the water quality objectives in the management of stormwater that runs off urban areas. T**he stormwater management components of WSUD in greenfield developments are considered under the *Sustainable Planning Act 2009* and these costs will be outside the scope of direct investment under the WQIP.** The policies will need to be run in conjunction with complementary capacity building projects if their potential is to be realised;
- any retrofitting WSUD in existing developed areas is likely to be relatively more costly and is currently outside the scope of any proposed regulatory regime. However, **if WSUD retrofitting is to be progressively implemented (100% retrofit by 2045), the magnitude of the annual investment is around $5.9m per annum, or a total cost of $210m**;[212] and
- achieving sediment reduction targets from rural diffuse sources in the most cost- effective way is likely to be achieved from best management practice in the grazing industry. Based on the costs achieved through incentive programs in the Burdekin, the targets outlined in the WQIP could be achieved for as little as $200,000 per annum.

211 The Queensland Government is committed to establishing a new approach to state planning policies that simplifies and clarifies the state's interests (including water quality). The new approach means that one single state planning policy will be developed to replace the various current state planning policies in existence. The State Planning Policy will set out policies about matters of state interest in the planning and development assessment system, and forms part of the government's broader commitment to planning reform for finalisation in 2013.

212 This is based on the assumption that retrofitting WSUD is 1.5 times the cost of implementing WSUD in greenfield developments.

Table 41: Indicative management actions costs

Management action	Indicative cost	Period	Comments
***WSUD*[213]**			
WSUD in greenfield sites (capital expenditure)	$4.4m	Per annum	Based on costs for Townsville case study for the new State Planning Policy for Healthy Waters. Note: This cost would be borne by developers and passed onto home purchasers.
WSUD in greenfield sites (additional ongoing management costs)	$85,000–$100,000	Per annum	Ongoing costs borne by local government and recovered via rates. These costs are based on the assumption that new developments will pay for their own WSUD costs.
100% retrofit WSUD by 2045	$5.9m	Per annum	Estimated capital cost per annum until 2045 to achieve full retrofit WSUD target. It is assumed that the acquisition costs of WSUD solutions will be on average 50% more costly than greenfield applications over the period to 2045 due to space limitations and limitations from existing infrastructure.[214]
Rural diffuse loads			
Best management practice (BMP) grazing[215]	$200,000	Per annum	Based on extension of Burdekin programs and costs. Other rural BMPs are not costed for sediment reduction as grazing is likely to be the lowest cost option.

Source: MJA.

213 Based on the efficient application of stormwater management actions (bioretention basins, underground detention basins & detention basins) used for the Townsville case study from Water by Design (2009) *Water Sensitive Urban Design to meet the proposed stormwater management objectives in Queensland: A Business Case*. South East Queensland Healthy Waterways Partnership. It is assumed that detached houses will account for 65% of future greenfield development, while units and townhouses will account for 35%.

214 Ecological Engineering, 2007, *Life Cycle Costs of Water Sensitive Urban Design (WSUD) Treatment Systems: Summary Report. A report for Brisbane City Council – City*. This report investigated typical costs of WSUD applications and found the total acquisition costs for bioretention swales, bioretention basins and constructed wetlands in greenfield situations range from $100/m² to $350/m². In some retrofit situations, unit rates increase by up to $300/m² (i.e. anywhere between 85% and 300% higher). However, MJA has assumed that with best practice design and recent advances in design, cost differentials can be reduced to 50% in the medium term.

215 MJA, based on Brodie et al., 2007, *Water Quality targets for the Burdekin Region*; Donaghy et al., *Unravelling the economic and environmental tradeoffs of reducing sediment movement from grazed pastures*; and Rolfe et al., 2008, *Using Conservation Tenders for Water Quality Improvements in the Burdekin*.

9.7 Policy and planning implications

The draft WQIP has outlined a broad range of potential interventions across multiple land uses. These options raise a number of policy and planning considerations regarding:

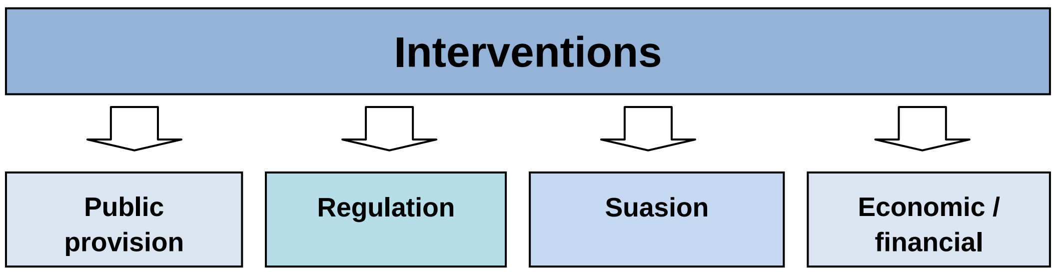
- policy instrument choice;
- the substitutability of different actions to meet load targets; and
- delivery efficiencies.

These issues are outlined in more detail.

9.7.1 Policy instrument choice

Policy instrument choice has been outlined in detail in Section 4.2 of the report above; as noted, potential interventions include public provision, regulation, suasion and economic/financial instruments (shown in Figure 29).

Figure 29: Policy tools to achieve natural resource management objectives



Source: MJA.

There are few restrictions on policy options for the Townsville WQIP because of the significant involvement and ownership of the local government sector. This creates options to develop a truly comprehensive and efficient set of interventions to achieve the objectives of the WQIP. Some of the key options are outlined.

Urban point-source loads

The proposed investment in wastewater treatment plants to meet regulated standards is an effective means to address urban point-source loads, particularly where the cost of establishing and operating plants is passed on to households and businesses via cost reflective pricing strategies.

However, total end of catchment loads will increase in the long term as volumes increase in line with population, holding concentrations constant. Therefore, in the medium- to longer-term, it would be prudent to investigate cost-effective, complementary policy measures that lower the overall costs of load management (such as nutrient trading or the opportunity for offsets for additional point-source loads).

Urban diffuse loads

There are two key policy challenges for urban diffuse loads: mitigating the risks of future development and reducing loads from existing developed areas. Optimal policies for these two challenges are likely to be different:

- for **greenfield development**, requirements for enhanced stormwater management under existing and proposed regulations should provide for effective management controls. The capital cost impost of these requirements on new developments is relatively minor at around 1% of construction costs. Where practicable, ongoing costs borne by local governments should be recovered in full through adjustments to rates. However, it should also be realised that the regulations for greenfield development will not entirely mitigate the impacts of development. In effect, the State's policy will only partially mitigate the impacts of new development;
- for **existing developed areas**, the most efficient set of policies is likely to be more complex. Retrofitting WSUD is likely to be less effective, with greater degrees of uncertainty in outcomes. Retrofitting is likely to be more costly than in fitting WSUD to greenfield applications. In addition, retrospective requirements for WSUD may create significant social impacts (e.g. affordability) depending on the funding policies. However, a number of complementary policies may be possible;
- the **continuation of suasive** measures (e.g. guidelines etc) as proposed may be possible. This will be necessary irrespective of what other approaches are adopted;
- **WSUD for redevelopment**: This will require the implementation of performance-based WSUD where land undergoes a major redevelopment, for example the subdivision of a peri-urban block into residential lots. However, the timing of these management actions will be determined by the broader land market and cost-effective solutions may not be available due to site constraints; and
- **direct investment** in WSUD in priority sites in developed areas. There are a number of financing options for this including broader catchment management levies imposed as part of the rating system, or funding by developers in lieu of implementing WSUD on actual development sites, for example via offsets to partially or fully meet WSUD outcomes.

Peri-urban diffuse loads

Management actions in peri-urban regions will involve highly heterogeneous outcomes and levels of cost-effectiveness. Inflexible regulatory approaches may produce expensive and inefficient outcomes. However, a suite of other policy approaches may be appropriate, including:

- the suasive approaches proposed in the WQIP are a necessary component of an action plan as they underpin all other approaches and will assist in eliciting voluntary actions; and
- financial incentives and market-based instruments. The heterogeneous nature of potential outcomes and costs, and the fact that the private costs of actions may exceed the private benefits, indicate that financial incentives may be also necessary to achieve desired outcomes. Evidence from natural resource management programs elsewhere has indicated that the opportunity cost (value of commercial opportunities foregone) is often very low

in peri-urban areas and incentive requirements can be quite modest (e.g. to cover the costs of fencing only).[216]

Rural diffuse loads

Presently, rural land use in the Townsville WQIP region is outside the regulatory controls being developed under the GBR Amendment Bill 2009. In addition, a number of other issues in the region may make regulatory approaches inefficient including: the heterogeneous nature of land use for horticulture, other crops and grazing; the size and business structure of enterprises; and physical characteristics such as location, condition, and potential contribution to end of catchment loads. However, a suite of other policy approaches may be appropriate:

- **suasive approaches**: The proposed, primarily suasive approach outlined in the Townsville WQIP to build on the rural diffuse loads programs being developed for adjacent WQIPs (e.g. the Burdekin WQIP) should result in design and delivery efficiencies and well as synergies within the broader GBR context.
- **financial incentives and market based instruments**: Lessons from the rural programs run elsewhere[217] have shown that sophisticated funding mechanisms such as competitive tenders provide a means of targeting the most cost-effective actions to achieve the water quality targets. Where financial inducements to encourage practice change are to be used, tenders are likely to be more cost-effective than other approaches.

9.7.2 Substitutability of management actions

Targets and interventions in the WQIP are largely being developed around achieving reductions in end-of-catchment loads. Where there is the potential for the targets to be met through multiple means, there an opportunity to implement the most cost-effective approach.

There may be significant opportunities for greater cost efficiencies where the substitutability of different practices is formally incorporated into the management framework. For example, a number of issues could be taken into account through the management framework including:

- the degree to which more management actions to reduce loads from diffuse sources (e.g. rural land use change) can substitute for additional point-source investments; and
- the degree to which rural management actions to reduce sediment loads at the end of catchments can substitute for very costly implementation of WSUD retrofitting in developed urban areas.

While the environmental equivalence of end-of-catchment loads from alternative interventions (e.g. WSUD vs. BMPs) are not fully known, it is instructive to consider the approximate relative costs of different treatment options such as WWTP, WSUD stormwater management and rural BMPs. This gives a broad indication of the potential gains in cost- effectiveness that could be achieved through more flexible approaches such as water quality offsets. Broad indications of relative cost-effectiveness are shown in Table 42.

216 Morrison et al., 2008, *Encouraging Participation in Market Based Instruments and Incentive Programs.*

217 Rolfe et al., 2008, *Using Conservation Tenders for Water Quality Improvements in the Burdekin.*

Table 42: Indicative cost effectiveness of load reduction approaches

Pollutant	Indicative cost range ($'000 tonne/annum)		
	Wastewater treatment plants	WSUD (stormwater management)	Rural BMPs
TN	180–850	380–750	30–55
TP	80–600	1,100–2,100	150–270
TSS	n.a.	2–3	0.05–0.10

Source: MJA based on BDA Group, 2006, Scoping Study on a Nutrient Trading Program to Improve Water Quality in Moreton Bay, Report prepared for the Queensland Environmental Protection Agency; Water by Design, 2009, Water Sensitive Urban Design to meet the proposed stormwater management objectives in Queensland: A Business Case, South East Queensland Healthy Waterways Partnership; Donaghy et al., 2008, Unravelling the economic and environmental tradeoffs of reducing sediment movement from grazed pastures; and Rolfe et al., 2008, Using Conservation Tenders for Water Quality Improvements in the Burdekin.

General observations are as follows:

- **rural BMPs have the potential to provide significantly more cost-effective load reductions than WSUD and wastewater treatment plants for TN; and**
- **if the objective of the Townsville WQIP is to reduce diffuse loads entering the GBR from the Townsville catchment, the rationale for direct investment in WSUD under the WQIP, particularly retrofitting WSUD, is questionable on efficiency grounds.** It would appear that the relative delivery rate of loads from their source to the bay would need to be 10 times higher for urban diffuse loads compared to rural loads before WSUD would be more cost-effective. However, WSUD is likely to be more effective in protecting local waterways and estuarine areas.

To fully exploit efficiencies from substituting management actions, a number of requirements would still need to be met, primarily:

- measuring environmental equivalence: there would be a need to measure or estimate the equivalence of different management practices, typically measured via the development of a metric. This would cover issues such as volumes, concentration and frequency of load reductions from different interventions. It would also require the quantitative estimation of the tradeoffs between potential load reductions and the risk associated with those volumes.[218] For example, engineering approaches such as WWTP provide relatively constant and certain load reductions, whereas rural diffuse actions provide more variable and less certain outcomes; and
- policy environment: the greater use of the substitutability of management actions will also require modifications to the policy and regulatory environment. For example, the opportunity to establish water quality offsets under the State's environmental offset framework, and the potential broadening of acceptable solutions under some regulatory frameworks to enable the use of innovative approaches.

9.7.3 Delivery efficiencies

Limitations in resources available to address water quality and waterway health in the Townsville WQIP region provide a strong rationale for ensuring that delivery of interventions is

[218] DEHP, 2009, *Development of a Water Quality Metric for South East Queensland to enable effective policy and program design and the use of market based instruments in the Lockyer, Bremer and Logan Catchments.*

as efficient as practicable.[219] The WQIP already demonstrates a strong commitment to ensuring efficient delivery of policies and programs between the parties implementing the WQIP. This approach should continue, perhaps to the point where major programs potentially funded under the Townsville WQIP are completely implemented by third party organisations such as the Burdekin Dry Tropics Natural Resource Management Board implementing the rural diffuse program.

[219] MJA, 2009, *Future Investment in Natural Resource Management.*

10. Wet Tropics (Herbert, Tully Murray Johnstone, Russell-Mulgrave, Barron)

This Section briefly outlines some of the key issues relevant to the establishment and implementation of the Healthy Water Management Plans (HWMPs) in the Wet Tropics – specifically the Barron, Herbert, Johnstone and Russell Mulgrave catchments. Each of these catchments and associated HWMPs is discussed in more detail in the remainder of the report (Sections 12-15).

A WQIP has been developed for the Barron catchment and a Wet Tropics HWMP is currently being developed for the Barron-Trinity, Johnstone, Russell and Mulgrave and Herbert catchments, and integrating key aspects of the Tully-Murray and Barron water quality improvement plans. The work will build on the significant work already completed and work underway to:

- update land use data to better understand the sources of loads; and
- assess key management actions and the potential efficacy of changing practices. The focus is on the grazing, cane, banana and pawpaw industries and sub-catchment specific practices are being developed in conjunction with each catchment community.

The HWMPs will then form the basis of a detailed set of implementation activities to reduce pollution loads from rural activities and will work in conjunction with initiatives to address urban diffuse and point source activities.

Through the process of researching, analysing and writing the catchment specific sections of this report, a number of key issues have emerged that are relevant to the implementation of the HWMPs.

10.1 Constraints in economic and social information – implications for HWMPs

While there has been a reasonable amount of focus on scientific research to understand the risk to waterway health and the GBR in the Wet Tropics catchments over several years, the same cannot be said of regionally specific economic and social research. The relative lack of economic research particularly constrains analysis of the impacts, benefits, costs, and economic risks significantly constrains the ability to design effective and efficient policies and programs to meet the objectives of the HWMPs. This section and the associated regional HWMP chapters are based on available information. In developing this would it should be recognised that:

- available data is often relatively dated;
- much of the social and demographic data is not available for the actual HWMP regions. Therefore, data has been concorded (best fitted) to the HWMP regions. However, it needs to be realised that this process does have its limitations; and
- most relevant production, practice and economic data are available at a whole of Wet Tropics region at best and/or are not available from Wet Tropics-specific studies at all. This results in the need to make assumptions on benefits and costs and transfer data from other comparable regions where data is available.

The implications of the constrained data environment are that the analysis conducted does not contain the information richness of analysis for previous WQIP regions and that intra-regional analysis is often not possible. Despite this, some significant insight for policy and program development is possible (see Section 11.5).

10.2 Inter-regional variability – implications for HWMPs

There is a significant degree of variability within the Wet Tropics and this will have implications for the implementation of the HWMPs. The first area of variability of note is the proportion of employment within each catchment that may be impacted by the implementation of the HWMPs both through consideration of management actions and also through a reduction in risks to the natural asset base upon which their sector is at least partly reliant. Table 43 shows the proportion of the labour force in key sectors in each of the catchments.

The key point to note is that the labour force makeup is significantly different in the Barron, where there is a low reliance on primary industries that may be required to undertake complex and costly actions to achieve water quality objectives, but a very high proportion of people employed in industries that will benefit from the reduction in employment.

Table 43: Labour force statistics – (% of labour force in sectors with strong connections to waterway management)

	Johnstone	Barron	Herbert	Russell-Mulgrave
Agriculture, Forestry and Fishing	13.8	3.0	18.6	13.6
Retail Trade	11.6	13.1	10.9	10.4
Accom., cafes, rest.	**6.8**	**10.2**	**6.0**	**6.2**

Source: ABS Census of population and housing. The categories are based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) 1993.

The second area where there is significant inter-regional variability is in land use and relative contribution to pollution loads. Table 44 shows the inter-regional variability in land use for the four areas outlined in the Wet Tropics regional sections.

Table 44: Inter-regional variability in land use

	Herbert		Barron		Russell-Mulgrave		Johnstone	
Land use	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
Cane	83,080	8.4	31,577	12.3	19,703	12.0	32,962	14.2
Horticulture	398	0.04	4,309	1.7	1,262	0.8	10,528	4.5
Cattle	564,686	57.4	65,273	25.4	6,761	4.1	35,833	15.4
Mining	2,006	0.2	496	0.2	37	0.0	227	0.1
Total	**984,173**	**100.0%**	**257,434**	**100.0%**	**164,109**	**100.0%**	**232,514**	**100.0%**

Source: DEHP land use mapping data.

The key point to note from this data is the significant variation in absolute and relative areas of land use under different industries between and within HWMP regions. In addition, there is significant inter-regional variation in pollution loads (Table 45 below).

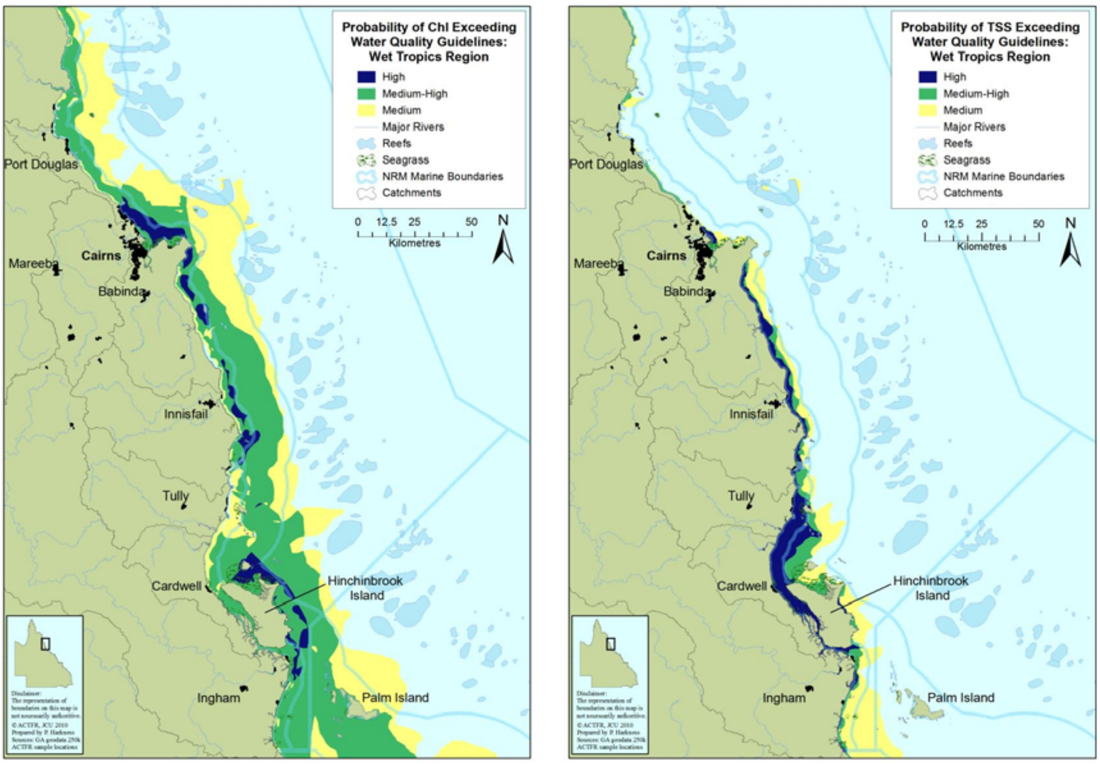
Table 45: Relative contribution to Wet Tropics pollution loads (%)

Pollution source	Herbert			Barron			Russell-Mulgrave			Johnstone		
	TSS	TN	TP	TSS	TN	TP	TSS	TN	TP	TSS	TN	TP
Natural	36	17	19	8	5	5	14	18	17	14	25	24
Baseline	25	16	10	7	4	3	16	28	39	26	25	25
Total	**28**	**17**	**12**	**8**	**5**	**4**	**15**	**25**	**33**	**23**	**25**	**25**

Source: Kroon F, Kunhert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J and Joo M, 2010, Baseline pollutant loads to the Great Barrier Reef. CSIRO.

In addition, recent research has shown the likelihood of pollution concentrations outlined in water quality guidelines being exceeded is not uniform across the wet tropics (Figure 30).

Figure 30: Likelihood of water quality guideline pollution loads being exceeded



Source: Devlin, M., Harkness, P., McKinna, L. and Waterhouse, J. (2011) Mapping the surface exposure of terrestrial pollutants in the Great Barrier Reef. Report to the GBR Marine Park Authority, August 2010. Australian Centre for Tropical Freshwater Research. Report Number 10/12.

Whole of Wet Tropics data on practices indicates there is significant scope for improved practices in cane production, and to a lesser extent horticulture production that could particularly target nutrient and phosphorus reduction. However, because of the high groundcover rates in the Wet Tropics for cattle production, there may be limited scope for reducing sediment loads from pastoral activities.[220] Furthermore, the limited economic data on

220 Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

practice changes available indicates that there are significant economic benefits from improving practices up to current best practice for both sugar farmers and potentially horticulturalists.[221]

The implications for HWMP design and implementation in the Wet Tropics are that significant reductions in pollution loads could be gained at very low cost where policies and programs are:

- geographically and land-use based targeted (based on source of loads and risks of water quality targets being exceeded); and
- specifically designed to exploit the cost-effective practice changes.

10.3 Drivers of future risk to water quality and waterway health outcomes – implications for the Wet Tropics HWMPs

While much of the focus of planning, policy and investment is rightly based on reducing current pollution loads levels to enhance the resilience of the GBR, it is also important to understand the economic and social drivers of future risks to water quality (increases or declines). In the Wet Tropics, key points to note include:

- sugar: sugar is a relatively mature crop with limited options for commercially viable expansion given a continuation of declining terms of trade and a high Australian dollar. While the area of cane production in North Queensland is expected to increase marginally over the next few years to 2016, this is largely in response to the reestablishment of crop production areas post Cyclone Yasi. Long-term prospects for material growth in production areas are very low;
- pastoral: the long-term global prospects for growth in beef consumption are high and Australia has a relative advantage in world markets – partly curbed by an expected continuation of the high Australian dollar. While most of the growth in Queensland production is expected to occur in regions such as the Fitzroy and the Burdekin, there may be some spillover pressure for more intensive cattle farming in the Wet Tropics;
- horticulture: as a general rule, rapid growth of horticulture production should not be expected without subsequent investments in horticulture processing that would allow access into rapidly growing international markets. Production growth in the Wet Tropics area in the fresh market is somewhat constrained due to location except to the extent that the area has a significant competitive advantage (e.g. bananas). ABARES estimate that the trade deficit for processed horticultural product is projected to continue reflecting the effect of relatively high Australian labour costs and the high Australian dollar. This will constrain growth in the short to medium term;
- mining: mining is a relatively low risk compared to many catchments in the GBR and the region has not been the focus of exploration and development to date (e.g. for coal). Hence the future risks of mining are relatively uncertain, but probably relatively low; and
- urban development: within the four HWMP regions assessed, the bulk of the urban population growth and urban land use development is expected to occur in the Cairns region. Growth in urban diffuse loads in this region is likely to grow in the short to medium term.

The implications for the HWMPs are that:

[221] Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

- for sugar, policies and programs should focus on existing producers;
- for beef, options may be limited to address current loads (due to high groundcover), but some emphasis on managing the negative water quality risks of any future intensification in production may be warranted;
- for horticulture, significant growth in production areas may be less likely in the short to medium term due to market conditions. This will constrain growth in pollution loads unless current practices deteriorate;
- for mining, future risks are relatively uncertain, but there needs to be a continuation of managing future risks via existing regulatory processes with an emphasis on assessing the cumulative risks of future developments; and
- for urban, the implementation of WSUD will only partly mitigate the risks of future growth (primarily focussed in the Barron).

10.4 Variability in abatement costs – implications for HWMPs

Typically there are multiple options to reduce water pollution entering waterways and ultimately the GBR. In addition, there is significant variability in the relative cost of reducing loads between and within different land uses (see Table 46 below for nitrogen).

Table 46: Relative costs of water pollution abatement - nitrogen

Source	Approximate costs ($/kg/annum)
Rural diffuse – cane BMPs	-31-+38
Urban diffuse - WSUD	360-450
Point sources - WWTPs	76-200

Source: MJA analysis.

This variability in abatement costs has a number of implications for planning, policy and program deliver for HWMPs in the Wet Tropics including:

- focussing investment on rural diffuse sources that represent the major sources of nutrient and pesticide emission;
- for some loads such as, pollution abatement can actually deliver commercial gains to the farmer (i.e. a win-win situation). Policies need to be designed to underpin commercially viable practice change to maximise returns for public investment in pollution abatement activities;
- there is variation in abatement costs for the same pollution type between sectors and land use categories. This raises the option to exploit market-like approaches to ensure pollution abatement objectives can be met at the lowest cost to society. This is particularly the case in the Barron where water quality offsets may be a possible efficient policy mechanism. This is discussed further in the Barron chapter; and
- different policy approaches (regulation, pricing, market, information, capacity building etc.) may be required to overcome different types of impediments to practice change. More analysis of the impediments and subsequent development of an efficient portfolio of policies and programs to reduce loads in the. Wet Tropics is likely to pay significant dividends .

These issues are discussed in more detail in the relevant HWMP sections following.

11. Herbert

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- The Herbert region's population is expanding at a slower rate than for the GBR catchment as a whole because drivers of population growth in other GBR regions, such as mining, are not prevalent in the Herbert region.
- Social conditions relatively are less favourable in the Herbert region than for the GBR and Queensland as a whole. There is a higher incidence of low-income families and lower rates of home ownership than for Queensland as a whole. Education levels are lower in the Herbert region than in the GBR or Queensland as a whole.
- The scale of sugar production in Herbert has resulted in the region being one of the major users of fertiliser in Queensland. This has an impact on nutrient loads entering the GBR.
- The high reliance on agriculture in terms of employment and business counts, particularly sugar and beef production, and the associated water quality risks from production are not likely to decline without policy intervention.
- There are significant economic and social constraints to changing agricultural practices and these have implications for policy and program design and implementation.

Scenarios assessed

Two scenarios were assessed:

- do nothing more; and
- a scenario of actions to accelerate uptake of better soil, nutrient and pesticide management practices across a number of rural and urban industries under the auspices of the WTHWMP and building on existing actions already underway under programs such as Reef Rescue.

Impacts

Impacts of the do nothing more scenario are likely to be a further decline in water quality and risks to the GBR. Key waterway assets such as wetlands will also be impacted. Negative impacts are likely on sectors reliant on water quality, particularly the GBR tourism drawcards such as boating, diving and snorkelling. There are also likely to be negative impacts on recreation, particularly fishing, and a general loss in ecosystem function.

Positive impacts of the scenario of actions include:

- a reduction in nitrogen loads by around 20% from sugar producers at virtually no cost;
- subsequent reductions in a number of other loads from the implementation of best management practice (e.g. pesticide loads including ametryn, atrazine, diuron, hexazinone, and/or tebuthirion);
- reductions in urban diffuse and point source loads; and
- significant benefits in terms of risk mitigation to the tourism industry and the recreational fishing industry.

Implementation issues

Through programs such as Reef Rescue, hundreds of small on-ground projects are being implemented across the Wet Tropics region across multiple sectors (sugar, grazing, diary horticulture (bananas and paw paws). While these actions should continue, given the makeup of land use in the region and the fact that grazing and horticulture both have high levels of adoption of best practice, options to significantly reduce loads from those sectors will be limited without imposing significant economic costs.

The key lessons for the implementation of the HWMP are that there should be a very focused effort on enhancing practices in cane production in the region for several reasons:

- sugar is probably the only sector that provides opportunities for significant reductions in loads in both absolute and relative terms. Current practices in grazing and horticulture limit the scope for significant reductions in loads without incurring significant economic costs; and
- there are significant opportunities to exploit win-win situations in sugar by targeting the 90% of the area of production that is subject to either C or D practices (C referring to common or code of practice; D to practices considered unacceptable by industry or community standards). In effect, the available data suggests nutrient loads could be reduced by around 20% while delivering higher returns to producers.

Given the opportunities in sugar, policies should be specifically designed to overcome impediments to practice change including information, extension, innovative market approaches to mitigate the risks of practice change (insurance-like approaches) and to overcome the capital investments required (loans for necessary capital). These approaches would enable significant reductions in loads to be achieved at a much lower cost than current approaches employed under Reef Rescue.

11.1 Introduction

The Herbert region, which is situated to the north of Townsville in North Queensland, is around 988,401 hectares. The river drains east through a rugged gorge section near Glen Eagle and flows into the Coral Sea at the southern end of the Hinchinbrook Channel near Ingham. Agriculture is the dominant land use within the region, accounting for approximately 59% of land use. Sugar cane is the dominant irrigation activity across the Herbert region.

In the upper catchment, the predominant land use is grazing of beef cattle through the agricultural production of rye grass pastures and maize. In the lower catchment, land is mostly used for sugar cane production. However, livestock and meat production is the major agricultural activity in the Lower Herbert based on value of production. There are two sugar mills in the Lower Herbert: the Victoria and Macknade Sugar Mills, both owned by CSR Limited.

Small scale mining activities occur in the Upper Herbert, largely concentrated around Mt Garnet, for copper, lead, silver and zinc. The mining industry is locally economically significant. Areas under intensive use, such as urban development and mining, only account for a small fraction of total land use (0.82%), but can have significant impacts on the region.

This section applies the framework outlined in Section Two to the potential actions in the Herbert HWMP. The scenarios assessed are based on:

- the Herbert Draft HWMP and other information from Terrain Natural Resource Management;
- potential diffuse urban source actions discussed with DEHP officials; and
- application of emerging State policies to increase wastewater standards to tertiary treatment in larger urban centres.

11.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the HWMP. This socio-economic profile is based on the 2006 Australian Bureau of Statistics (ABS) Census of Population and Housing. The data for the 2011 Census were not available at the time this chapter was prepared.

11.2.1 Demographic makeup

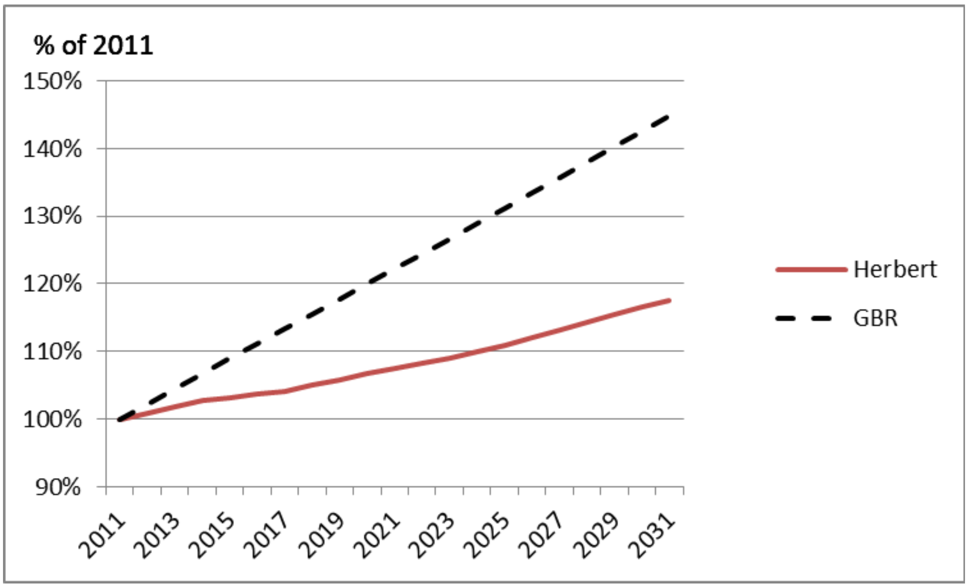
Population

From the 2006 Census, it is estimated that the population of the Herbert HWMP region was around 17,623. Figure 33 below shows the historic and forecast population growth for the Herbert HWMP region compared with all of the HWMP regions assessed in this report. It indicates that:

- significant population growth is expected across the HWMP regions over the next 20 years; and
- the Herbert region's rate of growth is likely to be significantly lower than for the GBR as a whole (at about one third of the total percentage increase by 2030). The Herbert region

does not have any of the major population drivers of other GBR regions, such as mineral resources.

Figure 31: Population growth projections (Herbert and all GBR HWMP regions)



Source: MJA based on DLGPSR and ABS 2011 census

Population and demographic statistics of note include:

- like much of the GBR, the population of the Herbert HWMP region is slightly skewed to males (51% of the population).;
- in the 2011 census, 8.4% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Herbert HWMP region, compared with around 3.6% for the whole of Queensland; and
- approximately 11% of people in the HWMP region were not born in Australia, compared with 17.9% for Queensland. In Herbert 6% of the population speak a language other than English at home, compared with 7.8% for Queensland. To the extent that these people are targeted for programs under the HWMPs, there may be difficulties in effective engagement.

Community capacity

Issues relating to the community's capacity to participate in natural resource management include the following:

- approximately 23% of adults (>15 years old) participate in voluntary work, potentially indicating reasonable levels of social capital, although this rate is lower than HWMP regions, such as the Fitzroy, with greater proportion of the population in primarily rural areas. Females had higher levels of participation in volunteer work at 27% compared with males at 20%. However, the ABS census data does not indicate what type of volunteer work was undertaken;
- Herbert has a higher incidence of low-income families than the State as a whole. Approximately 18% of families in the Herbert HWMP area are on low incomes (i.e. less than $500/week) compared with 8% for the State. However, reported household incomes are often lower in regions with higher proportions of agricultural enterprises and larger Indigenous populations. This is likely to be the case in Herbert; and

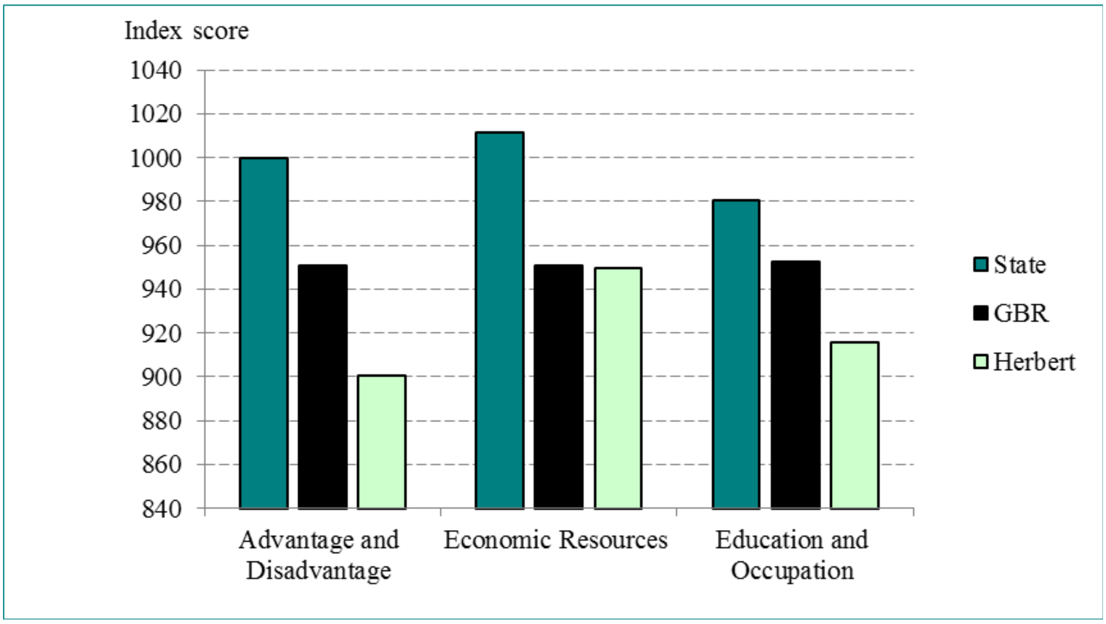
- household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In Herbert, approximately 70% of homes are owned or are being purchased. This compares with a State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad way of making relative comparisons of social and economic resources between regions. Three indices of most relevance are:

- the Index of Advantage–Disadvantage is a continuum of advantage to disadvantage. Low values indicate areas of disadvantage and high values indicate areas of advantage.
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties.
- the Index of Education and Occupation includes all education and occupation variables.

These indices were concorded to the HWMP regions to enable comparisons of each HWMP region to all of the regions assessed in this report and to Queensland as a whole. Results are shown in Figure 32.

Figure 32: SEIFA indices



Source: MJA based on ABS 2006 census SEIFA indices.

Analysis of the data indicates:

- relative to the State and the GBR as a whole, Herbert is at a significant disadvantage;
- economic resources in Herbert are significantly below the State average and a approximately the same for the GBR region as a whole; and
- education and occupation data indicate that the region is significantly worse off than the State, as well as worse off than the GBR as a whole, potentially indicating lower resilience to change.

This broadly implies that the Herbert region's lower social and economic wellbeing may make it more difficult to implement the HWMP here than in other regions. This is particularly due to the low levels of diversity in industry and occupations compared with other HWMP regions.

Education levels in Herbert are lower than the rest of the GBR catchments and the State as a whole as shown in Table 47.

Table 47: Educational attainment

Highest education level completed	Herbert (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	24.1	21.3	19.8
Year 12	24.7	30.1	37.2
Certificate or diploma	20.9	22.2	21.9
Undergraduate degree	4.8	6.6	9.3
Postgraduate degree	0.7	1.1	2.2

Source: ABS census of population and housing, 20011.

Employment and labour force

Labour force statistics in Table 55 indicate the dominance of agriculture, forestry and fishing industries in the Herbert region. Manufacturing is a more significant employer in the Herbert region than in the GBR as a whole and the state. This is explained by primary goods processing plants, particularly for sugarcane.[222] Mining is less important to the region than for the GBR as a whole, but more important than for the State. Government administration is also a more significant employer in the Herbert region than in the GBR and the State, potentially due to higher welfare dependence associated with lower socio-economic outcomes for the Herbert region. Retail trade and accommodation, cafes and restaurants, often used as a proxy for the tourism industry, are less important in the Herbert region than for the GBR as a whole.

The specialisation ratio is highest in Agriculture, Forestry and Fishing. The specialisation ratio is the ratio of the industry employment share for the region to the industry employment share for Queensland.

[222] Synergies Economic Consulting (2011).

Table 48: Labour force statistics

	Number			Percentage		
	Herbert	GBR	Qld	Herbert	GBR	Qld
Agriculture, forestry and fishing	1,035	23,546	54,563	15%	5%	3%
Mining	267	27,793	51,656	4%	6%	3%
Manufacturing	825	34,978	169,025	12%	8%	8%
Electricity, gas, water and waste services	47	6,962	24,764	1%	2%	1%
Construction	525	40,558	179,947	8%	9%	9%
Wholesale trade	119	13,561	73,377	2%	3%	4%
Retail trade	809	46,833	214,617	12%	11%	11%
Accommodation and food services	366	32,649	140,036	5%	7%	7%
Transport, postal and warehousing	268	24,591	104,924	4%	6%	5%
Information media and telecommunications	20	3,588	25,282	0%	1%	1%
Financial and insurance services	80	6,317	53,833	1%	1%	3%
Rental, hiring and real estate services	40	7,086	36,875	1%	2%	2%
Professional, scientific and technical services	226	18,497	131,921	3%	4%	7%
Administrative and support services	126	12,383	64,185	2%	3%	3%
Public administration and safety	439	30,251	135,586	6%	7%	7%
Education and training	590	33,080	160,241	8%	7%	8%
Health care and social assistance	748	47,500	240,017	11%	11%	12%
Arts and recreation services	48	4,210	28,418	1%	1%	1%
Other services	254	17,688	78,157	4%	4%	4%
Not Stated	152	10,814	22,913	2%	2%	1%
Total	**6,984**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS Census of Population and Housing, 20011 The categories are based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) 1993.

11.2.2 Economic structure

The structure of the economy can provide some indication of a region's capacity to change in response to natural resource management policies or programs. Table 49 indicates the economic structure of Herbert's economy indicated by business counts by industry. Key points to note include:

- agriculture, forestry and fishing has a significantly higher proportion of business counts, at 47.5%, than for Queensland as a whole (11.1%);
- accommodation and food services, which relates to the tourism industry, comprises 3.5% of business counts for the Herbert region. This is slightly lower than the proportion for Queensland, at 3.6%; and
- generally, Herbert has a much narrower economic base than the State as a whole, with primary industries being disproportionately dominant. Where policies developed under the HWMP impact negatively on this sector, the impacts could be relatively greater than similar policies in other regions.

Table 49: Counts of registered businesses by industry, Herbert Region, 2006

Industry	Herbert Region		Queensland	
Agriculture, forestry and fishing	888	47.5	46,624	11.1
Mining	27	1.4	1,913	0.5
Manufacturing	93	5.0	18,193	4.3
Electricity, gas, water and waste services	9	0.5	1,039	0.2
Construction	204	10.9	78,768	18.8
Wholesale trade	15	0.8	13,442	3.2
Retail trade	96	5.1	27,747	6.6
Accommodation and food services	66	3.5	14,950	3.6
Transport, postal and warehousing	72	3.9	27,180	6.5
Information media and telecommunications	0	0.0	2,772	0.7
Financial and insurance services	42	2.2	25,827	6.2
Rental, hiring and real estate services	127	6.8	46,636	11.1
Professional, scientific and technical services	42	2.2	41,509	9.9
Administrative and support services	30	1.6	15,724	3.7
Public administration and safety	0	0.0	1,460	0.3
Education and training	6	0.3	4,559	1.1
Health care and social assistance	36	1.9	17,630	4.2
Arts and recreation services	9	0.5	5,313	1.3
Other services	81	4.3	18,591	4.4
Not Classified	25	1.3	9,533	2.3
Total	**1,868**	**100.0**	**419,410**	**100.0**

Source: OESR, Queensland Regional Profiles citing Australian Bureau of Statistics, Counts of Australian Businesses, including Entries and Exits, June 2007 to June 2009, cat no. 8165.0. Note: For this data it was not possible to concord the Herbert region exactly, so it is taken as the SLAs of Herberton and Hinchinbrook.

Note: The classifications used are based on ANZSIC 2006.

Hence, the economic structure of Herbert has significant implications on the prioritisation, design and implementation of the HWMP. Of particular importance is the dominance of the sugar industry and the need to target significant effort within that industry if nutrient targets are to be achieved.

Tourism

While tourism is important to the region, Herbert is not as heavily reliant on tourism as other regions in the GBR, such as the Mackay Whitsunday region. The Herbert area has some significant tourism sites including Hinchinbrook Island National Park, Wallaman Falls in the Girringun National Park, the Paluma Range National Park and the Herberton Tin Mining Museum.

Reef-based tourism is important for the Hinchinbrook Island area of the Herbert region. Analysis of GBRMPA's EMC data indicates that an estimated 821,428 water-based tourist activities occurred in the Townsville-Whitsunday Management Area region (which includes

Hinchinbrook Island) in 2010. This is roughly similar to the number of visitors for the Cairns-Cooktown Management Area in 2010, but significantly more than for the Mackay-Capricorn management zone. There are potential risks to reef-based tourism and other forms of nature-based tourism industry from any loss in tourism attributable to water quality.[223]

Semi-structured interviews undertaken by MJA with approximately 15 dive operators across the GBR in 2008 indicated that any deterioration in reef and marine condition has a negative impact in the sector in two main ways. Firstly, operators are often forced to travel further offshore to find quality dive sites increasing operating costs and reducing profits. Secondly, if water quality is poor, dive tourists are less inclined to undertake subsequent dives during their current holiday or return to the region for dive holidays in the future.[224]

Agriculture

The key industry targeted for practice change in the HWMP is agriculture Table 50.

the value and share of agricultural production for the three SLAs included in the Herbert catchment. The analysis shows:

- tropical crops (sugarcane and banana) are the primary agricultural product in the Herbert region, consisting of 86% of the value of agricultural production, equivalent to $153.7 million. This indicates a significantly disproportionate reliance on sugarcane in the Herbert region;
- crops make up a much less significant proportion of the value of agricultural production for Queensland as a whole, at 47.9%, and compared with 48% for the GBR as a whole;
- livestock slaughterings account for 9.9% of the value of agricultural production in the Herbert Region, valued at $17.8 million. Livestock slaughtering comprises a much larger share of the value of agricultural production for Queensland as a whole at 47.4%; and
- livestock products make up only 4.1% the value of agricultural production in the Herbert region, valued at $7.3 million. Livestock products comprise a similar proportion of the value of agricultural production in Queensland as a whole.

The significant dominance of sugar for cropping and irrigation has a major significance for the prioritisation and development of programs to address reductions in nutrient loads from the Herbert region. Analysis of other key headline agriculture data indicates:

- Herbert accounts for around 5.3% of the total cropping area in the GBR;[225] and
- the scale of sugar production in Herbert has resulted in the region being one of the major users of fertiliser in Queensland. This has an impact on nutrient loads entering the GBR.

223 GBPMPA, 2008, unpublished data.

224 MJA, 2008, *The economic contribution of the dive industry to the GBR.*

225 ABS, 2008-09, *Land Management Practices in the Great Barrier Reef Catchments, Preliminary, 2008-09,* Category no. 4619.0.

Table 50: Value of agricultural production by statistical local area, Herbert Region, 2005–06

Statistical local area	Crops		Livestock slaughterings		Livestock products		Total
Cardwell (S)	5.1	98.2	0.1	1.8	0.0	0.0	5.2
Herberton (S)	8.1	26.9	14.6	48.7	7.3	24.4	30.0
Hinchinbrook (S)	140.5	97.9	3.0	2.1	0.0	0.0	143.6
Herbert Region	153.7	86.0	17.8	9.9	7.3	4.1	178.8
Queensland	4167.9	47.9	4125.2	47.4	415.8	4.8	8708.9
Region as % of Qld	**3.7**	. .	**0.4**	. .	**1.8**	. .	**2.1**

Source: OESR Regional Profile, citing: Australian Bureau of Statistics, Agricultural Commodities, Australia, 2005-06, cat. no. 7125.0. This data has been concorded as follows: Hinchinbrook (99%) within the region, Herberton (95%) within the region and Cardwell (2%) within the region.

Note: . . = not applicable

11.3 Pollution loads

Pollution loads in the Herbert are from natural sources, as well as from the consequences of changes in land use and land management. Load estimates are shown in Table 51.

Table 51: Estimated pollution loads in the Herbert (tonnes/year)

Load	TSS	TN	TP
Natural load	1,100	746	93
Baseline	2,690	1,830	151
Total	3,790	2,576	244
Total - % of natural loads	345%	345%	262%
Total - % of Wet Tropics	**28%**	**17%**	**12%**

Source: Kroon F, Kunhert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J and Joo M, 2010, Baseline pollutant loads to the Great Barrier Reef. CSIRO.

While this data is only for a subset of pollutants, the key points to note are that sediment and nutrient loads are now in excess of three times natural loads, and that the Herbert is a relatively significant source of pollutants in the Wet Tropics region, particularly for sediment (28% of regional loads). The major contributors to the loads above are primary industries (particularly grazing and sugar) and, to a lesser extent, more intensive land uses such as urban development, industrial development, mining, and linear infrastructure development (e.g. roads).

11.4 Potential actions

As noted above, HWMPs are currently being developed for the Herbert, Johnstone, Russell and Mulgrave catchments. Those HWMPs will build on the significant work already completed and work underway to:

- update land use data to better understand the sources of loads; and
- assess key management actions and the potential efficacy of changing practices. The focus is on the grazing, cane, banana and pawpaw industries and sub-catchment specific practices are being developed in conjunction with each catchment community.

The HWMPs will then form the basis of a detailed set of implementation activities to reduce pollution loads from rural activities.

In addition, actions to mitigate the risk of loads from other sources should also be developed, specifically urban diffuse loads and point source loads from regulated emitters (e.g. wastewater treatment plants, mines).

11.4.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the HWMP to address sediment and nutrient loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point source loads.

11.4.2 Scenario Two: A suite of changes to practice

This scenario would build on the current actions being undertaken in the region (often at least partially funded by Reef Rescue or Caring for Our Country). The current actions could be summarised categorised into two broad categories.

Firstly, there are a number of research, planning and governance activities that have been undertaken or are continuing. This includes research into the sources of loads, effective means to reduce loads, the identification of environmental objectives and values, and the establishment of plans and policies to underpin on-ground actions.

The second suite of actions that will make a direct impact on pollution loads is the provision of rants to underpin practice change. This includes grants to assist with initiatives such as improved herbicide management (e.g. hooded sprayers in sugar), improved nutrient management (e.g. subsurface fertiliser application, stool splitters in sugar), improved soil management (e.g. zero till, GPS controlled traffic farming), improved groundcover (e.g. for horticulture and cattle), soil detention basins, laser levelling (sugar and horticulture), riparian plantations and rehabilitation, permanent fencing and watering points (dairy and cattle) and effluent reuse systems (dairy).

The focus in developing the HWMP to date has been very much on rural diffuse loads. Urban diffuse loads are managed through the *Sustainable Planning Act 2009* and subordinate State Planning Policy, while significant point-source loads are managed as environmentally relevant activities under the Environmental Protection Act 1994.

The environmental values and water quality objectives for the region are currently being finalised through a process of scientific analysis and consultation. Under the HWMP, a further suite of actions will be prioritised and proposed to reduce pollutant loads from diffuse and point sources. These actions will enhance water quality in the freshwater and marine environment and enhance relevant environmental values across the region and adjacent areas of the GBR. Given the fact there are no finalised actions and targets for the region, MJA has assessed a number of actions, specifically:

- for rural diffuse loads, a progressive increase in the proportion of landholders adopting current best management practice (B practices) and moving from what are currently considered poor practices to more acceptable practices (i.e. D practice to C practice). It should be noted that there is insufficient detail in existing data to distinguish the benefits and costs of individual practices. Rather, broad incremental movement between suites of practices are assessed;
- future urban developments will address the State Planning Policy (Healthy Waters part) to protect the environmental values of waters and support the achievement of the water quality objectives. This will largely involve implementing best practice urban design for water quality and drainage recommended in the Urban Stormwater Queensland Best Practice Environment Management Guidelines; and
- where identified, point source loads will be addressed via upgrades to wastewater treatment plants and actions by mines in the region.

11.5 Potential impacts of HWMP

As part of the planning processes for the HWMP, priority waterway assets are being identified and the values that are derived from those assets. The HWMP is likely to have a number of positive environmental, social and economic impacts on the extent and condition of those assets. Key impacts are briefly outlined in Table 52. The extent to which those benefits can be achieved will be determined by the resources available and the efficiency of interventions and investment under the HWMP.

Table 52: Potential benefits of HWMP

Key benefits	Key elements and values
Maintenance of wetlands	The region has approximately 28,000 ha of wetlands, approximately one third of all wetlands in the wet tropics. The HWMP will reduce risks to the extent and quality of many of those wetlands.[226]
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive. Evidence from analysis in SEQ indicates that changes in turbidity impact on short-run costs (changes in electricity and chemical usage and changes in sludge management costs), but that the long-term costs of avoiding treatment plant augmentations are often more significant.[227]
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits are in the range of \$77,000 to \$200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[228]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector to maintain the region's attractiveness to visitors, particularly given the region's high proportion of reef-based tourism activities.
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Improved gross margins for farmers	Analysis undertaken by CSIRO indicates that gross margins can actually be increased in the longer term through improvements in practices, particularly incremental improvements from D practices to C practices, and C practices to B practices.[229]
Maintaining ecosystem function	**Previous research indicates that a 1% enhancement in GBR coastal water quality is worth around \$7.82 per household per year. This translates to around \$55,000 per annum for the residents of the Herbert alone.[230]**

Source: MJA.

11.6 Potential costs of HWMP implementation

This section briefly outlines our estimates of some of the more significant costs of reducing water pollution loads in the Herbert region. Because the HWMP process is yet to determine the

226 Anon 2011. Reef water quality protection plan report card.

227 KBR 2009. Valuing the natural asset investigating the impact of water quality changes on water treatment plant costs.

228 Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

229 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

230 MJA estimates based on Windle and Rolfe 2006, *Non-market values for improved NRM outcomes in Queensland*.

preferred suite of actions, MJA has modelled a number of costs that would relate to some of the more likely actions under the HWMP.

11.6.1 Costs of rural diffuse actions

Rural diffuse actions will primarily relate to actions by cane producers, beef producers and horticulture producers. Table 53 shows the estimates of uptake of management practices by growers in 2009 that relate to rural diffuse loads (the dominant source of loads).

Table 53: Adoption of management practices – % of growers (Wet Tropics)

Load	Sugar %	Horticulture %
A – cutting edge practices	1	37
B – current best practice	9	37
C – common or code of practice	44	15
D – practices considered unacceptable by industry or community standards	46	11

Source: Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

While there is significant variability in the results depending on particular types of management regimes (e.g. nutrient management, herbicide management and soil management), the key point to note from the data is that there is significant scope for enhancing practices and consequently reducing pollutant loads.

MJA has developed an economic model to estimate the potential cost of achieving load reductions from rural diffuse sources. The model is based on:

- data on the area of each major production system (e.g. sugar) under different management regimes (A, B, C, and D) as outlined in the table above;
- previous modelling of the potential efficacy of different management regimes (measured as pollution load (runoff & leached));[231] and
- data on likely changes in gross margins[232] attributable to different production systems transitioning between different state conditions.

Scenarios of management actions that result in higher proportions of farmers undertaking improved management practices can then be modeled to develop broad estimates of changes in loads (TSS, TN, TP) and the likely costs[233] of achieving those load reductions.

Sugar

For the purposes of this report, it is assumed that the area of sugar production in the Herbert is 83,000 ha (based on State land use mapping analysis) and that the dominant soil type for sugar production is well drained sandy loam. Furthermore, it is assumed that the adoption rates of

[231] Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship

[232] Gross margins are simply the difference between sales revenue and the production costs, excluding fixed costs such as overheads, interest payments and tax. Changes in gross margins will be the net impact of both any changes in yields (and subsequent revenues) and changes in inputs costs.

[233] It should be noted that the costs included in this model are the substantive costs of practice change (i.e., additional capital expenditure and changes in operating costs). They do not include administrative and other transaction costs.

management practices are currently the same as for the broader Wet Tropics region. Using the economic model developed for this report, MJA has modeled a number of scenarios. These scenarios are outlined in Table 54 below. They reflect a number of feasible paths of improvement over time as growers progressively improve from their current practices to current best practice (B practice) and beyond (A practice).

Table 54: Hypothetical scenarios modelled – changes in practice regimes

	% of area			
Scenario	**A**	**B**	**C**	**D**
Current	1	9	44	46
Scenario 1	1	20	55	24
Scenario 2	1	50	45	4
Scenario 3	1	80	19	0
Scenario 4	1	99	0	0

Source: MJA analysis.

Table 55 below shows MJA's estimates of changes in annual nutrient loads and the cost of achieving those load reductions.

Table 55: Scenarios modelled – changes in practice regimes

Scenario	Approximate regional load reduction (kg/N/annum)	% Change from current loads	Change in region's annual gross margin ($ millions)
Current	N/A	N/A	N/A
Scenario 1	320,000	-8	+3.0
Scenario 2	670,000	-17	+8.2
Scenario 3	815,000	-20	+12.3
Scenario 4	870,000	-22	+14.8

Source: MJA analysis.

The analysis shows that significant reductions in nutrient loads from cane could be achieved without necessarily impacting on regional productivity and gross margins. A program of continuous improvements in practice would actually increase total regional gross margins. This is largely due to the fact that CSIRO analysis suggests that yields per hectare are approximately 3-4% higher for A and B practices than for inferior practices. Our modelling indicates that it may be theoretically possible to reduce nutrient loads from cane production by 50% if all producers were implementing A practices.

However, the analysis does not consider the capital investments that are often required to enhance practices. Analysis undertaken by CSIRO suggests that, even when capital costs are also included, there is still a net financial benefit over a 10-year period from incremental improvements between categories of practice (e.g. C to B). The exception to this rule is moving from B practices to A practices, where the capital investments to move from B to A practices are almost twice the investment from moving from C to B practices. Table 56 below summarises the net economic costs over a ten year period to transition between classes of practice and the annual cost of pollution abatement.

Table 56: Costs of transition between classes of practices (120 ha farm)

Transition	Present value practice change ($/ha)	Pollution abatement – N ($/kg/year)	Comments
B to A	-489	-31	Transition investment approx. $90,000 plus significant savings in nitrogen use
C to B	615	39	Transition investment approx. $60,000 plus significant savings in nitrogen use
D to C	611	38	Significant savings in nitrogen use

Source: MJA based on Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

The key point to note from this analysis is that there are likely to be significant and sufficient private financial gains for most producers to move to current best practice. This could reduce nitrogen runoff and leaching by around 20%. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as insurance-like approaches), and action to overcome problems in accessing capital.

However, reducing nitrogen loads beyond around 20% from current levels would result in significant costs to producers and change should not be expected beyond that point without more costly policy interventions (e.g. financial incentives).

Cattle

State land use mapping data indicates that grazing potentially accounts for about 55% of the landmass of the Herbert region. Data for groundcover[234] in pastoral areas indicates that the mean dry season groundcover over the 1986-2009 period is 93%, significantly above the Reef Plan target of 50%. Furthermore, only around 1.2% of grazing lands had groundcover below 50%.[235] For this reason, specific analysis of the economic impacts of enhancing grazing practices in the Wet Tropics is very limited. However, studies undertaken elsewhere have shown that there are significant environmental (lower loads) and economic (high margins) from maintaining appropriate groundcover and undertaking best practice grazing management.[236]

The data overall indicates that there is likely to be more potential gains in focusing on sugar and horticulture growers to reduce loads, as opportunities in grazing may be limited.

Horticulture

State land use mapping data indicates that horticulture potentially accounts for about 400 hectares (0.5%) of the land mass of the Herbert region. Bananas are the dominant crop in the region and they are typically used as the default crop for assessments of options to reduce water pollution from horticulture.

234 Advice from Terrain indicates groundcover not as high as report card suggests.

235 Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

236 For example, see Roebeling., P, and Webster. J, 2004, Financial-Economic Analysis of Management Practices in Beef Cattle Production in the Douglas Shire. Report on the Cost-Effectiveness of BMP Implementation for Water Quality Improvement.

As with sugar and grazing, an A, B, C, D framework has been developed for horticulture management practices.[237] Furthermore there are a number of key management practices that can be adopted such as inter-row management[238]and efficient fertiliser application rates that can result in reductions in fertiliser application by almost 50% from around 520 kg/ha to 225 kg/ha.[239] Much of these improvements are already underway, reflected in the fact that almost 75% of producers in the Wet Tropics are already implementing A or B practices.

Table 57 below summarises the net economic costs over a ten year period to transition between classes of practice.[240] To date, there is insufficient data to estimate the actual cost of abatement such as nitrogen (i.e. $/kg/annum) although research is progressing in this area.[241]

Table 57: Costs of transition between classes of practices (60 ha farm)

Transition	Present value practice change ($/ha)	Comments
B to A	-6,600	Transition investment approx. $420,000 plus significant savings in nitrogen use
C to B	15,600	Transition investment approx. $160,000 plus significant savings in nitrogen use
D to C	21,700	Significant savings in nitrogen use

Source: Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

The key point to note from this analysis is that there are likely to be significant and sufficient private financial gains for the 26% of producers at C or D practice levels to move to current best practice (i.e. B practice). This would further reduce sediment, nitrogen and other chemical runoff without negatively impacting on the industry's profitability. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as insurance-like approaches), and action to overcome problems in accessing capital.

11.6.2 Cost of urban diffuse actions

Actions to mitigate the risk of water pollution from urban diffuse loads are also likely to be a focus. In a practical sense this usually involves the establishment of WSUD as an underlying approach to future urban development.

237 Van Grieken, M.E., Webster, A.J., Coggan, A., Thorburn and P. Biggs, J., 2010. Agricultural Management Practices for Water Quality Improvement in the Great Barrier Reef Catchments. CSIRO: Water for a Healthy Country National Research Flagship.

238 Roebeling, P. C., Webster, A. J., Biggs, J. and Thorburn, P, 2007, Financial-economic analysis of current best management practices for sugarcane, horticulture, grazing and forestry industries in the Tully-Murray catchment. Report to the Marine and Tropical Sciences Research Facility.

239 Armour J, and Daniells J, 2001, Banana nutrition in north Queensland. Final Report FR95013 to Horticulture Australia Ltd.

240 Based on a typical 60 ha banana farm.

241 For example, see Armour, J., Davis, D., Masters, B., Whitten, M and Mortimore, C. (2011). Paddock Scale Water Quality Monitoring: Interim Report 2009/2010 Wet Season, Wet Tropics Region. Queensland Department of Environment and Resource Management, Australian Centre for Tropical Freshwater Research and Queensland Department of Employment, Economic Development & Innovation for Terrain Natural Resource Management, Australia.

The costs of urban diffuse actions will largely relate to the cost of implementing WSUD in new developments. Based on estimated population growth for the region and the current makeup of households, it is likely that around 55 new dwellings will be established each year over the next 10 years. Census data indicates that 91% of residential dwellings in the Hinchinbrook Shire are detached houses.[242] MJA has estimated the potential pollution loads reductions and related costs for WSUD implementation over the next 10 years (Table 58 below).[243]

Table 58: Estimated cost of WSUD implementation in new developments and impacts on loads over next 10 years

Measure	Value
Number of new dwellings over next 10 years	550
Cost of establishing WSUD over next 10 years	$2.0-2.4 million
Reduction in TSS from business as usual after 10 years	85-90 tonnes per annum
Reduction in TN from business as usual after 10 years	410-430 kg per annum
Reduction in TP from business as usual after 10 years	120-150 kg per annum
Levelised cost of TSS abatement ($/tonne/annum)	$1,750-$2,150
Levelised cost of TN abatement ($/kg/annum)	$360-$450
Levelised cost of TP abatement ($/kg/annum)	**$1,110-$1,360**

Source: MJA analysis.

Urban diffuse actions in new developments have the potential to reduce regional TSS loads by up to 3% after 10 years, at a cost of around $2.0-2.4 million. Estimations of levelised costs of abatement (that include both capital and operating expenditures) indicate that urban diffuse actions are significantly less cost effective than rural diffuse actions at reducing pollution loads.

11.6.3 Costs of other actions – focus on point sources

In addition to diffuse actions, there are likely to be options to reduce loads from point sources such as wastewater treatment plants and the limited mining activity in the region.

Point sources – wastewater treatment plants

There are number of WWTPs in the region. These include:

- Ingham (conventional gravity collection, Ingham WWTP, wastewater disposal into artificial wetlands or Herbert River, with some wastewater reuse at CSR Victoria sugar mill);
- Lucinda (conventional gravity collection, Lucinda WWTP, wastewater disposal into irrigation and occasional ocean outfall);[244] and

242 ABS, Census of Population and Housing, 2006, Basic Community Profile

243 Estimates of load reductions and capital costs are based on MUSIC modelling estimates for small-detached housing developments in the Cairns climatic zone – specifically the use of bio-retention basins. See Water by Design (2010) A Business Case for Best Practice Urban Stormwater Management. Costs were derived from the same study and inflated to current terms using the Brisbane consumer price index. Levelised costs are based on all estimated capital, operations and maintenance, and refurbishment costs over a 25 year period.

244 Hinchinbrook Shire Council (undated) Total Management Plan.

- within the Tablelands Regional Council area, the $14.5 million Malanda Sewer Project is nearing completion. This will replace the use of septic systems across much of the region.[245]

The establishment and upgrades to WWTPs are often a key action of governments to meet multiple regulatory requirements. The costs of WWTP upgrades are driven by the engineering capital and operational costs and are specific to the actual plant.

MJA undertook analysis of expenditure data[246] for recent upgrades from secondary to tertiary treatment for several WWTPs in South East Queensland (data for other WWTPs was not available). MJA estimates the costs of treatment ranges from $76,000 to $200,000 per tonne of nutrients per annum.

Point sources – other environmentally relevant activities

There are a number of other environmentally relevant activities that undertake actions to mitigate the risks of water pollution entering waterways. These include:

- **sugar mills:** The Victoria and Macknade Sugar Mills have a combined capacity to process 5.5. million tonnes of cane per annum. While public domain data on water treatment costs is not available due to the commercially sensitive nature of the data, there is evidence to suggest mills are enhancing their environmental standards and reducing emissions. This includes reusing waste water at some mills; and
- **mines.** There are a number of copper, lead, silver and zinc mines including Mt Garnett, Bald Hill and Ball Gammon. ABS data indicates that approximately 7.4% of total environmental management expenditure in the metal ore mining sector is on liquid waste management.[247] Data on total environmental expenditure by the major mining company in the region (Kagara Ltd) is not available, but reported expenditure (rehabilitation) is approximately 1% of total costs.[248]

There will be other point source emitters in the region. However, data on their emissions and related expenditure is not available at the scale of the Herbert region.

11.7 Economic and social considerations for implementation of the HWMP

The analysis in previous sections indicates there is significant scope to reduce water pollution from changes in land management. This is particularly for sugar cane where there is significant scope to reduce nutrient and other loads. Opportunities for load reduction from grazing are limited due to the very high proportion of graziers who are already meeting best practice groundcover targets. Horticulture accounts for only a very small proportion of land use and there are already a very high proportion of growers that are meeting current best practice.

While population growth does pose some risk to water quality, the implementation of WSUD will mitigate the risks of significant urban diffuse load growth, while recent investments in WWTPs will reduce point source loads. Risks from other point sources such as mining activities

245 http://www.trc.qld.gov.au/infrastructure/malanda-sewerage

246 Data provided by Queensland EPA.

247 ABS (2002) Environmental Protection. Mining and Manufacturing Industries 2000-01. Cat. No. 4603.0.

248 Kagara Ltd (2011) Kagara Mining 2011 Annual Report.

and sugar mills are not well understood, particularly as the types of pollutants is significantly broader than those of agricultural and urban development activities.

While there is only cost information for a subset of actions to reduce loads, available data indicates there is very significant variation in the cost effectiveness between actions and industries. This is shown in Table 59 below.

Table 59: Relative costs of water pollution abatement - nitrogen

Source	Approximate costs ($/kg/annum)	Comments
Rural diffuse – cane BMPs	-31-+38	Significant scope for reductions and enhancing industry commercial outcomes.
Urban diffuse - WSUD	360-450	Limited scope to contribute material reductions in loads.
Point sources - WWTPs	76-200	Implementation will form part of infrastructure provision for regional growth

Source: MJA analysis.

The key lesson for the implementation is that there should be a very focussed effort on enhancing practice in cane production in the region for several reasons, specifically:

- sugar is probably the only sector that provides opportunities for significant reductions in loads in both absolute and relative terms. Current practices in grazing and horticulture limit the scope for significant reductions in loads without incurring significant economic costs; and
- there are significant opportunities to exploit win-win situations in sugar by targeting the 90% of the area of production that is either C or D practices. In effect, the available data suggests nutrient loads could be reduced by around 20% while delivering higher returns to producers.

Given the opportunities in sugar, policies should be specifically designed to overcome impediments to practice change.[249] Given the fact that moving from D to B practices pay financial dividends in the longer term, impediments to change are likely to be:

- *knowledge-based*: some producers may not be fully aware of the economic benefits of enhancing practices. This would indicate information and capacity development approaches would be most appropriate such as agronomic and economic extension;
- *risk:* many producers may perceive the commercial risk of changing practices to be too risky. These risks could be mitigated through demonstration farms in conjunction with extension. Furthermore, the use of approaches such as an insurance-like product to underpin the risk of practice change would be worth considering. Such an approach would only make a payment to a producer where their implementation of new practices actually reduced yields (when benchmarked against district averages); and
- *capital:* moving from C to B practices and B to A practices both require capital investments. However, these capital costs are recouped over time. Therefore, it should be possible to accelerate practices through the provision of low cost or no-interest loans to overcome any impediments to practice change due to limitation of access to capital.

[249] Greiner., R and Grieg., D, (2010) Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. Land Use Policy Volume 28, Issue 1, January 2011, pages 257–265.

In the longer-term, the public funding of these approaches would largely be limited to program design and delivery as any investments in on-ground change would be ultimately financed by producers themselves. This would be significantly more cost effective than current approaches being adopted under the Reef Rescue initiative.

In other sectors examined, the opportunities to achieve significant load reductions at low costs are limited. Any disproportionate focus on those sectors may ultimately reduce the return on the public investment to reduce loads in the region.

12. Johnstone

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- The Johnstone region in North Queensland is not growing as fast as other GBR regions because it lacks the major drivers of population growth in those regions, such as mining.
- Socio-economic conditions in Johnstone are generally on par with the GBR as a whole. Education levels are lower in the Johnstone region. However the region has a higher SEIFA score for economic resources than other GBR region.
- The region has a much higher proportion of Indigenous people than other GBR regions.
- The high reliance on agriculture, particularly sugar and beef production, as a source of employment and income and the associated water quality risks from production are not likely to decline without policy intervention.
- There are significant economic and social constraints to changing agricultural practices and these have implications for policy and program design and implementation.

Two scenarios were assessed:

- do nothing more; and
- a scenario of actions to accelerate uptake of better soil, nutrient and pesticide management practices across a number of rural and urban industries under the auspices of the Wet Tropics Healthy Waterway Management Plan (WTHWMP) and building on existing actions already underway under programs such as Reef Rescue and key actions to address the future risk of growth in urban diffuse loads.

Impacts

Impacts of the do nothing more scenario are likely to be a further decline in water quality and risks to the GBR. Key waterway assets such as wetlands will also be impacted. Negative impacts are likely on sectors reliant on water quality, particularly the GBR tourism drawcards such as boating, diving and snorkelling. There are also likely to be negative impacts on recreation, particularly fishing, and a general loss in ecosystem function.

Positive impacts of the scenario of actions include:

- a reduction in nitrogen loads by around 20% from sugar producers (up to 350,000 kg/annum at virtually no cost;
- reductions in nitrogen and phosphorus loads from horticulture;
- subsequent reductions in a number of other loads from the implementation of best management practice (e.g. pesticide loads including ametryn, atrazine, diuron, hexazinone, and/or tebuthirion); and
- significant benefits in terms of risk mitigation to the tourism industry and the recreational fishing industry.

Implementation issues

Through programs such as Reef Rescue, hundreds of small on-ground projects are being implemented across the Wet Tropics region across multiple sectors (sugar, grazing, diary horticulture (bananas, papaw and other crops such as potato).[250] While these actions should continue, given the makeup of land use in the region and the fact that grazing and horticulture both have high levels of adoption of best practice, options to significantly reduce loads from those sectors will be limited without imposing significant economic costs.

The key lessons for the implementation of the HWMP are that there should be a very focussed effort on enhancing practices in cane production in the region because there are significant opportunities to exploit win-win situations in sugar by targeting the 90% of the area of production that is subject to either C or D practices. In effect, the available data suggests nutrient loads could be reduced by around 20% while delivering higher financial returns to producers.

Given the opportunities in sugar, policies should continue to be specifically designed to overcome impediments to practice change including information, extension, innovative market approaches to mitigate the risks of practice change (insurance-like approaches) and to overcome the capital investments required (loans for necessary capital). These approaches would enable significant reductions in loads to be achieved at a much lower cost than current approaches employed under Reef Rescue.

---

250 For example in 2010-11, 213 Reef Rescue projects were funded in the Wet Tropics. The cost of those projects was about $10 million, and Reef Rescue funding accounted for about 40% of total project costs.

The other area of focus is to address future load risks attributable to horticulture, although the options for low cost pollution are more limited than for sugar.

12.1 Introduction

The Johnstone region[251] is around 232,950 hectares and is centred around the Johnstone River system, in the wet tropics of north Queensland, which includes the Johnstone and South Johnstone Rivers. Both systems rise in the south-eastern section of the Atherton Tableland and discharge through a common estuary at Innisfail to waters of the central Great Barrier Reef (GBR). The principal towns are Innisfail, Malanda and Millaa Millaa.[252] Agricultural production covers around one quarter of the land area in the catchment. Sugar cane growing, horticulture and beef cattle grazing are the primary agricultural activities. Cattle grazing, which occurs in both the Upper and Lower Johnstone, is more intense in the Upper Johnstone.[253]

The Upper Johnstone is one of Queensland's most significant regions for potato production. Irrigation of broadacre crops such as ryegrass pastures and maize occurs near the urban centres of Millaa Millaa and Malanda. There is also a milk processing plant located at Malanda.[254]

In the Lower Johnstone, agricultural production includes sugar cane, tropical fruit, turf farms, banana and paw paw production. The South Johnstone Mill, which is owned and operated by Bundaberg Sugar Ltd, is the only operating sugar mill in the Johnstone catchment. The Mill is situated near Innisfail and supplies raw sugar to the bulk sugar terminal at Mourilyan Harbour. The Mourilyan Mill was closed due to damaged caused by Cyclone Larry. There are also cocoa farms based in the lower catchment.[255]

Areas under intensive use, such as urban development and manufacturing and industrial uses, account for a relatively small fraction of total land use (2.6%), but can have significant impacts on the region.[256] This section applies the framework outlined in Section Two to the potential actions in the Johnstone HWMP. The scenarios assessed are based on:

- the Johnstone Draft HWMP and other information from Terrain Natural Resource Management;
- potential diffuse urban source actions; and
- application of best practice environmental management to new WWTPs in larger urban centres.

12.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to

[251] For most of the analysis in this section the Johnstone region was concorded to consist of these Statistical Local Areas (SLAs): Johnstone 95%, Eacham 62% and Herberton 1%. Where it was not possible to split the data, the region is taken to include the whole of Johnstone and Eacham.

[252] Hunter, H.M. (1997) *Nutrients and Suspended Sediments Discharged from the Johnstone River Catchment during Cyclone Sadie.* See http://www.reefed.edu.au/__data/assets/pdf_file/0020/4259/ws022_paper_01.pdf

[253] Synergies Economic Consulting (2011) *Wet Tropics Water Resource Plan Area*, report prepared for the Queensland Department of Environment and Resource Management.

[254] *Ibid.*

[255] *Ibid.*

[256] Based on an analysis of 2009 land use data estimated provided by the Queensland Land Use mapping project.

the development of the HWMP. This socio-economic profile is based on the 2006 Australian Bureau of Statistics (ABS) Census of Population and Housing.

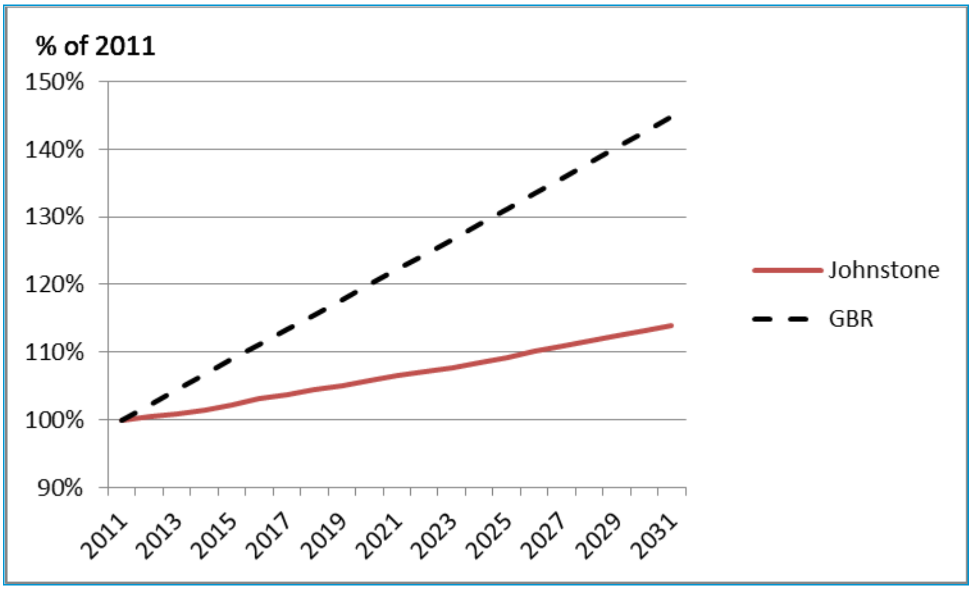
12.2.1 Demographic makeup

Population

From the 2006 Census, it is estimated that the population of the Johnstone HWMP region was 21,337.[257] Figure 37 below shows the historic and forecast population growth for the Johnstone HWMP region compared with all of the HWMP regions assessed in this report.[258] Figure 37 indicates:

- significant population growth is expected across the HWMP regions over the next 20 years; and
- the Johnstone region's rate of growth is likely to be significantly lower than for the GBR as a whole (at about one third of the total percentage increase by 2030). The Johnstone region does not have any of the major population drivers as other GBR regions, such as mineral resources.

Figure 33: Population growth projections (Johnstone and all GBR HWMP regions)



Source: MJA based on DLGPSR and ABS 2011 census.

Population and demographic statistics of note include:

- like much of the GBR, the population of the Johnstone HWMP region is slightly skewed to males (50.6% of the population);
- in the 2011 census, 9.5% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Johnstone HWMP region, compared with around 3.3% for the whole of Queensland; and

[257] This estimate is based on ABS census data concorded (best-fitted) to the Johnstone HWMP region by OESR. Population estimates are based on a census participant's usual place of residence.

[258] Based on DLGPSR Population Forecasting Unit's mid-estimates for each relevant LGA concorded to HWMP boundaries.

- approximately 13% of people in the HWMP region were not born in Australia and around 5% of the population speak a language other than English at home.[259] To the extent that these people are targeted for programs under the HWMPs, there may be difficulties in effective engagement.

Community capacity

Issues related to the community's capacity to participate in natural resource management include the following:

- approximately 19 of adults (>15 years old) in the Johnstone region participate in voluntary work, potentially indicating moderate levels of social capital. Females had higher levels of participation in volunteer work 22%, compared with males (at 16%). However, the ABS census data does not indicate what type of volunteer work was undertaken;
- Johnstone has a slightly higher incidence of low-income families than the State as a whole. Approximately 19% of families in the Johnstone HWMP area are on low incomes (i.e. < $500/week), compared with 8% for the State. However, reported household incomes are often lower in regions with higher proportions of agricultural enterprises. This is likely to be the case in Johnstone; and
- household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In Johnstone, approximately 66% of homes are owned or are being purchased. This compares with a State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad way of making relative comparisons of social and economic resources between regions. Three indices of most relevance are:[260]

- the Index of Advantage–Disadvantage is a continuum of advantage to disadvantage. Low values indicate areas of disadvantage and high values indicate areas of advantage.
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties.
- the Index of Education and Occupation includes all education and occupation variables.

These indices were concorded to the HWMP regions to enable comparisons of each HWMP region to all of the regions assessed in this report and to Queensland as a whole.[261] Results are shown in Figure 34.

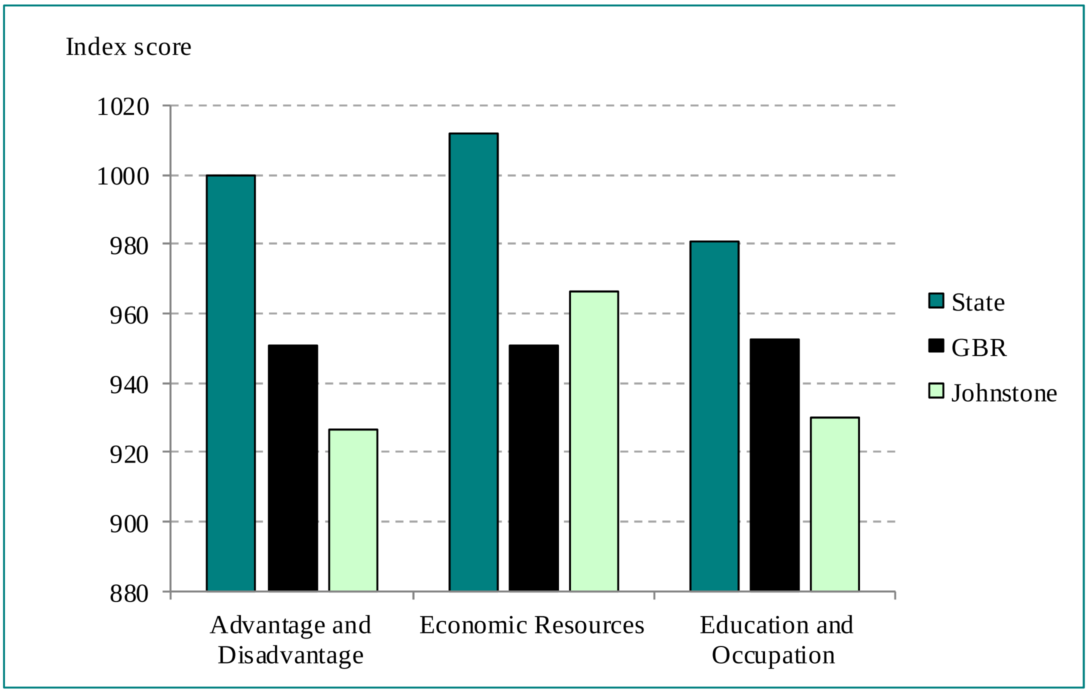
---

259 Based on analysis of 2006 ABS census data.

260 ABS, 2001, 2039.0 *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas, Australia*, 2001.

261 MJA estimated concorded index scores for each HWMP region using concorded population figures to derive each LGA's SEIFA score to the overall HWMP SEIFA score.

Figure 34: SEIFA indices



Source: MJA based on ABS 2006 census SEIFA indices.

Analysis of the data indicates:

- relative to the State, Johnstone is at a significant disadvantage, but it is less significantly disadvantaged compared to the GBR;
- economic resources in Johnstone are significantly below the State, but are higher than for the GBR region as a whole, which may reflect the greater diversity in Johnstone's regional economy than in some other GBR regions;
- education and occupation data indicate that the region is significantly worse off than the State, as well as worse off than the GBR as a whole, potentially indicating lower resilience to change.

Johnstone's mixed SEIFA indicators indicate that it may be somewhat difficult to implement the HWMP here, for example due to higher levels of disadvantage and lower scores for education and occupation. However the region does have a better economic resources score than some other GBR regions, which may give Johnstone some relative advantages in adapting to the HWMP. Education levels in Johnstone are somewhat lower than the rest of the GBR catchments and the State as a whole as shown in Table 60.

Table 60: Educational attainment

Highest education level completed	Johnstone (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	23.8	21.3	19.8
Year 12	25.8	30.1	37.2
Certificate or diploma	22.1	22.2	21.9
Undergraduate degree	5.1	6.6	9.3
Postgraduate degree	0.8	1.1	2.2

Source: ABS Census of Population and Housing, 2006.

General education levels in the Johnstone region lower than the GBR average and Queensland. The proportion with a Certificate or Diploma is only slightly lower in Johnstone than in GBR and Queensland, but the proportion with either an undergraduate or postgraduate degree is significantly lower.

12.2.2 Employment and labour force

Labour force statistics in Table 61 indicate the dominance of primary industries and mining.

Table 61: Labour force statistics

	Number			Percentage		
	Johnstone	GBR	Qld	Johnstone	GBR	Qld
Agriculture, forestry and fishing	1,444	23,546	54,563	15	5	3
Mining	210	27,793	51,656	2	6	3
Manufacturing	828	34,978	169,025	9	8	8
Electricity, gas, water and waste services	134	6,962	24,764	1	2	1
Construction	920	40,558	179,947	10	9	9
Wholesale trade	217	13,561	73,377	2	3	4
Retail trade	994	46,833	214,617	10	11	11
Accommodation and food services	613	32,649	140,036	6	7	7
Transport, postal and warehousing	371	24,591	104,924	4	6	5
Information media and telecommunications	74	3,588	25,282	1	1	1
Financial and insurance services	125	6,317	53,833	1	1	3
Rental, hiring and real estate services	120	7,086	36,875	1	2	2
Professional, scientific and technical services	297	18,497	131,921	3	4	7
Administrative and support services	211	12,383	64,185	2	3	3
Public administration and safety	489	30,251	135,586	5	7	7
Education and training	752	33,080	160,241	8	7	8
Health care and social assistance	1,101	47,500	240,017	11	11	12
Arts and recreation services	94	4,210	28,418	1	1	1
Other services	333	17,688	78,157	3	4	4
Not stated	290	10,814	22,913	3	2	1
Total	**9,617**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS Census of population and housing. The categories are based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) 1993.

The significant employment in primary industries is higher than for both the GBR as a whole, and the State. Manufacturing is more important than for the GBR on average, and is dominated by food product manufacturing (probably sugar). Mining is less important to the Johnstone region than for both the GBR and Queensland as a whole.

Retail trade and accommodation, cafes and restaurants, are often used as a proxy for the tourism industry. Retail trade, a significant employing industry in the Johnstone region, is roughly as important in the Johnstone region as in the GBR as a whole and Queensland. Accommodation, cafes and restaurants is slightly less important in the Johnstone region than in the GBR and Queensland.

12.2.3 Economic structure

The structure of the economy can provide some indication of a region's capacity to change in response to natural resource management policies or programs. Table 62 indicates the economic structure of Johnstone's economy indicated by business counts by industry. Key points to note include:

- agriculture, forestry and fishing has a significantly higher proportion of business counts, at 13.7%, than for Queensland as a whole (3.4%);
- accommodation and food services, which relates to the tourism industry, comprises 6.9% of business counts for the Herbert region. This is slightly lower than the proportion for

Queensland, at 7.0%, leading to a specialisation ratio of 1.1. Retail Trade, which can also relate to the tourism sector, comprises 11.3% of business counts for the Johnstone region, which is roughly comparable to the 11.6% share for Queensland; and

- generally, Johnstone has a more diversified economic base than some of the other GBR regions. Primary industries and manufacturing are more dominant than for Queensland as a whole. Where policies developed under the HWMP impact negatively on this sector, the impacts could be slightly greater than similar policies in other regions.

Table 62: Counts of registered businesses by industry, Johnstone Region, 2008–09

Industry	Johnstone Region		Queensland	
	number	%	number	%
Agriculture, forestry and fishing	1,446	13.7	61,735	3.4
Mining	149	1.4	30,721	1.7
Manufacturing	1,106	10.5	180,212	9.9
Electricity, gas, water and waste services	160	1.5	18,540	1.0
Construction	899	8.5	164,936	9.0
Wholesale trade	282	2.7	72,075	3.9
Retail trade	1,193	11.3	212,422	11.6
Accommodation and food services	731	6.9	127,631	7.0
Transport, postal and warehousing	449	4.2	92,614	5.1
Information media and telecommunications	62	0.6	26,347	1.4
Financial and insurance services	123	1.2	52,035	2.9
Rental, hiring and real estate services	151	1.4	37,983	2.1
Professional, scientific and technical services	302	2.9	102,412	5.6
Administrative and support services	255	2.4	55,705	3.1
Public administration and safety	713	6.7	122,416	6.7
Education and Training	843	8.0	139,090	7.6
Health care and social assistance	933	8.8	186,336	10.2
Arts and recreation services	102	1.0	24,625	1.3
Other services	374	3.5	68,361	3.7
Total	**1,446**	**13.7**	**61,735**	**3.4**

Source: OESR, Queensland Regional Profiles citing Australian Bureau of Statistics, Counts of Australian Businesses, including Entries and Exits, June 2007 to June 2009, cat no. 8165.0. Note: For this data it was not possible to concord the Johnstone region exactly, so it is taken as the SLAs of Johnstone and Eacham.

Note: The classifications used are based on ANZSIC 2006.

Hence the economic structure of Johnstone has significant implications on the prioritisation, design and implementation of the HWMP.

Tourism

Tourism is relatively important to the Johnstone region, which extends out to the popular Atherton Tablelands. Significant tourism sites include Malanda Falls, Wooroonooran National Park, Paronella Park, Josephine Falls, Tchupala Falls and Wallicher Falls. Reef based tourism occurs out of Innisfail.

Analysis of the GBRMPA's EMC data indicates that an estimated 870,077 water-based tourist activities occurred in the Cairns-Cooktown Management Area region (which incorporates the Johnstone region) in 2010. This is roughly similar to the number of visitors for the Townsville-Whitsunday Management Area in 2010, but significantly more than for the Mackay-Capricorn management zone. There are potential risks to reef-based tourism and other forms of nature-based tourism industry from any loss in tourism attributable to water quality.[262]

Semi-structured interviews undertaken by MJA with approximately 15 dive operators across the GBR in 2008 indicated that any deterioration in reef and marine condition has a negative impact in the sector in two main ways. Firstly, operators are often forced to travel further offshore to find quality dive sites increasing operating costs and reducing profits. Secondly, if water quality is poor, dive tourists are less inclined to undertake subsequent dives during their current holiday or return to the region for dive holidays in the future.[263]

Agriculture

The key industry already the focus of best management practice is agriculture.

[262] GBPMPA, 2008, unpublished data.

[263] MJA, 2008, *The economic contribution of the dive industry to the GBR.*

Table 63 depicts the value and share of agricultural production for the three Statistical Local Areas included in the Johnstone catchment. The analysis shows:

- tropical crops (sugarcane, banana, potato, paw paw, tropical fruits) are the primary agricultural product in the Johnstone region, consisting of 77.5% of the value of agricultural production, equivalent to $192.7 million. This indicates a significantly disproportionate reliance on sugar in the Johnstone region. Crops make up a much less significant proportion of the value of agricultural production for Queensland as a whole, at 47.9%, and compares to 48% for the GBR as a whole;
- livestock slaughterings account for 11.9% of the value of agricultural production in the Johnstone Region, valued at $12.2 million. Livestock slaughtering comprises a much larger share of the value of agricultural production for Queensland as a whole at 47.4%; and
- livestock products make up only 4.8% the value of agricultural production in the Johnstone region, valued at $13.4 million. Livestock products comprise a similar proportion of the value of agricultural production in Queensland as a whole.

Table 63: Value of agricultural production by statistical local area, Johnstone Region, 2005–06

Statistical local area	Crops		Livestock slaughterings		Livestock products		Total
	$M	%	$M	%	$M	%	$M
Eacham (S)	2.1	9.1	8.1	34.8	13.0	56.1	23.2
Herberton (S)	0.1	26.9	0.2	48.7	0.1	24.4	0.3
Johnstone (S)	190.5	97.8	4.0	2.0	0.3	0.2	194.8
Johnstone Region	192.7	77.5	12.2	11.9	13.4	10.6	218.3
Queensland	4167.9	47.9	4125.2	47.4	415.8	4.8	8708.9
Region as % of Qld	3.7	. .	0.4	. .	1.8	. .	2.1

Source: OESR Regional Profile, citing: Australian Bureau of Statistics, Agricultural Commodities, Australia, 2005-06, cat. no. 7125.0.

Note: . . = not applicable

The significant dominance of cropping and irrigation has a major significance for the prioritisation and development of programs to address reductions in nutrient loads from the Johnstone region. Analysis of other key headline agriculture data indicates:

- Johnstone accounts for around 2.1% of the total cropping area in the GBR; [264] and
- the scale of sugar production in Johnstone has resulted in the region being one of the major users of fertiliser in Queensland. It is estimated that the Johnstone region accounts for 5.2% of the GBR's fertiliser use.[265] This has an impact on nutrient loads entering the GBR.

12.3 Pollution loads

Pollution loads in the Johnstone are both from natural sources, as well as from the consequences of changes in land use and land management. Load estimates are shown in Table 64.

---

264 ABS, 2008-09, *Land Management Practices in the Great Barrier Reef Catchments, Preliminary, 2008-09* (cat. no. 4619.0).

265 ABS, 2008-09, *Land Management Practices in the Great Barrier Reef Catchments, Preliminary, 2008-09* (cat. no. 4619.0).

Table 64: Estimated pollution loads in the Johnstone (tonnes/year)

Load	TSS	TN	TP
Natural load		1,094	120
Baseline	2,770	2,739	380
Total	3,180	3,833	500
Total - % of natural loads	776%	354%	417%
Total - % of Wet Tropics	23%	25%	25%

Source: Kroon F, Kunhert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J and Joo M, 2010, Baseline pollutant loads to the Great Barrier Reef. CSIRO.

While this data is only for a subset of pollutants, the key points to note are that sediment and nutrient loads are now in excess of three times natural loads, and that the Johnstone is a relatively significant source of pollutants in the Wet Tropics region, particularly for phosphorus (33% of regional loads). The major contributors to the loads above will be primary industries (particularly grazing and sugar) and, to a lesser extent, more intensive land uses such as urban development, industrial development, mining, and linear infrastructure development (e.g. roads).

12.4 Potential actions

HWMPs are currently being developed for the Barron-Trinity, Johnstone, Russell and Mulgrave catchments. Those HWMPs will build on the significant work already completed and work underway to:

- update land use data to better understand the sources of loads; and
- assess key management actions and the potential efficacy of changing practices. The focus is on the grazing, cane, banana and pawpaw industries and sub-catchment specific practices are being developed in conjunction with each catchment community.

The HWMPs will then form the basis of a detailed set of implementation activities to reduce pollution loads from rural activities.

In addition, actions to mitigate the risk of loads from other sources should also be developed, specifically urban diffuse loads and point source loads from regulated emitters (e.g. wastewater treatment plants, mines).

12.4.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the HWMP to address sediment and nutrient loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point source loads.

12.4.2 Scenario Two: A suite of changes to practice

This scenario would build on the current actions being undertaken in the region (often at least partially funded by Reef Rescue or Caring for Our Country). The current actions could be summarised categorised into two broad categories.

Firstly, there are a number of research, planning and governance activities that have been undertaken or are continuing. This includes research into the sources of loads, effective means to reduce loads, the identification of environmental objectives and values, and the establishment of plans and policies to underpin on-ground actions.

The second suite of actions that will make a direct impact on pollution loads is the provision of grants to underpin practice change. This includes grants to assist with initiatives such as improved herbicide management (e.g. hooded sprayers in sugar), improved nutrient management (e.g. subsurface fertiliser application, stool splitters in sugar), improved soil management (e.g. zero till, GPS controlled traffic farming), improved groundcover (e.g. for horticulture and cattle), soil detention basins, laser levelling (sugar and horticulture), riparian plantations and rehabilitation, permanent fencing and watering points (dairy and cattle), effluent reuse systems (dairy).[266]

The focus in developing the HWMP to date has been very much on rural diffuse loads. Urban diffuse loads are largely being managed through the State Planning Policy (Healthy Waters), while significant point-source loads are managed as environmentally relevant activities under the *Environmental Protection Act 1994.*

The environmental values and water quality objectives for the region are currently being finalised through a process of scientific analysis and consultation. Under the HWMP actions will be proposed to reduce pollutant loads from diffuse and point sources. These actions will enhance water quality in the freshwater and marine environment and enhance relevant environmental values across the region and adjacent areas of the GBR. Given the fact there are no finalised actions and targets for the region, MJA has assessed a number of actions, specifically:

- for rural diffuse loads, a progressive increase in the proportion of landholders adopting current best management practice (B practices) and moving from what are currently considered poor practices to more acceptable practices (i.e. D practice to C practice). It should be noted that there is insufficient detail in existing data to distinguish the benefits and costs of individual practices. Rather, broad incremental movement between suites of practices are assessed;
- future urban developments will address the Healthy Waters State Planning Policy. This will largely involve implementing best practice urban design for water quality and drainage recommended in the Urban Stormwater Queensland Best Practice Environment Management Guidelines; and
- where identified, point source loads will be addressed via upgrades to wastewater treatment plants and actions by mines in the region.

12.5 Potential impacts of HWMP

As part of the planning processes priority waterway assets and the values derived from those assets have been identified through the Barron Trinity Inlet WQIP.[267] Investment under this plan will have a number of positive environmental, social and economic impacts on the extent and condition of those assets. Key impacts are briefly outlined in Table 65. The extent to which

266 For a comprehensive list of funded projects see: www.terrain.org.au/programs/production/reef-rescue-wqig.html

267 Barron, F. and Haynes, D. (2009).Water Quality Improvement Plan for the catchments of the Barron River and Trinity Inlet. Terrain NRM.

those benefits can be achieved will be determined by the resources available and the efficiency of interventions and investment under the HWMP.

Table 65: Potential benefits of HWMP

Key benefits	Key elements and values
Maintenance of wetlands	The region has approximately 7,615 ha of wetlands, approximately 9.5% of all wetlands in the Wet Tropics. The HWMP will reduce risks to the extent and quality of many of those wetlands.[268]
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive. Evidence from analysis in SEQ indicates that changes in turbidity impact on short-run costs (changes in electricity and chemical usage and changes in sludge management costs), but that the long-term costs of avoiding treatment plant augmentations are often more significant.[269]
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[270]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector to maintain the region's attractiveness to visitors, particularly given the region's high proportion of reef-based tourism activities.
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Improved gross margins for farmers	Analysis undertaken by CSIRO indicates that gross margins can actually be increased in the longer term through improvements in practices, particularly incremental improvements from D practices to C practices, and C practices to B practices.[271]
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is worth around $7.82 per household per year. This translates to around $25,000 per annum for the residents of the Johnstone alone.[272]

Source: MJA.

12.6 Potential costs of HWMP implementation

This section briefly outlines our estimates of some of the more significant costs of reducing water pollution loads in the Johnstone region. Because the HWMP process is yet to determine

268 Anon 2011. Reef water quality protection plan report card.

269 KBR 2009. Valuing the natural asset investigating the impact of water quality changes on water treatment plant costs.

270 Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

271 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

272 MJA estimates based on Windle and Rolfe 2006, *Non-market values for improved NRM outcomes in Queensland*.

the preferred suite of actions, MJA has modelled a number of costs that would relate to some of the more likely actions under the HWMP.

12.6.1 Costs of rural diffuse actions

Rural diffuse actions will primarily relate to actions by cane producers, beef producers and horticulture producers. Table 66 shows the estimates of uptake of management practices by growers in 2009 which relate to rural diffuse loads (the dominant source of loads).

Table 66: Adoption of management practices – % of growers (Wet Tropics)

Load	Sugar %	Horticulture %
A – cutting edge practices	1	37
B – current best practice	9	37
C – common or code of practice	44	15
D – practices considered unacceptable by industry or community standards	46	11

Source: Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

While there is significant variability in the results depending on particular types of management regimes (e.g. nutrient management, herbicide management and soil management), the key point to note from the data is that there is significant scope for enhancing practices and consequently reducing pollutant loads.

MJA has developed an economic model to estimate the potential cost of achieving load reductions from rural diffuse sources. The model is based on:

- Data on the area of each major production system (e.g. sugar) under different management regimes (A, B, C, and D) as outlined in the table above.
- previous modelling of the potential efficacy of different management regimes (measured as pollution load (runoff & leached));[273] and
- data on likely changes in gross margins[274] attributable to different production systems transitioning between different state conditions.

Scenarios of management actions that result in higher proportions of farmers undertaking improved management practices can then be modelled to develop broad estimates of changes in loads (TSS, TN, TP) and the likely costs[275] of achieving those load reductions.

Sugar

For the purposes of this report, it is assumed that the area of sugar production in the Johnstone is 33,000 ha (based on State land use mapping analysis) and that the dominant soil type for sugar production is well drained sandy loam. Furthermore, it is assumed that the adoption rates of

[273] Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship.

[274] Gross margins are simply the difference between sales revenue and the production costs, excluding fixed costs such as overheads, interest payments and tax. Changes in gross margins will be the net impact of both any changes in yields (and subsequent revenues) and changes in inputs costs.

[275] It should be noted that the costs included in this model are the substantive costs of practice change (i.e. additional capital expenditure and changes in operating costs). They do not include administrative and other transaction costs.

management practices are currently the same as for the broader Wet Tropics region. Using the economic model developed for this report, MJA has modelled a number of scenarios. These scenarios are outlined in Table 67 below. They reflect a number of feasible paths of improvement over time as growers progressively improve from their current practices to current best practice (B practice) and beyond (A practice).

Table 67: Hypothetical scenarios modelled – changes in practice regimes

	% of area			
Scenario	A	B	C	D
Current	1	9	44	46
Scenario 1	1	20	55	24
Scenario 2	1	50	45	4
Scenario 3	1	80	19	0
Scenario 4	1	99	0	0

Source: MJA analysis.

Table 68 below shows MJA's estimates of changes in annual nutrient loads and the cost of achieving those load reductions.

Table 68: Scenarios modelled – changes in practice regimes

Scenario	Approximate regional load reduction (kg/N/annum)	% Change from current loads	Change in region's annual gross margin ($ million)
Current	N/A	N/A	N/A
Scenario 1	130,000	-8	+1.2
Scenario 2	270,000	-17	+3.3
Scenario 3	330,000	-20	+4.9
Scenario 4	350,000	-22%	+5.9

Source: MJA analysis.

The analysis shows that significant reductions in nutrient loads from cane could be achieved without necessarily impacting on regional productivity and gross margins. The analysis shows that a program of continuous improvements in practice would actually increase total regional gross margins. This is largely due to the fact that CSIRO analysis suggests that yields per hectare are approximately 3-4% higher for A and B practices than for inferior practices.[276] Our modelling indicates that it may be theoretically possible to reduce nutrient loads from cane production by 50% if all producers were implementing A practices.

However, the analysis does not consider the capital investments that are often required to enhance practices. Analysis undertaken by CSIRO suggests that, even when capital costs are also included, there is still a net financial benefit over a 10-year period from incremental improvements between categories of practice (e.g. C to B). The exception to this rule is moving from B practices to A practices, where the capital investments to move from B to A practices are almost twice the investment from moving from C to B practices. Table 69 below

276 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship.

summarises the net economic costs over a ten year period to transition between classes of practice and the annual cost of pollution abatement.[277]

Table 69: Costs of transition between classes of practices (120 ha farm)

Transition	Present value practice change ($/ha)	Pollution abatement – N ($/kg/year)	Comments
B to A	-489	-31	Transition investment approx. $90,000 plus significant savings in nitrogen use
C to B	615	39	Transition investment approx. $60,000 plus significant savings in nitrogen use
D to C	611	38	Significant savings in nitrogen use

Source: MJA based on Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

The key point to note from this analysis is that there are likely to be significant and sufficient private financial gains for most producers to move to current best practice. This could reduce nitrogen runoff and leaching by around 20%. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as insurance-like approaches), and action to overcome problems in accessing capital.

However, reducing nitrogen loads beyond around 20% from current levels would result in significant costs to producers and change should not be expected beyond that point without more costly policy interventions (e.g. financial incentives).

Cattle

State land use mapping data indicates that grazing potentially accounts for about 36,000 hectares or 15% of the landmass of the Johnstone region. Data for groundcover in pastoral areas indicates that the mean dry season groundcover over the 1986-2009 period is 93%, significantly above the Reef Plan target of 50%. Furthermore, only around 1.2% of grazing lands had groundcover below 50%.[278] For this reason, specific analysis of the economic impacts of enhancing grazing practices in the Wet Tropics is very limited. However, studies undertaken elsewhere have shown that there are significant environmental (lower loads) and economic (high margins) from maintaining appropriate groundcover and undertaking best practice grazing management.[279]

The data overall indicates that there is likely to be more potential gains in focusing on sugar and horticulture growers to reduce loads, as opportunities in grazing may be limited.

Horticulture

State land use mapping data indicates that horticulture potentially accounts for about 10,500 hectares (14%) of the landmass of the Johnstone region. Bananas, papaw and potato are

---

[277] Based on a typical 120 ha farm.

[278] Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

[279] For example, see Roebeling., P, and Webster. J, 2004, Financial-Economic Analysis of Management Practices in Beef Cattle Production in the Douglas Shire. Report on the Cost-Effectiveness of BMP Implementation for Water Quality Improvement.

probably the dominant crops in the region and bananas are typically used as the default crop for assessments of options to reduce water pollution from horticulture.

As with sugar and grazing, an A, B, C, D framework has been developed for horticulture management practices.[280] Furthermore there are a number of key management practices that can be adopted such as inter-row management[281]and efficient fertiliser application rates that can result in reductions in fertiliser application by almost 50% from around 520 kg/ha to 225 kg/ha.[282] Much of these improvements are already underway, reflected in the fact that almost 75% of producers in the Wet Tropics are already implementing A or B practices.

Table 70elow summarises the net economic costs over a ten year period to transition between classes of practice.[283] To date, there is insufficient data to estimate the actual cost of abatement such as nitrogen (i.e., $/kg/annum) although research is progressing in this area.[284]

Table 70: Costs of transition between classes of practices (60 ha farm)

Transition	Present value practice change ($/ha)	Comments
B to A	-6,600	Transition investment approx. $420,000 plus significant savings in nitrogen use
C to B	15,600	Transition investment approx. $160,000 plus significant savings in nitrogen use
D to C	21,700	Significant savings in nitrogen use

Source: Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

The key point to note from this analysis is that there are likely to be significant and sufficient private financial gains for the 26% of producers at C or D practice levels to move to current best practice (i.e., B practice). This would further reduce sediment, nitrogen and other chemical runoff without negatively impacting on the industry’s profitability. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as insurance-like approaches), and action to overcome problems in accessing capital.

280 Van Grieken, M.E., Webster, A.J., Coggan, A., Thorburn and P. Biggs, J., 2010. Agricultural Management Practices for Water Quality Improvement in the Great Barrier Reef Catchments. CSIRO: Water for a Healthy Country National Research Flagship.

281 Roebeling, P. C., Webster, A. J., Biggs, J. and Thorburn, P, 2007, Financial-economic analysis of current best management practices for sugarcane, horticulture, grazing and forestry industries in the Tully-Murray catchment. Report to the Marine and Tropical Sciences Research Facility.

282 Armour J, and Daniells J, 2001, Banana nutrition in north Queensland. Final Report FR95013 to Horticulture Australia Ltd.

283 Based on a typical 60 ha banana farm.

284 For example, see Armour, J., Davis, D., Masters, B., Whitten, M and Mortimore, C. (2011). Paddock Scale Water Quality Monitoring: Interim Report 2009/2010 Wet Season, Wet Tropics Region. Queensland Department of Environment and Resource Management, Australian Centre for Tropical Freshwater Research and Queensland Department of Employment, Economic Development & Innovation for Terrain Natural Resource Management, Australia.

12.6.2 Cost of urban diffuse actions

Actions to mitigate the risk of water pollution from urban diffuse loads are a continuing focus. In a practical sense this usually involves the establishment of WSUD as an underlying approach to future urban development.

The costs of urban diffuse actions will largely relate to the cost of implementing WSUD in new developments. Based on estimated population growth for the region and the current makeup of households, it is likely that around 650 new dwellings will be established each year over the next 10 years. Census data indicates that around 80-90% of residential dwellings in the region are detached houses. MJA has estimated the potential pollution loads reductions and related costs for WSUD implementation over the next 10 years (Table 71 below).[285] These reductions are not significant in the broader Wet Tropics context – largely due to the relatively low population and population growth prospects in the region.

Table 71: Estimated cost of WSUD implementation in new developments and impacts on loads over next 10 years

Measure	Value
Number of new dwellings over next 10 years	650
Cost of establishing WSUD over next 10 years	$2-3million
Reduction in TSS from business as usual after 10 years	90-110 tonnes per annum
Reduction in TN from business as usual after 10 years	480-500 kg per annum
Reduction in TP from business as usual after 10 years	150-170 kg per annum
Levelised cost of TSS abatement ($/tonne/annum)	$1,750-$2,150
Levelised cost of TN abatement ($/kg/annum)	$360-$450
Levelised cost of TP abatement ($/kg/annum)	**$1,110-$1,360**

Source: MJA analysis.

Urban diffuse actions in new developments have the potential to significantly reduce regional loads from a business as usual estimate after 10 years, at a cost of around $240,000 -$250,000 pa. Estimations of levelised costs of abatement (that include both capital and operating expenditures) indicate that urban diffuse actions are significantly less cost effective than rural diffuse actions at reducing pollution loads.

12.6.3 Costs of other actions – focus on point sources

In addition to diffuse actions, there are likely to be options to reduce loads from point sources such as wastewater treatment plants and the limited mining activity in the region.

Point sources – wastewater treatment plant

There is one wastewater treatment plan in the region at Innisfail. The plant is a secondary treatment plant that has an inlet structure, two primary sedimentation tanks, two secondary sedimentation tanks, two digesters (primary and secondary), and a chlorine contact tank for

285 Estimates of load reductions and capital costs are based on MUSIC modelling estimates for small-detached housing developments in the Cairns climatic zone – specifically the use of bio-retention basins. See Water by Design (2010) A Business Case for Best Practice Urban Stormwater Management. Costs were derived from the same study and inflated to current terms using the Brisbane consumer price index. Levelised costs are based on all estimated capital, operations and maintenance, and refurbishment costs over a 25 year period.

sodium hypochlorite disinfection. The plant is currently being upgraded to a standard where nitrogen and phosphorus will also be treated.[286]

The establishment and upgrades to WWTPs are often a key action of governments to meet multiple regulatory requirements. The costs of WWTP upgrades are driven by the engineering capital and operational costs and are specific to the actual plant.

MJA undertook analysis of expenditure data[287] for recent upgrades from secondary to tertiary treatment for several WWTPs in South East Queensland (data for other WWTPs was not available). MJA estimates the costs of treatment ranges from $76,000 to $200,000 per tonne of nutrients per annum.

Point sources – other environmentally relevant activities

The sugar sector on the region is serviced by sugar mills including the South Johnstone Mill. There is some mining activity in the region that is regulated. There will be other relatively small point source emitters in the region, particularly industrial firms in the region. However, data on emissions and related expenditure is not available at the scale of the Johnstone region, but is not expected to be significant.

12.7 Economic and social considerations for implementation of the HWMP

The analysis in previous sections indicates there is significant scope to reduce water pollution from changes in land management. This is particularly for sugar cane where there is significant scope to reduce nutrient and other loads. Horticulture also accounts for a high proportion of land use within the context of the sector in the Wet Tropics and there are already a very high proportion of growers that are meeting current best practice. Opportunities for load reduction from grazing are limited due to the very high proportion of graziers who are already meeting best practice groundcover targets. In addition, because of the low population expected in the region, opportunities to address urban diffuse are also relatively limited.

While there is only cost information for a subset of actions to reduce loads, available data indicates there is very significant variation in the cost effectiveness between actions and industries. This is shown in Table 72 below.

Table 72: Relative costs of water pollution abatement - nitrogen

Source	Approximate costs ($/kg/annum)	Comments
Rural diffuse – cane BMPs	-31-+38	Significant scope for reductions and enhancing industry commercial outcomes
Urban diffuse - WSUD	360-450	Limited scope to contribute material reductions in loads
Point sources - WWTPs	76-200	Implementation will form part of infrastructure provision for regional growth

Source: MJA analysis.

286 www.cassowarycoast.qld.gov.au/web/guest/sewerage-treatment

287 Data provided by Queensland EPA.

The key lesson for the implementation in the Johnstone is that, the most efficient reductions in pollution loads are likely to be achieved through focussing on cane, and to a lesser extent horticulture, specifically:

- sugar provides the greatest opportunity for reducing nutrient loads at the lowest cost to the community;
- horticulture also presents significant opportunities to reduce loads at little or no cost to the community; and
- for both sugar and horticulture, the key area of focus should be to facilitate producers at C or D practice levels to move to current best practice (i.e. B practice). This would further reduce sediment, nitrogen and other chemical runoff without negatively impacting on profitability.

Given the opportunities in sugar and horticulture, policies should continue to be designed to overcome impediments to practice change.[288] Given the fact that moving from D to B practices pay financial dividends in the longer term, impediments to change are likely to be:

- *knowledge-based*: some producers may not be fully aware of the economic benefits of enhancing practices. This would indicate information and capacity development approaches would be most appropriate such as agronomic and economic extension; and
- *risk*: many producers may perceive the commercial risk of changing practices to be too risky. These risks could be mitigated through demonstration farms in conjunction with extension. Furthermore, the use of approaches such as an insurance-like product to underpin the risk of practice change would be worth considering. Such an approach would only make a payment to a producer where their implementation of new practices actually reduced yields (when benchmarked against district averages). This approach has most applicability in sugar; and
- *capital*: moving from C to B practices and B to A practices both require capital investments. However, these capital costs are recouped over time. Therefore, it should be possible to accelerate practices through the provision of low cost or no-interest loans to overcome any impediments to practice change due to limitation of access to capital.

In the longer-term, the public funding mix of these approaches could focus more on program design and delivery.

These approaches, in conjunction with harnessing market-like approaches such as water quality offsets should enable the objectives of the HWMP.

[288] Greiner., R and Grieg., D, (2010) Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. Land Use Policy Volume 28, Issue 1, January 2011, pages 257–265.

13. Tully Murray

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- The population of the Tully Murray region is expanding at a rate slightly slower than the GBR catchment population as a whole. Over time, the rate of growth is expected to move closer to the GBR average.
- Social conditions in the Tully Murray region are generally below the GBR as a whole on all measures of the SEIFA index (disadvantage, economic resource, education and employment). Social conditions are less favourable in the Tully Murray than for the State as a whole.
- The dominant employer and producer in the region is agriculture, particularly sugar. The associated water quality risks from production are not likely to decline without policy intervention.
- There are significant economic and social constraints to changing agricultural practices and these have implications for policy and program design and implementation.

Scenarios assessed

Two scenarios were assessed:

- do nothing more; and
- a scenario of actions to accelerate uptake of better soil, better soil, nutrient and pesticide management practices across a number of rural (cane, horticulture and grazing) and urban (land development) industries. The potential for WWTP upgrades is also considered.

Impacts

Impacts of the do nothing more scenario are likely to be a further decline in water quality and increasing risks to the GBR; negative impacts on sectors reliant on water quality, particularly GBR tourism drawcards largely outside the immediate Tully Murray WQIP region; negative impacts on recreation, particularly fishing; and a general loss in ecosystem function.

Impacts of the second scenario include:

- reductions in dissolved inorganic nitrogen loads by 25%, particulate nitrogen loads by 16%, and particulate phosphorus loads by 17%;
- a reduction in total suspended solids of 18%;
- significant reductions in pesticide loads; and
- significant benefits in terms of risk mitigation to industries reliant on water quality and enhancements in ecosystem function in the region.

Implementation issues

The targets established in the WQIP cannot be met purely through voluntary measures. Financial incentives will be required. The costs of implementing changed management practices in rural industries by 2013 are highly dependent on the sectors that are prioritised and the design of policy tools. There are significant benefits to be gained through an efficient investment in practice change that could result in sediment load targets being met for as little as $2.5–$3.5m, with similar costs for nutrients.

The efficient portfolios of investment should initially concentrate on the 'win–win' opportunities in sugar and then consider investments in changed grazing practice once low-cost options in sugar are exhausted. However, inefficient prioritisation could see the costs of meeting the targets in the WQIP increase fivefold.

Riparian rehabilitation outlined in the WQIP could prove costly, potentially as high as $20m. Given these costs, there is a need to carefully consider the most cost-effective means to achieve the objectives of riparian rehabilitation management action targets.

The cost-effectiveness of rural diffuse programs could potentially be enhanced by two main actions:

- careful design of incentives to ensure the most cost-effective use of public funds. This includes: the use of competitive tenders to select the most cost-effective proposals from landholders; potential use of structural adjustment loans to meet some up-front capital costs that result in sufficiently increased gross margins in subsequent years to cover repayments; and careful consideration of who is eligible for incentives provided, such as whether landholders or contractors should be targeted for some incentives; and
- actions should primarily concentrate on the sugar and grazing industries, with limited investment in horticulture and forestry.

13.1 Introduction

The Tully Murray region is dominated by primary production, especially sugarcane farming, horticulture (primarily bananas) and to a lesser extent, grazing and forestry.

This section assesses the potential economic and social implications of implementing the Tully Murray WQIP. Scenarios assessed are based on:

- the draft Tully Murray WQIP;
- information available from State sources and previous work undertaken my MJA; and
- applying emerging State policies to increase wastewater standards to tertiary treatment in larger urban centres.

13.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the WQIP.

13.2.1 Demographic makeup

Population

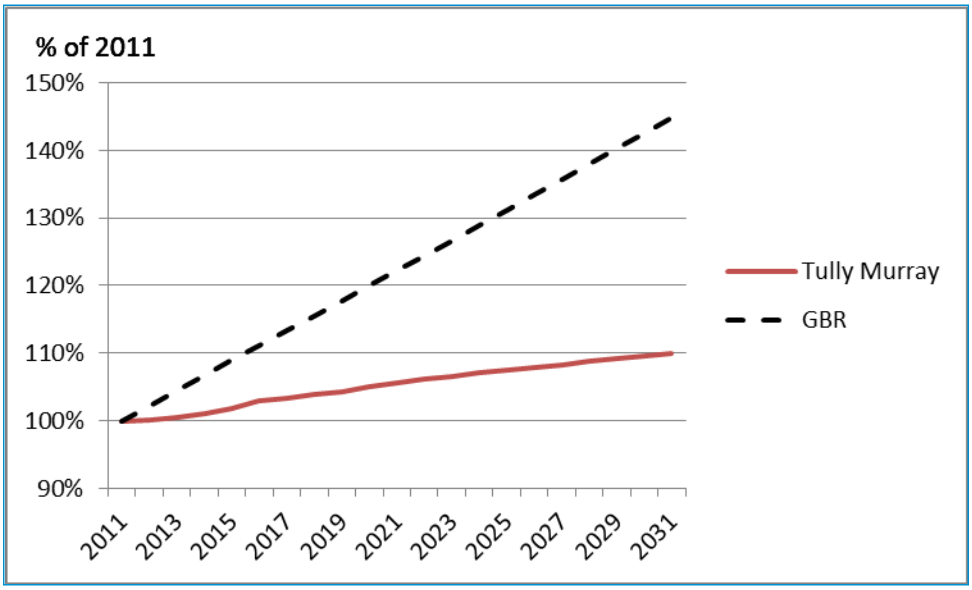
From the 2006 census, it is estimated that the population of the Tully Murray WQIP region is around 11,375.[289] Figure 35 shows the recent historical and forecast population growth for the Tully Murray WQIP region compared to all WQIP regions assessed in this report.[290] It indicates that:

- significant population growth is expected in both the Tully Murray and across the WQIP regions over the next 20 years; and
- the Tully Murray's rate of population growth is likely to be slightly lower than for the GBR as a whole, trending towards the average population growth rate over time.

[289] This estimate is based on ABS census data concorded (best fitted) to the TM WQIP region by OESR. Population estimates are based on a census participant's usual place of residence.

[290] Based on DLGPSR Population Forecasting Unit's mid-estimates for each relevant LGA concorded to WQIP boundaries.

Figure 35: Population growth projections (Tully Murray and all GBR WQIP regions)



Source: MJA based on DLGPSR and ABS 2011 census.

Other population and demographic statistics are noted below:

- like much of the GBR, the population of the Tully Murray WQIP region is slightly skewed to males (52.5% of the population);
- in the 2011 census, 7.
- 7.5% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Tully Murray WQIP region compared to around 3.6% for the whole of Queensland; and
- approximately 15% of people in the Tully Murray WQIP region were not born in Australia and around 5% of the population speak a language other than English at home.[291] To the extent that these people are targeted for programs under the WQIP, there may be difficulties in effective engagement.

Community capacity

A community's capacity to participate in natural resource management is often indicated by a number of issues:

- approximately 22% of adults (>15 years old) participate in voluntary work, potentially indicating reasonable levels of social capital.[292] Females had higher levels of participation in volunteer work 26%, compared to males (at 18%). However, the ABS census data does not indicate what type of volunteer work (e.g. environmental management) was undertaken;
- the relative financial impact of projects or policies that impact on costs must be considered, as the burden may be relatively greater for lower-income families. The Tully Murray has a significantly higher incidence of low-income families than the State as a whole. Approximately 23% of families in the Tully Murray WQIP area are on low

291 Based on analysis of 2006 ABS census data.

292 Levels of participation in voluntary community activities are often used as a proxy indicator of social capital in a community.

incomes (i.e. < $600/week) compared to 8% for the State. However, reported household incomes are often lower in regions with higher proportions of agricultural enterprises. This is likely to be the case in the Tully Murray; and

- household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In the Tully Murray, approximately 64% of homes are owned or are being purchased, somewhat below the State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad means to make relative comparisons of social and economic resources between regions. The three indices of most relevance are:[293]

- the Index of Advantage–Disadvantage is a continuum of values in which low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation includes all education and occupation variables only.

These indices were concorded to the WQIP regions to enable comparisons of each WQIP region to all of the regions assessed in this report and Queensland as a whole.[294] Results are shown in Figure 36.

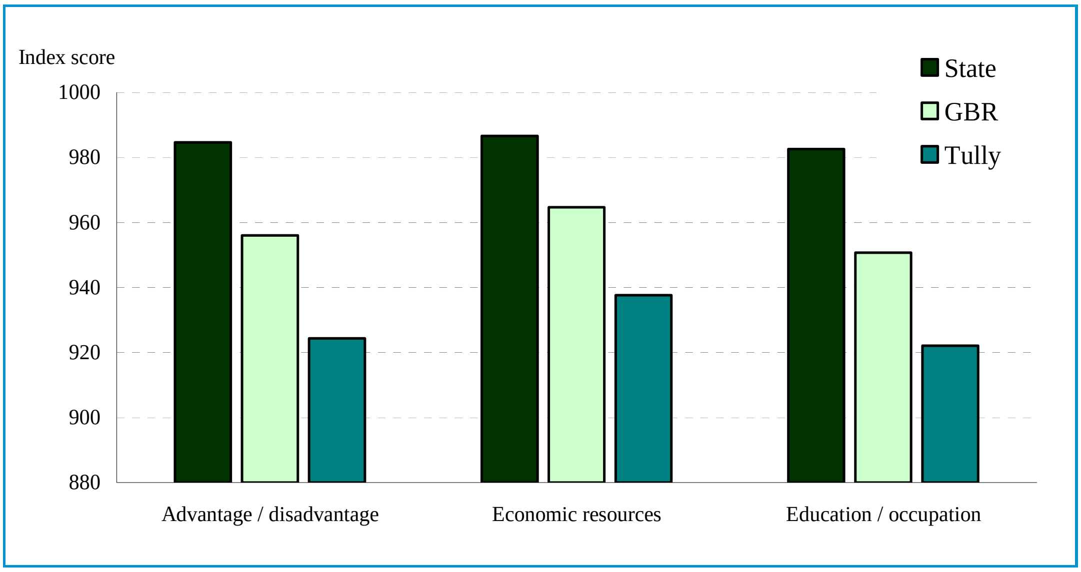
Analysis of the data indicates:

- the Tully Murray region is at a relatively significant disadvantage to both the State, and the GBR as a whole; and
- economic resources in the Tully Murray are below the State, and the whole GBR, while education and occupation data indicates that the Tully Murray is significantly worse off than the State as a whole and worse off than the GBR as a whole. This may indicate lower resilience to change.

[293] ABS, 2001, 2039.0, *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas*, Australia, 2001.

[294] MJA estimated concorded index scores for each WQIP region using concorded population figures to derive each LGA's SEIFA score to the overall WQIP SEIFA score.

Figure 36: SEIFA indices



Source: MJA based on ABS 2001 Census SEIFA indices.

This broadly implies that the Tully Murray region's lower social and economic wellbeing may make it more difficult to implement the WQIP here than in other regions. This is particularly due to the low levels of diversity in industry and occupations compared to other WQIP regions. A relatively low level of diversification of occupations indicates possibly a lower capacity of the community to adapt to change. Measures to address this constraint may be necessary.

Education levels in the Tully Murray are broadly on par with the rest of the GBR catchments, but tertiary education rates are lower than the State as a whole as shown in Table 73: Educational attainment.

Table 73: Educational attainment

Highest education level completed	Tully Murray(% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	23.4	21.3	19.8
Year 12	27.8	30.1	37.2
Certificate or diploma	21.6	22.2	21.9
Undergraduate degree	5.0	6.6	9.3
Postgraduate degree	0.9	1.1	2.2

Source: ABS Census of Population and Housing.

13.2.2 Employment and labour force

Labour force statistics shown in Table 74: Labour force statistics indicate the dominance of primary industries in the Tully Murray, compared with the broader GBR and the Queensland average. Employment in primary industries in the Tully Murray region is much higher than the GBR as a whole, and is over seven times more important than at the State level and almost four times as important than for the GBR as a whole. Manufacturing is a slightly more important employer in the Tully Murray than for the rest of the GBR, largely due to sugar manufacturing. Unlike some other areas of the GBR, mining is a relatively small employer in the region, comparable to the State as a whole.

Sectors typically related to tourism such as accommodation, food and retail trade are generally on par with the Stage and the GBR as a whole. Due to the dominance of the agricultural sector, most other sectors are comparable or slightly lower employers than GBR and State averages.

13.2.3 Economic structure

The structure of the economy can provide some indication of a region's capacity to change in response to natural resource management policies or programs. As with much of the GBR region, the Tully Murray economy is focused on agriculture and tourism. The Draft Far North Queensland Regional Plan notes the significant employment based around primary industries, including agriculture and horticulture, dairy and beef cattle, fishing, aquaculture, mining, quarrying and forestry.

In terms of agricultural land use, sugarcane dominates the Tully Murray catchment (367,000 ha), followed by grazing (22,000 ha), horticulture (8,600 ha) and forestry (5,800 ha). The agricultural area covers 25 per cent of the catchment area, and the gross value of cropping (mainly sugarcane and horticulture) is approximately $125m.[295] Table 74: Labour force statistics provides these figures. A shortage of land for future industrial expansion is also noted in the Cardwell–Tully area.[296]

The economic structure of the Tully Murray has significant implications on prioritising, designing and implementing the WQIP. Of particular importance is the dominance of the sugar industry and the need to target this industry if nutrient targets are to be achieved.

[295] Roebeling et al., 2007, *Environmental–economic analysis for exploration of efficient land use and land management arrangements, water quality improvement targets and incentives for best management practice adoption in the Tully Murray catchment.*

[296] http://www.dip.qld.gov.au/docs/temp/fnq/FNQRegPlan2025-DRAFT.pdf . Accessed 8 November 2009.

Table 74: Labour force statistics

	Number			Percentage		
	Tully Murray	GBR	Qld	Tull Murray	GBR	Qld
Agriculture, forestry and fishing	975	23,546	54,563	21	5	3
Mining	110	27,793	51,656	2	6	3
Manufacturing	377	34,978	169,025	8	8	8
Electricity, gas, water and waste services	49	6,962	24,764	1	2	1
Construction	527	40,558	179,947	11	9	9
Wholesale trade	80	13,561	73,377	2	3	4
Retail trade	478	46,833	214,617	10	11	11
Accommodation and food services	356	32,649	140,036	8	7	7
Transport, postal and warehousing	222	24,591	104,924	5	6	5
Information media and telecommunications	41	3,588	25,282	1	1	1
Financial and insurance services	50	6,317	53,833	1	1	3
Rental, hiring and real estate services	68	7,086	36,875	1	2	2
Professional, scientific and technical services	107	18,497	131,921	2	4	7
Administrative and support services	101	12,383	64,185	2	3	3
Public administration and safety	184	30,251	135,586	4	7	7
Education and training	284	33,080	160,241	6	7	8
Health care and social assistance	315	47,500	240,017	7	11	12
Arts and recreation services	66	4,210	28,418	1	1	1
Other services	165	17,688	78,157	4	4	4
Not stated	141	10,814	22,913	3	2	1
Total	**4,696**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS 2006 Census of Population and Housing.

Tourism

As with all areas of the GBR, tourism is a relatively important contributor to the economy, and an important source of economic diversification from primary industries. The Tully River is renowned for white water rafting, and backpackers often combine visits with seasonal work on sugar cane and banana plantations.

Nature-based tourism is the primary tourist attraction of the area, including the Tully River and Gorge, waterfalls and walking. Nature-based tourism industry competes with consumptive industries for environmental values, including water quality.

Agriculture

The key industry targeted for practice change in the WQIP is agriculture.

Table 75: Key agriculture sector statistics, Tully Murray catchment shows estimates of key agricultural land uses for the Tully Murray catchment drawn from CSIRO 2007 data. As can be seen in the data, the largest land use area is dedicated to sugar cane, followed by livestock pasture. Cattle and sheep number approximately 11,500 and 4,400 respectively.[297]

Intensive horticulture is dominated by tropical fruits, especially bananas, and to a lesser extent, paw paws, mangoes, citrus and pineapples.

[297] MJA analysis based on ABS census data.

Table 75: Key agriculture sector statistics, Tully Murray catchment

Land use	Agriculture holdings (ha)	Economic contribution ($m)
Sugar cane	35,975	63
Grazing	21,585	9
Horticultural crops	8,634	50
Forestry	5,756	4

Source: MJA based on CSIRO, 2007.

The dominance of sugar for cropping has major significance for prioritising and developing programs to address reductions in nutrient loads from the Tully Murray region.

13.3 Proposed changes in practice under the WQIP

The draft Tully Murray WQIP[298] outlines a number of proposed changes in practice that are designed to address diffuse and point sources of pollutants across the spectrum of land use activities. MJA has assessed the impacts of the proposed changes in practice outlined in the WQIP against a 'do nothing more' base case.

13.3.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the WQIP to address rural diffuse pollutant loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point source loads.

[298] Terrain NRM, 2008, *Summary of the Tully Water Quality Improvement Plan.*

13.3.2 Scenario Two: A suite of practice changes

Under the draft WQIP, a suite of actions are proposed to reduce pollutant loads from diffuse and point sources. These actions will enhance water quality in the freshwater and marine environments, and enhance relevant environmental values across much of the Tully Murray catchment and adjacent areas of the GBR, while potentially increasing economic efficiencies in local industries. These environmental values are outlined in depth in the WQIP document. Through a process of consultation, underpinned by other research and modelling, target changes in sediment, nutrient and herbicide loads attributable to the implementation of the WQIP were established. These figures are shown in **Table 76.**

Table 76: Changes in pollutant loads targeted by the Tully Murray WQIP

Current loads		Management Action Targets (2013)	Reduction	
Pollutant	**Tonnes**	**Tonnes**	**Tonnes**	**%**
Total Suspended Solids	119,000	97,500	22,650	18
Dissolved Inorganic Nitrogen	1,159	870	286	25
Dissolved Organic Nitrogen	529	n/a		
Particulate Nitrogen	630	n/a	95	16
Total Nitrogen	2,318	2,029	361	16
Filterable Reactive Phosphorus	54	n/a		
Dissolved Organic Phosphorus	31	n/a		
Particulate Phosphorus	159	n/a	26	17
Total Phosphorus	244	n/a	26	17

Source: Terrain NRM, 2008, Summary of the Tully Water Quality Improvement Plan.

These targets are underpinned by a number of management action targets for nutrients, herbicides, sediment and restoration of floodplain function, summarised in Table 77..

Key changes recommended by the Tully Murray WQIP include:

- full adoption of the ‘Six Easy Steps’ program by sugarcane farmers by 2010;
- complete adoption or renewal of ChemCert® accreditation (or equivalent) by all farmers and growers by 2010;
- accelerated extension of zero tillage in sugarcane by 2013;
- restoration of key riparian locations by 2013;
- more appropriate land use planning in the Tully Murray WQIP area;
- continued research into nitrogen replacement technology;
- research into the viability of nitrogen fixing sugarcane;
- further research and accelerated extension on key nutrient management practices in horticulture by 2013; and
- further research and accelerated extension on zonal tillage in bananas by 2013.

Table 77: Management Action Targets (MATs) and Resource Condition Targets (RCTs) developed for the Tully Murray WQIP

Critical areas for action	Asset		
	Water resources	*Sustainable industries*	*Riparian zones & wetlands*
Nutrient management	Reduce total dissolved inorganic nitrogen loads delivered to receiving waters by streams and rivers by 25% to 870 tonnes per year by 2013.	Reduce nitrate loss from contributing land uses by 50% by 2013.	Undertake 285.5 km of riparian rehabilitation in identified areas to de-nitrify groundwater delivered to streams by 2013.
Herbicide management	Meet the Australian and GBR water quality guidelines for pesticides by 2013.	Reduce herbicide losses from contributing land uses by 50% by 2013.	Minimise impact of invasive species that threaten inland aquatic and terrestrial ecosystems by 2013.
Sediment management	Reduce total suspended solids loads delivered to receiving waters by streams and rivers by 18% to 97,500 tonnes per year by 2013.	Reduce sediment loss by 10% from contributing hot spots by 2013.	Undertake 124 km of riparian rehabilitation in identified areas to minimise bank erosion by 2013.
Restoration of floodplain function	Identify floodplain retention areas that can contribute to filtering function by 2013.	Implement and continuously update current recommended practices for all land uses by 2013.	Ensure no further degradation or fragmentation of aquatic ecosystems by 2013.

Source: Terrain NRM, 2008, Summary of the Tully Water Quality Improvement Plan.

13.4 Potential impacts of WQIP

The WQIP is likely to have a number of positive environmental, social and economic impacts. Key impacts are briefly outlined in Table 78.

Table 78: Potential benefits of WQIP

Key benefits	Key elements and values
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive.
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry in freshwater systems and marine systems in the GBR.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[299]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector in terms of maintaining the region's attractiveness to visitors.
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Crop yields and gross margins	Analysis undertaken by CSIRO indicates that some management actions have no impact on yields and a positive impact on gross margins, via lower input costs.
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is valued at around $7.82 per household per year. This translates to around $38,000 per annum for local residents of the Tully Murray region. *If* the modelled reductions in loads outlined in this chapter translate into similar relative improvements in water quality, the annual value of enhanced ecosystems functions and services would be in the vicinity of $800,000.[300]

Source: MJA.

13.5 Economic costs

There are two sets of actions outlined in the WQIP that have material economic consequences: reducing loads from rural diffuse sources and reducing loads through rehabilitation of riparian zones.

13.5.1 Reducing loads rural diffuse source

Detailed modelling has been undertaken linking recommended WQIP changed land management practices to biophysical changes in marine and freshwater environments with their economic costs and benefits. This analysis explored the cost-effectiveness of industry-specific land management arrangements for water quality improvement and assessed the effectiveness of price policy instruments in promoting industry best management practice adoption.[301] By

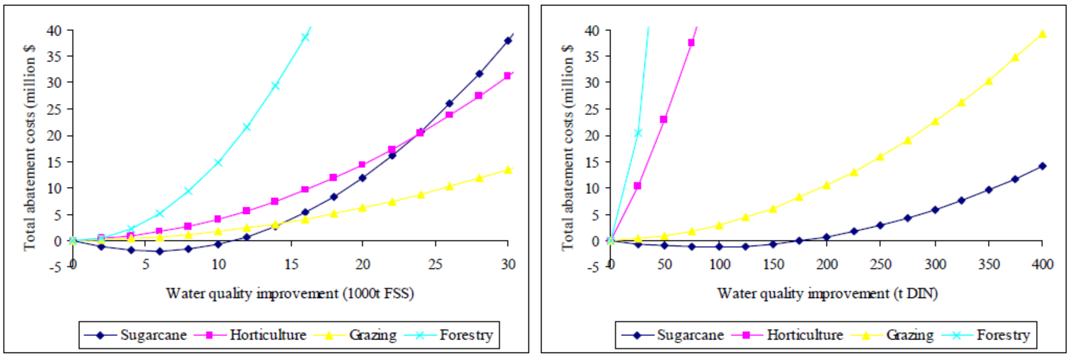
[299] Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.*

[300] MJA estimates based on Windle and Rolfe, 2006, *Non-market values for improved NRM outcomes in Queensland.*

[301] Roebelling, et al, 2007. *Environmental-economic analysis for exploration of efficient land use and land management arrangements, water quality improvement targets and incentives for best management practice adoption in the Tully–Murray catchment.* CSIRO.

linking management changes with the economic value of environmental changes, modelling can explore efficient water quality improvement targets. Figure 37 shows the costs of pollution abatement by industry for fine suspended solids (FSS) and DIN pollution developed by CSIRO.

Figure 37: Water pollution abatement cost curves per industry for Fine Suspended Solids and Dissolved Inorganic Nitrogen



Source: Roebelling, et al., 2007.

The modelling undertaken by Roebelling et al. indicates the costs of meeting the sediment abatement targets in the WQIP up to 2013 vary significantly depending on the industry and the volume of pollutants abated. The approximate costs of meeting the fine suspended solids and dissolved inorganic nitrogen targets are shown in Table 79.

Table 79: Potential costs of meeting key WQIP targets

Pollutant targets and industry	Approximate cost to meet 2013 target ($m)
Sediment (target 22,650 tonnes)	
Grazing only	7.0–8.0
Sugar only	15.0–16.0
Horticulture only	17.0–18.0
Forestry only	N/A
Efficient portfolio (approx. 50% sugar and 50% grazing)	2.5–3.5
Nitrogen (target 286 tonnes)	
Grazing	21.0–22.0
Sugar	4.9–5.0
Horticulture	N/A
Forestry	N/A
Efficient portfolio (at least 50% sugar, then remainder of target from sugar or grazing)	2.5–3.5

Source: MJA based on Roebelling, et al., 2007.

Key points are noted below:

- for **sediment,** grazing provides the lowest cost single industry solution at around $7–$8m. However, for sugar, there are some ‘win-win’ situations where there are likely to be financial benefits accruing to farmers from reducing loads. This indicates a multiple industry strategy is likely to be most effective;

- if an efficient portfolio of investments is to be developed, it would probably achieve the targets at a cost of around $2.5–$3.5 million. This portfolio approach primarily targets sugar, where the win-win situations occur until the marginal abatement cost from sugar exceeds the cost of abatement from grazing;
- for **nitrogen**, sugar offers the lowest cost single industry abatement option at around $4.9–$5.0m largely due to win-win outcomes. However, for load reductions beyond about 150 tonnes where all win-win options are exhausted, the marginal abatement costs are similar for both sugar and grazing. Again, this indicates a multiple industry approach, initially concentrating on sugar, is likely to provide the most efficient portfolio of abatement investments;
- **horticulture**: reducing loads from horticultural sources is generally less cost-effective than from sugar or grazing; although reaching pesticide targets through modified horticultural practice may prove very efficient. Reducing fine suspended solids in the horticultural, particularly banana, industry can be achieved at relatively low cost, through adopting grassed inter-rows. However, reducing dissolved inorganic nitrogen can only be achieved at significant financial cost to the banana industry through reduced areas under cultivation and decreased fertiliser rates; and
- **forestry**: water pollution reductions in the small forestry sector can only be achieved at high cost for both fine suspended solids (FSS) and dissolved inorganic nitrogen (DIN).

13.5.2 Riparian rehabilitation

There are two key restorative management actions proposed for riparian rehabilitation:

- primarily for nutrient management, 285.5 km of riparian rehabilitation is to be undertaken in identified areas to denitrify groundwater delivered to streams by 2013; and
- primarily sediment management, undertake a further 124 km of riparian rehabilitation in identified areas to minimise bank erosion by 2013.

The cost of riparian rehabilitation varies significantly based on the location, vegetation, condition, slope and the opportunity cost. Previous research has found riparian rehabilitation costs can range from $5,000 to $50,000 per kilometre in rural areas, with rehabilitation in tropical climates being closer to the top end of this spectrum due to vegetation types.[302] Therefore, the riparian rehabilitation costs could be between $2.0m and $20.4m over the life of the WQIP. The variation in costs is driven by specific site conditions (location, slope, current condition), the rehabilitation actions required, variance in opportunity costs (i.e. agricultural productive values foregone), and the degree to which landholders are prepared or able to co-invest in rehabilitation actions.

Table 80: Potential costs of riparian rehabilitation

Action	Range of costs ($m)		
	Low	Mid	High
Riparian rehabilitation (MAT RW1)	1.4	6.4	14.2
Riparian rehabilitation (MAT RW3)	0.6	2.8	6.2
Total riparian rehabilitation	**2.0**	**9.2**	**20.4**

Source: MJA.

302 WBM Oceanics, 2005, *Diffuse Source Best Management Practices: Review of Efficacy and Costs.*

13.5.3 Total WQIP cost

The total cost of the meeting the targets through rural diffuse loads via practice change and rehabilitation of riparian zones for 2013 could be as low as $7.0 million for an efficient portfolio of agricultural practice change and low cost riparian rehabilitation.[303] However, the costs of meeting pesticide targets and the fact that riparian rehabilitation may be closer to the higher end of the estimates suggests a figure of $10m–$15m may be more realistic.

13.6 WQIP implementation issues

There are two key areas of the WQIP implementation phase that can be enhanced by the considering economic and social issues: prioritising sectors for activity and investment and choice of policy tools. Consideration of these issues should lead to a more cost-effective investment of limited public funding available to enhance the condition of the GBR.

13.6.1 The prioritisation of sectors and actions

Table 79 shows that for sediments and nutrients, the grazing and sugar industries are likely to provide the most cost-effective source of load abatement. The WQIP also indicates the most cost-effective option to reduce rates of herbicide application is for sugarcane, for example via the use of hooded sprayers, which could lead to a 50% decrease in herbicide delivery to end-of-river systems with limited impacts on gross margins. Other points to note include:

- generally, forestry is unable to make significant contributions to reducing sediment loads and it is relatively more expensive at reducing both sediment and nutrient loads. The potential contribution of horticulture to reducing loads is both limited and generally not cost effective; and
- the WQIP also indicates that the revegetation of key areas will reduce sediment loads by around 5,950 tonnes (5% of total and almost one-third of the target).[304] However, revegetation costs, particularly in riparian areas, could be relatively high.

The structure of the agriculture sector in terms of number of enterprises and the areas under management for each sector, suggest that program management efficiencies could be obtained by concentrating effort under the WQIP primarily on sugar, for nutrients, and grazing, for sediments. Major investment in other sectors such as horticulture and cropping could only be justified where the relative effectiveness of investment in those sectors was significantly higher than for sugar and grazing. This is generally consistent with the development of the WQIP to date. Therefore, an efficient prioritisation of sectors and actions should probably be as follows:

- **sugar**: using win-win actions to reduce sediment and nutrient loads should be the first priority for the implementation of the WQIP. In addition, sugar should probably be the first priority for pesticide management, particularly via actions such as the conversion to hooded sprayers;

[303] There are also likely to be cost synergies where actions to reduce one pollutant (e.g. sediments) will also deliver relatively efficient reductions in another pollutant (e.g. nitrogen). Therefore, the cost of meeting the targets in the WQIP is likely to be lower than the sum of the costs of achieving individual load targets outlined.

[304] Armour J.D., Hateley, L.R., Pitt, G.L., 2007, *Improved SedNet and Annex modelling of the Tully–Murray catchment. A report prepared for the Tully Water Quality Improvement Plan*. Department of Natural Resources and Water.

- **grazing**: once win-win situations for sugar have been exploited, the cost curves for grazing and sugar are relatively similar. Investment in grazing and sugar are then on a par; and
- **riparian rehabilitation:** rehabilitation of riparian zones will deliver multiple environmental benefits, but may not be cost effective in reducing sediment and nutrient loads when compared to changes in other farm practices, for example zero till practices. Therefore, it may be prudent to schedule investment in riparian rehabilitation until later on in the WQIP implementation process.

Given the relatively high costs of abatement from the horticulture and forestry industries, the rationale for significant investment of public money in practice change beyond basic extension activities is questionable.

13.6.2 Policy tools

Roebelling et al. (2007) found that **voluntary behaviour by itself will not be sufficient to prompt the changes to management practices required to achieve the optimal environmental outcomes**, given the associated financial costs incurred by primary producers. Incentives and potentially efficient regulation will therefore be required to prompt these changes.

The analysis undertaken for the development of the WQIP indicates significant variability in the effectiveness and cost of load abatement between and within industries. In addition, the non-financial impediments to changing practices will also differ between sectors. Therefore, a suite of policy tools is most likely to be needed to achieve targeted practice change, ranging from suasive measures such as basic information and extension, through to relatively sophisticated market approaches and potentially efficient regulation.

With the exception of limited win-win situations for sugar, virtually all other actions to reduce loads have a direct financial trade-off with productivity or profitability. This creates a risk that compliance with regulatory approaches may be low without sufficient financial incentives.

Specific recommendations for choosing policy tools are listed below:

- **information**: underpin all programs with information on the effectiveness and potential private costs and benefits of practice change, including information about the timing of changes. This should assist landholders determine their ability to implement change;
- **avoid fixed price incentives and use flexible price mechanisms**: there is evidence of significant variance in the costs of practice change in sugar farming and grazing. Therefore, fixed-price incentives create a risk of overpayment in some circumstances, where the incentive rate exceeds the cost of practice change, or low levels of participation where the incentive rate is less than the cost of practice change. Flexible price mechanisms such as competitive tenders will distribute incentive funding, overcoming these risks and generally leading to more efficient finding allocations;
- **develop metrics to assist in prioritisation**: because of the variability in the contribution of load abatement and costs between and within industries in the Tully Murray WQIP region, there is a need to establish metrics to enable transparent and repeatable prioritisation of incentives;
- **transitional funding arrangements**: while some practice changes may result in win-win situations in the longer term, significant up-front capital investments or time lags between costs incurred and benefits received may inhibit practice change. Therefore, some form of

transitional funding or risk sharing is appropriate. One option is to provide financial incentives for capital equipment in the form of structural adjustment loans, with repayments more closely aligned to enhancements in cashflow; and

- **target correct section of industry**: because some business inputs are typically outsourced, particularly in the sugar industry, it is important to ensure that incentives are targeted at the section of the industry that is likely to provide the most cost-effective change. The key example is the increased use of hooded sprayers in the sugar industry, where incentives to contractors to convert to hooded sprayers may be extremely cost effective.

14. Russell-Mulgrave

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- The Russell-Mulgrave region in North Queensland has been achieving population growth relatively on-par with the GBR average. However over the medium to long-term this is expected to drop slightly below the average population growth for the GBR.
- Socio-economic conditions are somewhat less favourable in the Russell-Mulgrave region than for Queensland as a whole. There is a slightly higher incidence of low-income families and lower rates of home ownership than for Queensland as a whole. The education profile is quite different to that of the GBR and Queensland, with higher rates of Certificate / Diploma qualifications.
- The high reliance on agriculture in terms of employment and business counts, particularly sugar production and tropical crops, and the associated water quality risks from production are not likely to decline without policy intervention.

Scenarios assessed

Two scenarios were assessed:

- do nothing more; and
- a scenario of actions to accelerate uptake of better soil, nutrient and pesticide management practices across a number of rural and urban industries under the auspices of the Wet Tropics Healthy Waterway Management Plan (WTHWMP) and building on existing actions already underway under programs such as Reef Rescue.

Impacts

Impacts of the do nothing more scenario are likely to be a further decline in water quality and risks to the GBR. Key waterway assets such as wetlands will also be impacted. Negative impacts are likely on sectors reliant on water quality in the broader region, particularly the GBR tourism drawcards such as boating, diving and snorkelling. There are also likely to be negative impacts on recreation, particularly fishing, and a general loss in ecosystem function.

Positive impacts of the scenario of actions include:

- a reduction in nitrogen loads by up to 20% from sugar producers at virtually no cost;
- significant reduction in loads from horticulture activities at virtually no cost;
- subsequent reductions in a number of other loads from the implementation of best management practice (e.g. pesticide loads including ametryn, atrazine, diuron, hexazinone, and/or tebuthirion);
- reductions in urban diffuse and point source loads; and
- significant benefits in terms of risk mitigation to the tourism industry and the recreational fishing industry.

Implementation issues

Through programs such as Reef Rescue, hundreds of small on-ground projects are being implemented across the Wet Tropics region across multiple sectors (sugar, grazing, diary horticulture (bananas and papaw).[305] These actions should continue, but given the makeup of land use in the region and the fact that grazing and horticulture both have high levels of adoption of best practice, options to significantly reduce loads from those sectors will be limited without imposing significant economic costs.

The key lessons for the implementation of the HWMP are that there should be a very focussed effort on enhancing practices in cane production and horticulture in the region for several reasons.

- sugar is probably the only sector that provides opportunities for significant reductions in loads in both absolute and relative terms;
- there are significant opportunities to exploit win-win situations in sugar by targeting the 90% of the area of production that is subject to either C or D practices. In effect, the available data suggests nutrient loads could be reduced by around 20% while delivering higher returns to producers; and
- the relative scale of horticulture production in the region would suggest significant reductions in loads could be achieved without incurring significant economic costs.

Given the opportunities in sugar and horticulture, policies should continue to be specifically designed to overcome impediments to practice change including information, extension, innovative market approaches to mitigate the

305 For example in 2010-11, 213 Reef Rescue projects were funded in the Wet Tropics. The cost of those projects was about $10 million, and Ref rescue funding accounted for about 40% of total project costs.

risks of practice change (insurance-like approaches) and to overcome the capital investments required (loans for necessary capital). These approaches would enable significant reductions in loads to be achieved at a lower cost.

14.1 Introduction

The Russell-Mulgrave region[306] is around 199,972 hectares. Much of the Russell-Mulgrave catchment is forested, with conservation and natural environments accounting for approximately 72% of land use within the region. Gordonvale, Yarrabah, Babinda and Bramston Beach are the main population / urban centres within the Russell-Mulgrave region.[307]

Cropping is a relatively significant land use in the Russell-Mulgrave catchment, at 13%. Prominent agricultural activities include sugar cane growing, tropical fruit farms, commercial turf farms and banana growing.[308]

Livestock grazing represents about 3% of the land use in the area.[309] Cattle grazing occurs in a small part of the catchment near the Russell River.[310] The Mulgrave Central Mill, a sugar Mill, is the only producer of raw sugar in the Russell-Mulgrave catchment, following the closure of the Babinda Sugar Mill earlier in 2011. According to a spokesman for the Babinda sugar mill the loss of land to banana crops and forestry means that the mill is no longer viable.[311]

This section applies the framework outlined in Section Two to the potential actions in the Russell-Mulgrave HWMP. The scenarios assessed are based on:

- the Russell-Mulgrave Draft HWMP and other information from Terrain Natural Resource Management;
- potential diffuse urban source actions discussed with DEHP officials; and
- application of best practice environmental management to new WWTPs.

14.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the HWMP. This socio-economic profile is based on the 2006 Australian Bureau of Statistics (ABS) Census of Population and Housing.

306 For most of the analysis in this section the Russell-Mulgrave region was concorded to consist of these Statistical Local Areas (SLAs): Cairns Part B 96%, Eacham 11%, Cairns Trinity 5% and Johnstone 1%. Where it was not possible to split the data, the region is taken to include the whole of Cairns Part B.

307 Synergies Economic Consulting (2011) *Wet Tropics Water Resource Plan Area*, report prepared for the Queensland Department of Environment and Resource Management, p24.

308 Ibid, p25.

309 QLUMP data, 2009, provided by DEHP.

310 Ref 3.

311 http://www.abc.net.au/rural/news/content/201102/s3133158.htm

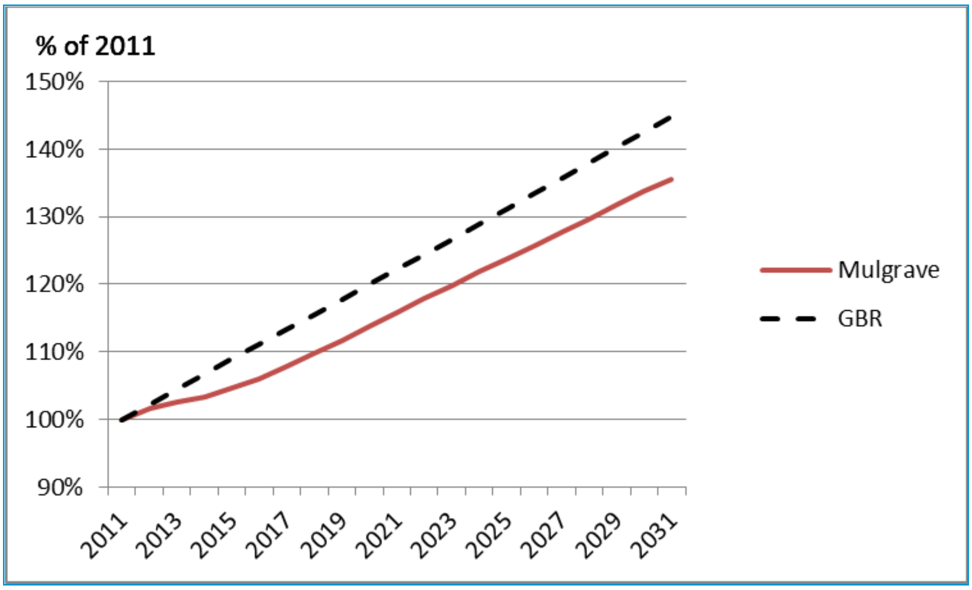
14.2.1 Demographic makeup

Population

From the 2006 Census, it is estimated that the population of the Russell-Mulgrave HWMP region was around 7,090.[312] Figure 38 below shows the historic and forecast population growth for the Russell-Mulgrave HWMP region compared with all of the HWMP regions assessed in this report.[313] Figure 39 indicates:

- significant population growth is expected across the region over the next 20 years; and
- The Russell-Mulgrave region's rate of growth is likely to be slightly lower than for the GBR as a whole, but high relative to a number of other GBR regions. This is because of the region's proximity to outer Cairns.

Figure 38: Population growth projections (Russell-Mulgrave and all GBR HWMP regions)



Source: MJA based on DLGPSR and ABS 2011 census

Population and demographic statistics of note include:

- like much of the GBR, the population of the Russell-Mulgrave HWMP region is slightly skewed to males (51% of the population);
- in the 2011 census, 32% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Russell-Mulgrave HWMP region, compared with around 3.6% for the whole of Queensland.; and
- approximately 9% of people in the HWMP region were not born in Australia and around 3% of the population speak a language other than English at home.[314]

---

312 This estimate is based on ABS census data concorded (best-fitted) to the Russell-Mulgrave HWMP region by OESR. Population estimates are based on a census participant's usual place of residence.

313 Based on DLGPSR Population Forecasting Unit's mid-estimates for each relevant LGA concorded to HWMP boundaries.

314 Based on analysis of 2006 ABS census data.

Community capacity

Issues relating to the community's capacity to participate in natural resource management include the following:

- approximately 18% of adults (>18 years old) participate in voluntary work, potentially indicating reasonable levels of social capital.,[315] Females had higher levels of participation in volunteer work 22%, compared with males (at 15%). However, the ABS census data does not indicate what type of volunteer work was undertaken;
- Russell-Mulgrave has a higher incidence of low-income families than the State as a whole. Approximately 17% of families in the Russell-Mulgrave HWMP area are on low incomes (i.e. less than $600/week) compared with 8% for the State; and
- Household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In Russell-Mulgrave, approximately 63% of homes are owned or are being purchased. This compares with a State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad way of making relative comparisons of social and economic resources between regions. Three indices of most relevance are:[316]

- the Index of Advantage–Disadvantage is a continuum of advantage to disadvantage. Low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation includes all education and occupation variables.

These indices were concorded to the HWMP regions to enable comparisons of each HWMP region to all of the regions assessed in this report and to Queensland as a whole.[317] Results are shown in Figure 39.

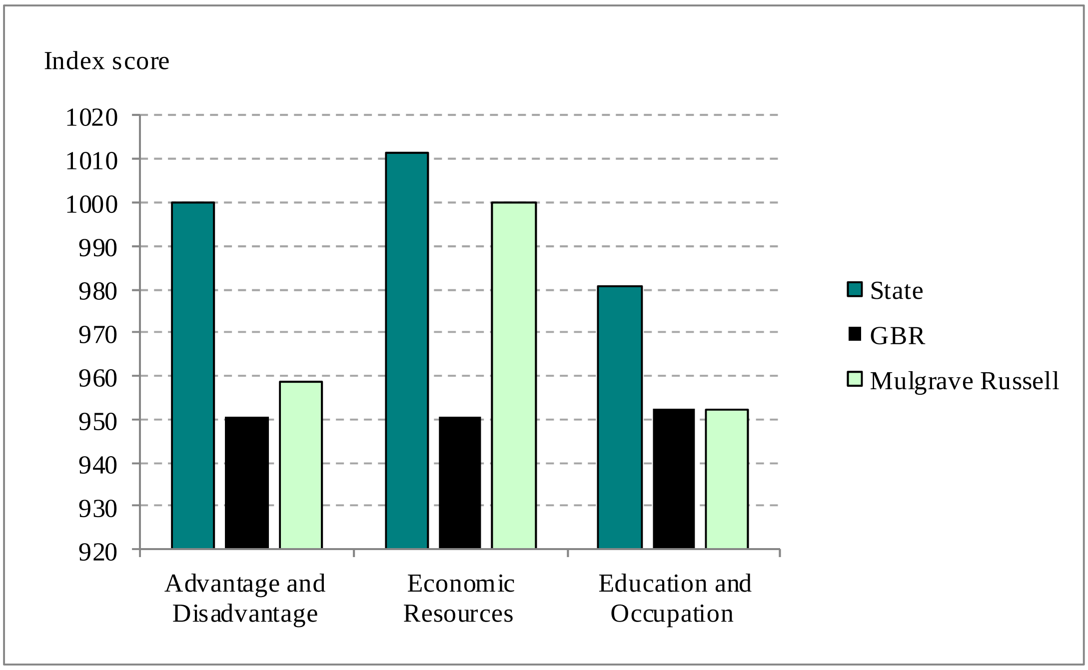
---

[315] Levels of participation in voluntary community activities are often used as a proxy indicator of social capital in a community.

[316] ABS, 2001, 2039.0 *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas, Australia*, 2001.

[317] MJA estimated concorded index scores for each HWMP region using concorded population figures to derive each LGA's SEIFA score to the overall HWMP SEIFA score.

Figure 39: SEIFA indices



Source: MJA based on ABS 2006 census SEIFA indices.

Analysis of the data indicates:

- relative to Queensland, Russell-Mulgrave is at a relatively significant disadvantage. However Russell-Mulgrave is slightly more advantaged than GBR regions as a whole;
- economic resources in Russell-Mulgrave are slightly below the State average, but much higher than for the GBR region as a whole; and
- education and occupation data indicate that the region is fairly significantly worse-off than the State, but about the same as the GBR as a whole, potentially indicating higher resilience to change relative to the other GBR regions.

This broadly implies that the Russell-Mulgrave region's higher social and economic wellbeing than other GBR regions may make it slightly easier to implement the HWMP here than in other GBR regions. The region does have a better economic resources score than some other GBR regions, which may give Russell-Mulgrave some relative advantages in adapting to the HWMP. However it should be remembered that the Russell-Mulgrave region still has much lower advantage/disadvantage and education/occupation index scores than for Queensland as a whole.

As shown in Table 81, the Russell-Mulgrave region has a much higher proportion of people with a Certificate or Diploma non-school qualification than for the GBR as a whole or Queensland. Russell-Mulgrave also has a higher proportion of people with an undergraduate degree than for the GBR as a whole, although it is slightly less than for Queensland. However Russell-Mulgrave has a significantly lower proportion of people with schooling to Year 12 than for Queensland and the GBR, suggesting that people in the region move into trades before completing high school.

Table 81: Educational attainment

Highest education level completed	Russell Mulgrave (% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	22.8	21.3	19.8
Year 12	29.0	30.1	37.2
Certificate or diploma	24.1	22.2	21.9
Undergraduate degree	5.8	6.6	9.3
Postgraduate degree	0.8	1.1	2.2

Source: ABS census of Population and Housing, 2006

14.2.2 Employment and labour force

Labour force statistics in Table 82 indicate the significance of agriculture, forestry and fishing, manufacturing, construction and retail trade as employing industries in the Russell-Mulgrave region. These statistics demonstrate that the economy of the Russell-Mulgrave region is relatively diversified compared to other GBR regions.

Table 82: Labour force statistics

	Number			Percentage		
	Russell-Mulgrave	GBR	Qld	Russell-Mulgrave	GBR	Qld
Agriculture, forestry and fishing	384	23,546	54,563	11	5	3
Mining	61	27,793	51,656	2	6	3
Manufacturing	277	34,978	169,025	8	8	8
Electricity, gas, water and waste services	35	6,962	24,764	1	2	1
Construction	336	40,558	179,947	10	9	9
Wholesale trade	119	13,561	73,377	4	3	4
Retail trade	265	46,833	214,617	8	11	11
Accommodation and food services	135	32,649	140,036	4	7	7
Transport, postal and warehousing	121	24,591	104,924	4	6	5
Information media and telecommunications	22	3,588	25,282	1	1	1
Financial and insurance services	29	6,317	53,833	1	1	3
Rental, hiring and real estate services	27	7,086	36,875	1	2	2
Professional, scientific and technical services	100	18,497	131,921	3	4	7
Administrative and support services	79	12,383	64,185	2	3	3
Public administration and safety	333	30,251	135,586	10	7	7
Education and training	338	33,080	160,241	10	7	8
Health care and social assistance	420	47,500	240,017	12	11	12
Arts and recreation services	43	4,210	28,418	1	1	1
Other services	154	17,688	78,157	5	4	4
Not stated	94	10,814	22,913	3	2	1
Total	**3,372**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS Census of Population and Housing, 2006. The categories are based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) 1993.

The significant employment in agriculture, forestry and fishing in the Russell-Mulgrave region is higher than for both the GBR as a whole, and the State. Manufacturing is a slightly more significant employer in the Russell-Mulgrave region than in the GBR as a whole and Queensland. This is explained by sugarcane processing.

Retail trade and accommodation, cafes and restaurants, often used as a proxy for the tourism industry, comprises a relatively significant share of the employment by industry in the Russell-Mulgrave region. However, the proportion of the labour force employed in retail trade and accommodation in Russell-Mulgrave region is lower than for the GBR as a whole and Queensland.

The specialisation ratio is highest in agriculture, forestry and fishing. The specialisation ratio is the ratio of the percentage for the region to the percentage for Queensland.

14.2.3 Economic structure

The structure of the economy can provide some indication of a region's capacity to change in response to natural resource management policies or programs. Table 83 indicates the economic structure of Russell-Mulgrave's economy indicated by business counts by industry. Key points to note include:

- agriculture, forestry and fishing has a significantly higher proportion of business counts, at 40.2%, than for Queensland as a whole (11.1%);
- accommodation and food services, which relates to the tourism industry, comprises 2.6% of business counts for the Russell-Mulgrave region. This is lower than the proportion for Queensland, at 3.6%; and
- construction comprises a significant proportion of business counts by industry, at approximately 18.4%. This is only slightly lower than the proportion for Queensland, and is driven by population growth in the region (which is close to Cairns).

Table 83: Counts of registered businesses by industry, Johnstone Region, 2006

Industry	Russell-Mulgrave Region		Queensland	
	number	%	number	%
Agriculture, forestry and fishing	233	40.2	46,624	11.1
Mining	0	0.0	1,913	0.5
Manufacturing	24	4.1	18,193	4.3
Electricity, gas, water and waste services	0	0.0	1,039	0.2
Construction	107	18.4	78,768	18.8
Wholesale Trade	9	1.6	13,442	3.2
Retail Trade	24	4.1	27,747	6.6
Accommodation and food services	15	2.6	14,950	3.6
Transport, postal and warehousing	36	6.2	27,180	6.5
Information media and telecommunications	0	0.0	2,772	0.7
Financial and insurance services	12	2.1	25,827	6.2
Rental, hiring and real estate services	45	7.8	46,636	11.1
Professional, scientific and technical services	21	3.6	41,509	9.9
Administrative and support services	15	2.6	15,724	3.7
Public administration and safety	3	0.5	1,460	0.3
Education and training	0	0.0	4,559	1.1
Health care and social assistance	3	0.5	17,630	4.2
Arts and recreation services	3	0.5	5,313	1.3
Other services	15	2.6	18,591	4.4
Not classified	15	2.6	9,533	2.3
Total	**580**	**100.0**	**419,410**	**100.0**

Source: OESR, Queensland Regional Profiles citing Australian Bureau of Statistics, Counts of Australian Businesses, including Entries and Exits, June 2007 to June 2009, cat no. 8165.0. Note: For this data it was not possible to concord the Russell-Mulgrave region exactly, so it is taken as the SLA Cairns Part B.

Note: The classifications used are based on ANZSIC 2006.

Hence, the economic structure of Russell-Mulgrave has significant implications for the prioritisation, design and implementation of the HWMP. Of particular importance is the dominance of the sugar industry and the need to target significant effort within that industry if nutrient targets are to be achieved.

Tourism

While tourism is important to the region, Russell-Mulgrave is not as heavily reliant on tourism as other regions in the GBR, such as Cairns. This is because the region is relatively more economically diversified than other regions in the GBR. The Russell-Mulgrave area has some significant tourism sites including the Russell River National Park, Woonoorooran National Park and Josephine Falls, Eubenangee Swamp National Park, and the offshore Frankland Group National Park.

Analysis of the GBRMPA's EMC data indicates that approximately 870,077 water-based tourist activities occurred in the Cairns-Cooktown Management Area region in 2010. This is roughly similar to the number of visitors for the Townsville-Whitsunday Management Area in 2010, but significantly more than for the Mackay-Capricorn management zone. There are potential risks to reef-based tourism and other forms of nature-based tourism industry from any loss in tourism attributable to water quality.[318]

Semi-structured interviews undertaken by MJA with approximately 15 dive operators across the GBR in 2008 indicated that any deterioration in reef and marine condition has a negative impact in the sector in two main ways. Firstly, operators are often forced to travel further offshore to find quality dive sites increasing operating costs and reducing profits. Secondly, if water quality is poor, dive tourists are less inclined to undertake subsequent dives during their current holiday or return to the region for dive holidays in the future.[319]

Agriculture

The key industry continuing to address best management practice is agriculture. Table 84 depicts the value and share of agricultural production for the three SLAs included in the Russell-Mulgrave catchment. The analysis shows:

- tropical crops (sugarcane and banana) are the primary agricultural product in the Russell-Mulgrave region, consisting of 94% of the value of agricultural production, equivalent to $73.2 million. This indicates a significantly disproportionate agricultural reliance on sugar in the Russell-Mulgrave region. Crops make up a much less significant proportion of the value of agricultural production for Queensland as a whole, at 47.9%, and compares to 48% for the GBR as a whole;
- livestock slaughterings account for 3% of the value of agricultural production in the Russell-Mulgrave region, valued at $2.3 million. Livestock slaughtering comprises a much larger share of the value of agricultural production for Queensland as a whole at 47.4%; and
- livestock products make up only 3.0% the value of agricultural production in the Russell-Mulgrave region, valued at $2.3 million. Livestock products comprise a slightly greater proportion of the value of agricultural production in Queensland as a whole.

318 GBPMPA, 2008, unpublished data.

319 MJA, 2008, *The economic contribution of the dive industry to the GBR*..

Table 84: Value of agricultural production by statistical local area, Russell-Mulgrave Region, 2005–06

Statistical local area	Crops		Livestock slaughterings		Livestock products		Total
	$M	%	$M	%	$M	%	$M
Cairns (C) - Pt B	70.1	98.8	0.8	1.2	0.0	0	70.9
Cairns (C) - Trinity	0.8	98.8	0.0	1.2	0.0	0	0.8
Eacham (S)	0.4	9.1	1.4	34.8	2.3	56.1	4.1
Johnstone (S)	2.0	97.8	0.0	2	0.0	0.2	2.1
Russell-Mulgrave Region	73.2	94.0	2.3	3.0	2.3	3.0	77.9
Queensland	4,167.9	47.9	4,125.2	47.4	415.8	4.8	8,708.9
Region as % of Qld	**1.8**	. .	**0.1**	. .	**0.6**	. .	**0.9**

Source: OESR Regional Profile, citing: Australian Bureau of Statistics, Agricultural Commodities, Australia, 2005-06, cat. no. 7125.0. This data has been concorded as follows: Cairns Pt B (96%); Eacham (11%); Cairns Trinity (5%); and Johnstone (1%).

Note: . . = not applicable

The significant dominance of sugar for cropping has a major significance for the prioritisation and development of programs to address reductions in nutrient loads from the Russell-Mulgrave region. Analysis of other key headline agriculture data indicates that Russell-Mulgrave accounts for around 1.7% of the total cropping area in the GBR.[320]

14.3 Pollution loads

Pollution loads in the Russell-Mulgrave are both from natural sources, as well as from the consequences of changes in land use and land management. Load estimates are shown in Table 85.

Table 85: Estimated pollution loads in the Russell-Mulgrave (tonnes/year)

Load	TSS	TN	TP
Natural load	410	775	
Baseline	1,670	3,101	593
Total	2,080	3,876	677
Total - % of natural loads	507%	500%	806%
Total - % of Wet Tropics	**15%**	**25%**	**33%**

Source: Kroon F, Kunhert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J and Joo M, 2010, Baseline pollutant loads to the Great Barrier Reef. CSIRO.

While this data is only for a subset of pollutants, the key points to note are that sediment and nutrient loads are now in excess of three times natural loads, and that the Russell-Mulgrave is a relatively significant source of pollutants in the Wet Tropics region, particularly for phosphorus

320 ABS, *2009 Land Management Practices in GBR Catchments.*

(33% of regional loads). The major contributors to the loads above will be primary industries (particularly grazing and sugar) and, to a lesser extent, more intensive land uses such as urban development, industrial development, mining, and linear infrastructure development (e.g. roads).

14.4 Potential actions

HWMPs are currently being developed for the Russell-Mulgrave, Johnstone, Russell and Mulgrave catchments. Those HWMPs will build on the significant work already completed and work underway to:

- update land use data to better understand the sources of loads; and
- assess key management actions and the potential efficacy of changing practices. The focus is on the grazing, cane, banana and pawpaw industries and sub-catchment specific practices are being developed in conjunction with each catchment community.

The HWMPs will then form the basis of a detailed set of implementation activities to reduce pollution loads from rural activities.

In addition, actions to mitigate the risk of loads from other sources should also be developed, specifically urban diffuse loads and point source loads from regulated emitters (e.g. wastewater treatment plants, mines).

14.4.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the HWMP to address sediment and nutrient loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point source loads.

14.4.2 Scenario Two: A suite of changes to practice

This scenario would build on the current actions being undertaken in the region (often at least partially funded by Reef Rescue or Caring for Our Country). The current actions could be summarised categorised into two broad categories.

Firstly, there are a number of research, planning and governance activities that have been undertaken or are continuing. This includes research into the sources of loads, effective means to reduce loads, the identification of environmental objectives and values, and the establishment of plans and policies to underpin on-ground actions.

The second suite of actions that will make a direct impact on pollution loads is the provision of rants to underpin practice change. This includes grants to assist with initiatives such as improved herbicide management (e.g. hooded sprayers in sugar), improved nutrient management (e.g. subsurface fertiliser application, stool splitters in sugar), improved soil management (e.g. zero till, GPS controlled traffic farming), improved groundcover (e.g. for horticulture and cattle), soil detention basins, laser levelling (sugar and horticulture), riparian plantations and rehabilitation, permanent fencing and watering points (dairy and cattle), effluent reuse systems (dairy).[321]

The focus in developing the HWMP to date has been very much on rural diffuse loads. Urban diffuse loads are largely being managed through initiatives such as the Environmental Protection (Water) Policy 2009, while significant point-source loads are managed as environmentally relevant activities under the *Environmental Protection Act 1994.*

The environmental values and water quality objectives for the region are currently being finalised through a process of scientific analysis and consultation. Under the HWMP, a further suite of actions will be prioritised and proposed to reduce pollutant loads from diffuse and point sources. These actions will enhance water quality in the freshwater and marine environment and enhance relevant environmental values across the region and adjacent areas of the GBR. Given the fact there are no finalised actions and targets for the region, MJA has assessed a number of actions, specifically:

- for rural diffuse loads, a progressive increase in the proportion of landholders adopting current best management practice (B practices) and moving from what are currently considered poor practices to more acceptable practices (i.e. D practice to C practice). It should be noted that there is insufficient detail in existing data to distinguish the benefits and costs of individual practices. Rather, broad incremental movement between suites of practices are assessed;
- future urban developments will need to comply with the Healthy Waters State Planning Policy to achieve the requirements of the Environmental Protection (Water) Policy 2009 (EPP Water). This will largely involve implementing best practice urban design for water quality and drainage recommended in the Urban Stormwater Queensland Best Practice Environment Management Guidelines; and
- where identified, point source loads will be addressed via upgrades to wastewater treatment plants and actions by mines in the region.

14.5 Potential impacts of HWMP

As part of the planning processes for the HWMP priority waterway assets are being identified and the values that are derived from those assets. The HWMP is likely to have a number of positive environmental, social and economic impacts on the extent and condition of those assets. Key impacts are briefly outlined in Table 86. The extent to which those benefits can be achieved will be determined by the resources available and the efficiency of interventions and investment under the HWMP.

321 For a comprehensive list of funded projects see: www.terrain.org.au/programs/production/reef-rescue-wqig.html

Table 86: Potential benefits of HWMP

Key benefits	Key elements and values
Maintenance of wetlands	The region has approximately 14,200 ha of wetlands, approximately 18% of all wetlands in the Wet Tropics. The HWMP will reduce risks to the extent and quality of many of those wetlands.[322]
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive. Evidence from analysis in SEQ indicates that changes in turbidity impact on short-run costs (changes in electricity and chemical usage and changes in sludge management costs), but that the long-term costs of avoiding treatment plant augmentations are often more significant.[323]
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[324]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector to maintain the region's attractiveness to visitors, particularly given the region's high proportion of reef-based tourism activities.
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Improved gross margins for farmers	Analysis undertaken by CSIRO indicates that gross margins can actually be increased in the longer term through improvements in practices, particularly incremental improvements from D practices to C practices, and C practices to B practices.[325]
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is worth around $7.82 per household per year. This translates to around $22,000 per annum for the residents of the Russell-Mulgrave alone.[326]

Source: MJA.

14.6 Potential costs of HWMP implementation

This section briefly outlines our estimates of some of the more significant costs of reducing water pollution loads in the Russell-Mulgrave region. Because the HWMP process is yet to

322 Anon 2011. Reef water quality protection plan report card.

323 KBR 2009. Valuing the natural asset investigating the impact of water quality changes on water treatment plant costs.

324 Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

325 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

326 MJA estimates based on Windle and Rolfe 2006, *Non-market values for improved NRM outcomes in Queensland*.

determine the preferred suite of actions, MJA has modelled a number of costs that would relate to some of the more likely actions under the HWMP.

14.6.1 Costs of rural diffuse actions

Rural diffuse actions will primarily relate to actions by cane producers, beef producers and horticulture producers. Table 87 shows the estimates of uptake of management practices by growers in 2009 which relate to rural diffuse loads (the dominant source of loads).

Table 87: Adoption of management practices – % of growers (Wet Tropics)

Load	Sugar	Horticulture
	%	%
A – cutting edge practices	1	37
B – current best practice	9	37
C – common or code of practice	44	15
D – practices considered unacceptable by industry or community standards	46	11

Source: Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

While there is significant variability in the results depending on particular types of management regimes (e.g. nutrient management, herbicide management and soil management), the key point to note from the data is that there is significant scope for enhancing practices and consequently reducing pollutant loads.

MJA has developed an economic model to estimate the potential cost of achieving load reductions from rural diffuse sources. The model is based on:

- data on the area of each major production system (e.g. sugar) under different management regimes (A, B, C, and D) as outlined in the table above;
- previous modelling of the potential efficacy of different management regimes (measured as pollution load (runoff & leached));[327]
- data on likely changes in gross margins[328] attributable to different production systems transitioning between different state conditions.

Scenarios of management actions that result in higher proportions of farmers undertaking improved management practices can then be modeled to develop broad estimates of changes in loads (TSS, TN, TP) and the likely costs[329] of achieving those load reductions.

Sugar

For the purposes of this report, it is assumed that the area of sugar production in the Russell-Mulgrave is 19,700 ha (based on State land use mapping analysis) and that the dominant soil

[327] Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship.

[328] Gross margins are simply the difference between sales revenue and the production costs, excluding fixed costs such as overheads, interest payments and tax. Changes in gross margins will be the net impact of both any changes in yields (and subsequent revenues) and changes in inputs costs.

[329] It should be noted that the costs included in this model are the substantive costs of practice change (i.e. additional capital expenditure and changes in operating costs). They do not include administrative and other transaction costs.

type for sugar production is well drained sandy loam. Furthermore, it is assumed that the adoption rates of management practices are currently the same as for the broader Wet Tropics region. Using the economic model developed for this report, MJA has modeled a number of scenarios. These scenarios are outlined in Table 88 below. They reflect a number of feasible paths of improvement over time as growers progressively improve from their current practices to current best practice (B practice) and beyond (A practice).

Table 88: Hypothetical scenarios modelled – changes in practice regimes

	% of area			
Scenario	A	B	C	D
Current	1	9	44	46
Scenario 1	1	20	55	24
Scenario 2	1	50	45	4
Scenario 3	1	80	19	0
Scenario 4	1	99	0	0

Source: MJA analysis.

Table 89 below shows MJA's estimates of changes in annual nutrient loads and the cost of achieving those load reductions.

Table 89: Scenarios modelled – changes in practice regimes

Scenario	Approximate regional load reduction (kg/N/annum)	% Change from current loads	Change in region's annual gross margin ($ million)
Current	N/A	N/A	N/A
Scenario 1	75,000	-8	+0.8
Scenario 2	160,000	-17	+2.0
Scenario 3	195,000	-20	+2.9
Scenario 4	205,000	-22	+3.5

Source: MJA analysis.

The analysis shows that significant reductions in nutrient loads from cane could be achieved without necessarily impacting on regional productivity and gross margins. The analysis shows that a program of continuous improvements in practice would actually increase total regional gross margins. This is largely due to the fact that CSIRO analysis suggests that yields per hectare are approximately 3-4% higher for A and B practices than for inferior practices.[330] Our modelling indicates that it may be theoretically possible to reduce nutrient loads from cane production by 50% if all producers were implementing A practices.

However, the analysis does not consider the capital investments that are often required to enhance practices. Analysis undertaken by CSIRO suggests that, even when capital costs are also included, there is still a net financial benefit over a 10-year period from incremental improvements between categories of practice (e.g. C to B). The exception to this rule is moving from B practices to A practices, where the capital investments to move from B to A practices

330 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship.

are almost twice the investment from moving from C to B practices. Table 90 below summarises the net economic costs over a ten year period to transition between classes of practice and the annual cost of pollution abatement.[331]

Table 90: Costs of transition between classes of practices (120 ha farm)

Transition	Present value practice change ($/ha)	Pollution abatement – N ($/kg/year)	Comments
B to A	-489	-31	Transition investment approx. $90,000 plus significant savings in nitrogen use
C to B	615	39	Transition investment approx. $60,000 plus significant savings in nitrogen use
D to C	611	38	Significant savings in nitrogen use

Source: MJA based on Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

The key point to note from this analysis is that there are likely to be significant and sufficient private financial gains for most producers to move to current best practice. This could reduce nitrogen runoff and leaching by around 20%. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as. insurance-like approaches), and action to overcome problems in accessing capital.

However, reducing nitrogen loads beyond around 20% from current levels would result in significant costs to producers and change should not be expected beyond that point without more costly policy interventions (e.g. financial incentives).

Cattle

State land use mapping data indicates that grazing potentially accounts for about 4% of the landmass of the Russell-Mulgrave region. Data for groundcover in pastoral areas indicates that the mean dry season groundcover over the 1986-2009 period is 93%, significantly above the Reef Plan target of 50%. Furthermore, only around 1.2% of grazing lands had groundcover below 50%.[332] For this reason, specific analysis of the economic impacts of enhancing grazing practices in the Wet Tropics is very limited. However, studies undertaken elsewhere have shown that there are significant environmental (lower loads) and economic (high margins) from maintaining appropriate groundcover and undertaking best practice grazing management.[333]

The data overall indicates that there is likely to be more potential gains in focusing on sugar and horticulture growers to reduce loads, as opportunities in grazing may be limited.

Horticulture

State land use mapping data indicates that horticulture potentially accounts for about 1,250 hectares (0.8%) of the landmass of the Russell-Mulgrave region. Bananas and papaw are

331 Based on a typical 120 ha farm.

332 Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

333 For example, see Roebeling., P, and Webster. J, 2004, Financial-Economic Analysis of Management Practices in Beef Cattle Production in the Douglas Shire. Report on the Cost-Effectiveness of BMP Implementation for Water Quality Improvement.

probably the dominant crops in the region and bananas are typically used as the default crop for assessments of options to reduce water pollution from horticulture.

As with sugar and grazing, an A, B, C, D framework has been developed for horticulture management practices.[334] Furthermore there are a number of key management practices that can be adopted such as inter-row management[335]and efficient fertiliser application rates that can result in reductions in fertiliser application by almost 50% from around 520 kg/ha to 225 kg/ha.[336] Much of these improvements are already underway, reflected in the fact that almost 75% of producers in the Wet Tropics are already implementing A or B practices.

Table 91 below summarises the net economic costs over a ten year period to transition between classes of practice.[337] To date, there is insufficient data to estimate the actual cost of abatement such as nitrogen (i.e. $/kg/annum) although research is progressing in this area.[338]

Table 91: Costs of transition between classes of practices (60 ha farm)

Transition	Present value practice change ($/ha)	Comments
B to A	-$6,600	Transition investment approx. $420,000 plus significant savings in nitrogen use
C to B	$15,600	Transition investment approx. $160,000 plus significant savings in nitrogen use
D to C	$21,700	Significant savings in nitrogen use

Source: Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

The key point to note from this analysis is that there are likely to be significant and sufficient private financial gains for the 26% of producers at C or D practice levels to move to current best practice (i.e. B practice). This would further reduce sediment, nitrogen and other chemical runoff without negatively impacting on the industry’s profitability. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as insurance-like approaches), and action to overcome problems in accessing capital.

334 Van Grieken, M.E., Webster, A.J., Coggan, A., Thorburn and P. Biggs, J., 2010. Agricultural Management Practices for Water Quality Improvement in the Great Barrier Reef Catchments. CSIRO: Water for a Healthy Country National Research Flagship.

335 Roebeling, P. C., Webster, A. J., Biggs, J. and Thorburn, P, 2007, Financial-economic analysis of current best management practices for sugarcane, horticulture, grazing and forestry industries in the Tully-Murray catchment. Report to the Marine and Tropical Sciences Research Facility.

336 Armour J, and Daniells J, 2001, Banana nutrition in north Queensland. Final Report FR95013 to Horticulture Australia Ltd.

337 Based on a typical 60 ha banana farm.

338 For example, see Armour, J., Davis, D., Masters, B., Whitten, M and Mortimore, C. (2011). Paddock Scale Water Quality Monitoring: Interim Report 2009/2010 Wet Season, Wet Tropics Region. Queensland Department of Environment and Resource Management, Australian Centre for Tropical Freshwater Research and Queensland Department of Employment, Economic Development & Innovation for Terrain Natural Resource Management, Australia.

14.6.2 Cost of urban diffuse actions

Under the EPP Water, actions to mitigate the risk of water pollution from urban diffuse loads are also likely to be a focus. In a practical sense this usually involves the establishment of WSUD as an underlying approach to future urban development.

The costs of urban diffuse actions will largely relate to the cost of implementing WSUD in new developments. Based on estimated population growth for the region and the current makeup of households, it is likely that around 60 new dwellings will be established each year over the next 10 years. Census data indicates that around 90% of residential dwellings in the Hinchinbrook Shire are detached houses. MJA has estimated the potential pollution loads reductions and related costs for WSUD implementation over the next 10 years (Table 92 below).[339]

Table 92: Estimated cost of WSUD implementation in new developments and impacts on loads over next 10 years

Measure	Value
Number of new dwellings over next 10 years	600
Cost of establishing WSUD over next 10 years	$2.2-2.6 million
Reduction in TSS from business as usual after 10 years	90-100 tonnes per annum
Reduction in TN from business as usual after 10 years	450-460 kg per annum
Reduction in TP from business as usual after 10 years	145-155 kg per annum
Levelised cost of TSS abatement ($/tonne/annum)	$1,750-$2,150
Levelised cost of TN abatement ($/kg/annum)	$360-$450
Levelised cost of TP abatement ($/kg/annum)	**$1,110-$1,360**

Source: MJA analysis.

Urban diffuse actions in new developments have the potential to marginally reduce regional TSS loads after 10 years, at a cost of around $2.2-2.6 million. Estimations of levelised costs of abatement (that include both capital and operating expenditures) indicate that urban diffuse actions are significantly less cost effective than rural diffuse actions at reducing pollution loads.

14.6.3 Costs of other actions – focus on point sources

In addition to diffuse actions, there are likely to be options to reduce loads from point sources such as wastewater treatment plants and the limited mining activity in the region.

Point sources – wastewater treatment plants

The major wastewater treatment plants in the region are at Gordonvale and Babinda. Due to population growth, capital investments in augmentation of around $6 million are expected in the

339 Estimates of load reductions and capital costs are based on MUSIC modelling estimates for small-detached housing developments in the Cairns climatic zone – specifically the use of bio-retention basins. See Water by Design (2010) A Business Case for Best Practice Urban Stormwater Management. Costs were derived from the same study and inflated to current terms using the Brisbane consumer price index. Levelised costs are based on all estimated capital, operations and maintenance, and refurbishment costs over a 25 year period.

next 10 years.[340] Most other areas are services by either wastewater pumps are by site-specific septic systems.[341]

The establishment and upgrades to WWTPs are often a key action of governments to meet multiple regulatory requirements. The costs of WWTP upgrades are driven by the engineering capital and operational costs and are specific to the actual plant.

MJA undertook analysis of expenditure data[342] for recent upgrades from secondary to tertiary treatment for several WWTPs in South East Queensland (data for other WWTPs was not available). MJA estimates the costs of treatment ranges from $76,000 to $200,000 per tonne of nutrients per annum.

Point sources – other environmentally relevant activities

There are a no sugar mills directly in the region, nor is there any mining activity of a material scale. There will be other relatively small scale point source emitters in the region. However, data on emissions and related expenditure is not available at the scale of the Russell-Mulgrave region.

14.7 Economic and social considerations for implementation of the HWMP

The analysis in previous sections indicates there is significant scope to reduce water pollution from changes in land management. This is particularly for sugar cane where there is significant scope to reduce nutrient and other loads. Opportunities for load reduction from grazing are limited due to the very high proportion of graziers who are already meeting best practice groundcover targets. Horticulture accounts for only a very small proportion of land use and there are already a very high proportion of growers that are meeting current best practice.

While population growth does pose some risk to water quality, the implementation of WSUD will mitigate the risks of significant urban diffuse load growth, while recent investments in WWTPs will reduce point source loads. Risks from other point sources such as mining activities and sugar mills are not well understood, particularly as the types of pollutants is significantly broader than those of agricultural and urban development activities.

While there is only cost information for a subset of actions to reduce loads, available data indicates there is very significant variation in the cost effectiveness between actions and industries. This is shown in Table 93 below.

[340] Cairns Regional Council (2010) Edmonton and Gordonvale Wastewater Treatment Plant sewerage catchment planning report.

[341] Cairns Regional Council (2008) Local disaster management plan.

[342] Data provided by Queensland EPA.

Table 93: Relative costs of water pollution abatement - nitrogen

Source	Approximate costs ($/kg/annum)	Comments
Rural diffuse – cane BMPs	-$31-+38	Significant scope for reductions and enhancing industry commercial outcomes
Urban diffuse - WSUD	$360-450	Limited scope to contribute material reductions in loads
Point sources - WWTPs	$76-200	Implementation will form part of infrastructure provision for regional growth

Source: MJA analysis.

The key lesson for the implementation is that there should be a very focussed effort on enhancing practice in cane production in the region for several reasons, specifically:

sugar is probably the only sector that provides opportunities for significant reductions in loads in both absolute and relative terms. Current practices in grazing and horticulture limit the scope for significant reductions in loads without incurring significant economic costs; and

- there are significant opportunities to exploit win-win situations in sugar by targeting the 90% of the area of production that is either C or D practices. In effect, the available data suggests nutrient loads could be reduced by around 20% while delivering higher returns to producers.

The other area of focus should be to facilitate the horticulture producers at C or D practice levels to move to current best practice (i.e. B practice). This would further reduce sediment, nitrogen and other chemical runoff without negatively impacting on the industry's profitability.

Given the opportunities in sugar and horticulture, policies should be specifically designed to overcome impediments to practice change.[343] Given the fact that moving from D to B practices pay financial dividends in the longer term, impediments to change are likely to be:

- *knowledge-based*: some producers may not be fully aware of the economic benefits of enhancing practices. This would indicate information and capacity development approaches would be most appropriate such as agronomic and economic extension.
- *risk*: many producers may perceive the commercial risk of changing practices to be too risky. These risks could be mitigated through demonstration farms in conjunction with extension. Furthermore, the use of approaches such as an insurance-like product to underpin the risk of practice change would be worth considering. Such an approach would only make a payment to a producer where their implementation of new practices actually reduced yields (when benchmarked against district averages). This approach has most applicability in sugar.
- *capital*: moving from C to B practices and B to A practices both require capital investments. However, these capital costs are recouped over time. Therefore, it should be possible to accelerate practices through the provision of low cost or no-interest loans to overcome any impediments to practice change due to limitation of access to capital.

In the longer-term, the public funding of these approaches would largely be limited to program design and delivery as any investments in on-ground change would be ultimately financed by

343 Greiner., R and Grieg., D, (2010) Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. Land Use Policy Volume 28, Issue 1, January 2011, pages 257–265.

producers themselves. This would be significantly more cost effective than current approaches being adopted under the Reef Rescue initiative.

In other sectors examined, the opportunities to achieve significant load reductions at low costs are limited. Any disproportionate focus on those sectors may ultimately reduce the return on the public investment to reduce loads in the region.

15. Barron

KEY FINDINGS FROM ANALYSIS

Social and economic profile

- Population growth in the Barron-Trinity Inlet region in North Queensland is expected to very closely track average population growth for the GBR as a whole, over the next couple of decades.
- Socio-economic conditions are in some ways relatively more favourable in the Barron-Trinity Inlet region than in other GBR regions. For example, education levels are generally higher than in other GBR regions, although lower than for Queensland as a whole. However, the region has greater proportions of people on low incomes, and lower rates of home ownership than for Queensland as a whole.
- The Barron-Trinity Inlet region has a higher Indigenous population than the average for Queensland, and also has a relatively large proportionate of the population who were born overseas.
- While agricultural industries are still important to the Barron-Trinity Inlet region, it is not as heavily reliant on primary industries as other GBR regions.
- The Barron-Trinity Inlet is relatively reliant on tourism industries (e.g. retail trade and accommodation, cafes and restaurants), particularly in terms of employment. This has implications for the importance of reef-health to the Barron-Trinity Inlet region.

Scenarios assessed

Two scenarios were assessed:

- do nothing more;
- a scenario of actions to accelerate uptake of better soil, nutrient and pesticide management practices across a number of rural and urban industries under the auspices of the Wet Tropics Healthy Waterway Management Plan (WTHWMP) and building on existing actions already underway under programs such as Reef Rescue and key actions to address the future risk of growth in urban diffuse loads.

Impacts

Impacts of the do nothing more scenario are likely to be a further decline in water quality and risks to the GBR. Key waterway assets such as wetlands will also be impacted. Negative impacts are likely on sectors reliant on water quality, particularly the GBR tourism drawcards such as boating, diving and snorkelling. There are also likely to be negative impacts on recreation, particularly fishing, and a general loss in ecosystem function.

Positive impacts of the scenario of actions include:

- a reduction in nitrogen loads by around 20% from sugar producers at virtually no cost;
- subsequent reductions in a number of other loads from the implementation of best management practice (e.g. pesticide loads including ametryn, atrazine, diuron, hexazinone, and/or tebuthirion);
- reductions in urban diffuse and point source loads (i.e. 10-11,000 kg nitrogen per annum after 10 years); and
- significant benefits in terms of risk mitigation to the tourism industry and the recreational fishing industry.

Implementation issues

Through programs such as Reef Rescue, hundreds of small on-ground projects are being implemented across the Wet Tropics region across multiple sectors (sugar, grazing, diary horticulture (bananas and papaw).[344] These actions should continue, However, given the makeup of land use in the region and the fact that grazing and horticulture both have high levels of adoption of best practice, options to significantly reduce loads from those sectors will be limited without imposing significant economic costs.

Implementation strategies for the Barron need to be broader than those for the wider Wet Tropics region as there is a relatively higher proportion of horticulture land use and there are major risks attributable to future urban growth.

The key lessons for the implementation of the HWMP are that there should be a very focussed effort on enhancing practices in cane production in the region because there are significant opportunities to exploit win-win situations in sugar by targeting the 90% of the area of production that is subject to either C or D practices. In effect, the

344 For example in 2010-11, 213 Reef Rescue projects were funded in the Wet Tropics. The cost of those projects was about $10 million, and Ref rescue funding accounted for about 40% of total project costs.

available data suggests nutrient loads could be reduced by around 20% while delivering higher financial returns to producers.

Given the opportunities in sugar, policies should be specifically designed to overcome impediments to practice change including information, extension, innovative market approaches to mitigate the risks of practice change (insurance-like approaches) and to overcome the capital investments required (loans for necessary capital). These approaches would enable significant reductions in loads to be achieved at a much lower cost than current approaches employed under Reef Rescue.

The other area of focus is to address future load risks attributable to urban diffuse loads. While these loads would normally be addressed by implementing WSUD, in some circumstances WSUD is a relatively high cost in addressing loads. There may be significant efficiency gains possible through the establishment of water quality offsets, where some urban development loads that are extremely costly to mitigate on site are offset by developers purchasing actions that mitigate loads from farmers.

15.1 Introduction

The Barron-Trinity Inlet region[345] encompasses most of Cairns and is around 215,265 hectares, it includes the Barron River, which is one of the region's largest easterly flowing waterways, at more than 165km in length.[346] The Barron-Trinity Inlet HWMP area encompasses the entire Barron River catchment, including Lake Tinaroo, Trinity Inlet, and the coastal plain to the north of the Barron River to Wangetti (the Northern Beaches). The Barron River is the most modified river in the Wet Tropics region.[347]

Agriculture is a relatively significant land use within the region accounting for approximately 27.5%. Grazing, dairy, sugarcane and bananas are the main agricultural activities undertaken in the region. In recent years there has been a reduction in dairying. Livestock grazing is particularly significant, comprising 30.1% of the land area.

Residential land use is a relatively significant intensive land use in the region, comprising 4.9% of the land area. The region covers most of the SLAs in Cairns. Other significant land uses include nature conservation (21.6%), and forestry production (17%).

This section applies the framework outlined in Section Two to the potential actions in the Barron-Trinity Inlet HWMP. The scenarios assessed are based on:

- the Barron-Trinity Inlet Draft HWMP and other information from Terrain Natural Resource Management;
- potential diffuse urban source actions discussed with DEHP officials; and
- application of best practice environmental management to new WWTPs in larger urban centres.

345 For most of the analysis in this section the Barron region was concorded to consist of these Statistical Local Areas (SLAs): Cairns – Barron (100%); Cairns - Central Suburbs (100%); Cairns - City (100%); Cairns - Mt Whitfield (100%); Cairns – Northern Suburbs (100%); Cairns – Western Suburbs (100%); Atherton (100%); Cairns – Trinity (95%); Mareeba (77%); Eacham (27%); Cairns Pt B (4%). Where it was not possible to split the data, the region is taken to include the whole of Cairns (Barron, Central Suburbs, City, Mt Whitfield, Northern Suburbs, Western Suburbs, Trinity); .Atherton and Mareeba.

346 Barron, F. and Haynes, D. (2009) *Water Quality Improvement Plan for the Catchments of the Barron River and Trinity Inlet,* Terrain NRM.

347 Ref 2.

15.2 Social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key issues relevant to the development of the HWMP. This socio-economic profile is based on the 2006 Australian Bureau of Statistics (ABS) Census of Population and Housing.

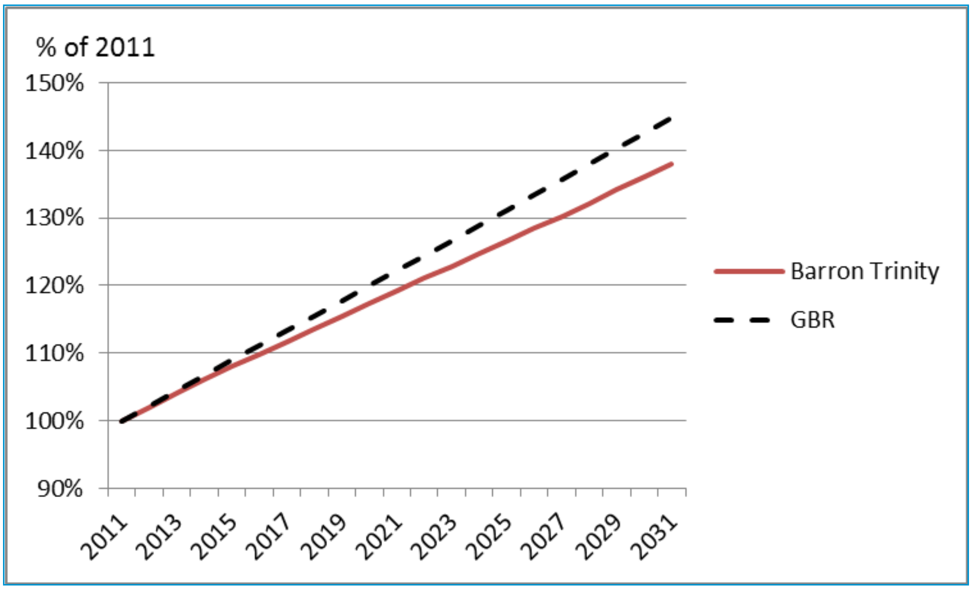
15.2.1 Demographic makeup

Population

From the 2006 Census, it is estimated that the population of the Barron-Trinity Inlet HWMP region was around 147,881.[348] Figure 35 below shows the historic and forecast population growth for the Barron-Trinity Inlet HWMP region compared with all of the HWMP regions assessed in this report.[349] Figure 40 indicates:

- significant population growth is expected across the HWMP regions over the next 20 years; and
- the Barron-Trinity Inlet region's rate of growth is likely to be slightly higher than for the GBR as a whole over the medium term, dropping to slightly less than the GBR as a whole in the later part of the projection period. Population growth in this region is driven by population growth in Trinity Inlet.

Figure 40: Population growth projections (Barron-Trinity Inlet and all GBR HWMP regions)



Source: MJA based on DLGPSR and ABS 2011 census.

Population and demographic statistics of note include:

- unlike much of the GBR, the population of the Barron-Trinity HWMP region has almost equal proportions of male and female residents;

[348] This estimate is based on ABS census data concorded (best-fitted) to the Barron-Trinity Inlet HWMP region by OESR. Population estimates are based on a census participant's usual place of residence.

[349] Based on DLGPSR Population Forecasting Unit's mid-estimates for each relevant LGA concorded to HWMP boundaries.

- in the 2011 census, 9.4% of respondents identified themselves as being Aboriginal or Torres Strait Islander in the Barron-Trinity HWMP region, compared with around 3.6% for the whole of Queensland;
- approximately 20% of people in the HWMP region were not born in Australia and around 5% of the population speak a language other than English at home.[350] To the extent that these people are targeted for programs under the HWMPs, there may be difficulties in effective engagement.

Community capacity

Issues relating to the community's capacity to participate in natural resource management include the following:

- approximately 18 of adults (>15 years old) participate in voluntary work, potentially indicating somewhat low levels of social capital. This rate is considerably lower than HWMP regions such as the Fitzroy with greater proportion of the population in primarily rural areas.351 Females had higher levels of participation in volunteer work 20%, compared with males (at 16%). However, the ABS census data does not indicate what type of volunteer work was undertaken;
- Barron-Trinity Inlet has a higher incidence of low-income families than the State as a whole. Approximately 14% of families in the Barron-Trinity Inlet HWMP area are on low incomes (i.e. less than $500/week), compared with 8% for the State; and
- household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In Barron-Trinity, approximately 58% of homes are owned or are being purchased. This compares with a State average of 55%.

The ABS SEIFA is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad way of making relative comparisons of social and economic resources between regions. Three indices of most relevance are:[352]

- the Index of Advantage–Disadvantage is a continuum of advantage to disadvantage. Low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments, and rental properties; and
- the Index of Education and Occupation includes all education and occupation variables.

These indices were concorded to the HWMP regions to enable comparisons of each HWMP region to all of the regions assessed in this report and to Queensland as a whole.[353] Results are shown in Figure 41.

---

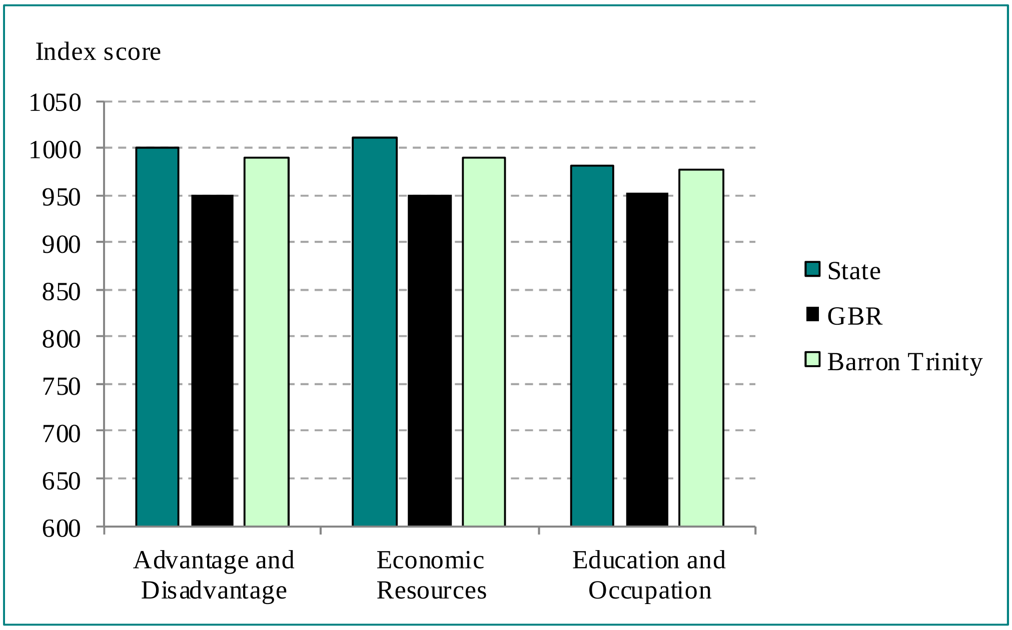
350 Based on analysis of 2006 ABS census data.

351 Levels of participation in voluntary community activities are often used as a proxy indicator of social capital in a community.

352 ABS, 2001, 2039.0 *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas, Australia*, 2001.

353 MJA estimated concorded index scores for each HWMP region using concorded population figures to derive each LGA's SEIFA score to the overall HWMP SEIFA score.

Figure 41: SEIFA indices



Source: MJA based on ABS 2006 census SEIFA indices.

Analysis of the data indicates:

- relative to the State and the GBR as a whole, Barron-Trinity Inlet is at an advantage;
- economic resources in Barron-Trinity Inlet are significantly higher than the GBR region as a whole but below the State; and
- education and occupation data indicates that the region is worse off than the State, but better off than the GBR as a whole.

As shown in Table 94, education levels in the Barron-Trinity Inlet region are generally higher than the GBR average, but lower than for Queensland.

Table 94: Educational attainment

Highest education level completed	Barron(% of pop)	Average for GBR (% of pop)	QLD (% of pop)
Year 10	17.9	21.3	19.8
Year 12	34.7	30.1	37.2
Certificate or diploma	23.2	22.2	21.9
Undergraduate degree	8.2	6.6	9.3
Postgraduate degree	1.5	1.1	2.2

Source: ABS Census of Population and Housing.

15.2.2 Employment and labour force

Labour force statistics in Table 95 indicate that agriculture, forestry and fishing are less significant employing industries in the Barron-Trinity Inlet than in other GBR regions, or in Queensland. Mining and manufacturing are also less significant employing industries in the Barron-Trinity Inlet region than in other GBR regions or in Queensland as a whole. This reflects the fact that the Barron-Trinity Inlet HWMP area covers Cairns city which is a significant urban area.

Retail trade and accommodation, cafes and restaurants, often used as a proxy for the tourism industry when taken together are more important in the Barron-Trinity Inlet region than for the GBR as a whole. This reflects the importance of tourist sector to employment in the region.

Reflecting the relative diversity of the Barron-Trinity Inlet economy compared with other GBR regions, no employing industry has a particularly high specialisation ratio. The specialisation ratio is the ratio of the percentage for the region to the percentage for Queensland.

Table 95: Labour force statistics

	Number			Percentage		
	Barron-Trinity	GBR	Qld	Barron-Trinity	GBR	Qld
Agriculture, forestry and fishing	1,789	23,546	54,563	2	5	3
Mining	1,277	27,793	51,656	2	6	3
Manufacturing	4,026	34,978	169,025	5	8	8
Electricity, gas, water and waste services	949	6,962	24,764	1	2	1
Construction	6,862	40,558	179,947	9	9	9
Wholesale trade	2,457	13,561	73,377	3	3	4
Retail trade	9,430	46,833	214,617	12	11	11
Accommodation and food services	7,281	32,649	140,036	9	7	7
Transport, postal and warehousing	4,948	24,591	104,924	6	6	5
Information media and telecommunications	682	3,588	25,282	1	1	1
Financial and insurance services	1,289	6,317	53,833	2	1	3
Rental, hiring and real estate services	1,532	7,086	36,875	2	2	2
Professional, scientific and technical services	3,970	18,497	131,921	5	4	7
Administrative and support services	2,819	12,383	64,185	4	3	3
Public administration and safety	6,475	30,251	135,586	8	7	7
Education and training	6,250	33,080	160,241	8	7	8
Health care and social assistance	9,901	47,500	240,017	13	11	12
Arts and recreation services	1,311	4,210	28,418	2	1	1
Other services	3,236	17,688	78,157	4	4	4
Not stated	1,954	10,814	22,913	2	2	1
Total	**78,438**	**442,885**	**1,990,337**	**100%**	**100%**	**100%**

Source: ABS Census of Population and Housing, 2006. The categories are based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) 1993.

15.2.3 Economic structure

The structure of the economy can provide some indication of a region's capacity to change in response to natural resource management policies or programs. Table 96 indicates the economic structure of Barron-Trinity Inlet's economy indicated by business counts by industry. Key points to note include:

- unlike other regions in the GBR, Barron-Trinity Inlet has a smaller proportion of businesses registered in the agriculture, forestry and fishing industry than Queensland;
- accommodation and food services, which relates to the tourism industry, comprises 4.9% of business counts for the Barron-Trinity Inlet region. This is slightly higher than the

proportion for Queensland, at 3.6%, and reflects the importance of tourism to the region's economy;

- construction has a higher share of the business counts in Barron-Trinity Inlet, at 20.1%, than for Queensland with 18.8%. This reflects the population growth in the region, particularly around the Trinity Inlet;[354] and
- Barron-Trinity Inlet is different from other GBR regions in that its economic base relatively diversified (although reliant on tourism-related industries). This may indicate that policies implemented as part of the HWMP will have less of an impact on Barron-Trinity than on other, less diversified regions that are more reliant on primary industries.

Table 96: Counts of registered businesses by industry, Barron-Trinity Region, 2008–09

Industry	Barron-Trinity Region		Queensland	
	Number	%	Number	%
Agriculture, forestry and fishing	1,504.0	9.3	46,624.0	11.1
Mining	90.0	0.6	1,913.0	0.5
Manufacturing	616.0	3.8	18,193.0	4.3
Electricity, gas, water and waste services	27.0	0.2	1,039.0	0.2
Construction	3,244.0	20.1	78,768.0	18.8
Wholesale trade	385.0	2.4	13,442.0	3.2
Retail trade	1,242.0	7.7	27,747.0	6.6
Accommodation and food services	792.0	4.9	14,950.0	3.6
Transport, postal and warehousing	1,162.0	7.2	27,180.0	6.5
Information media and telecommunications	96.0	0.6	2,772.0	0.7
Financial and insurance services	900.0	5.6	25,827.0	6.2
Rental, hiring and real estate services	1,869.0	11.6	46,636.0	11.1
Professional, scientific and technical services	1,322.0	8.2	41,509.0	9.9
Administrative and support services	695.0	4.3	15,724.0	3.7
Public administration and safety	60.0	0.4	1,460.0	0.3
Education and training	180.0	1.1	4,559.0	1.1
Health care and social assistance	603.0	3.7	17,630.0	4.2
Arts and recreation services	233.0	1.4	5,313.0	1.3
Other services	757.0	4.7	18,591.0	4.4
Not classified	330.0	2.0	9,533.0	2.3
Total	**16,107.0**	**100.0**	**419,410.0**	**100.0**

Source: OESR, Queensland Regional Profiles citing Australian Bureau of Statistics, Counts of Australian Businesses, including Entries and Exits, June 2007 to June 2009, cat no. 8165.0. Note: For this data it was not possible to concord the Herbert region exactly, so it is taken as the SLAs of Cairns (Barron, Central Suburbs, City, Mt Whitfield, Northern Suburbs, Western Suburbs Trinity); Atherton and Mareeba.

Note: The classifications used are based on ANZSIC 2006.

[354] See this presentation from OESR: http://www.oesr.qld.gov.au/products/presentations-papers/latest-reg-pop-trends/latest-reg-pop-trends-2009.pdf.

Hence, the economic structure of Barron-Trinity Inlet has significant implications for the prioritisation, design and implementation of the HWMP.

Tourism

The Barron-Trinity region is relatively reliant on tourism, with many GBR tourists visiting the reef adjacent to Cairns and Port Douglas.[355]

Reef-based tourism is important for the Barron-Trinity Inlet region. Analysis of GBRMPA's EMC data indicates that an estimated 870,077 water-based tourist activities occurred in the Cairns-Cooktown Management Area region in 2010. This is roughly similar to the number of visitors for the Townsville-Whitsunday Management Area in 2010, but significantly more than for the Mackay-Capricorn management zone. There are potential risks to reef-based tourism and other forms of nature-based tourism industry from any loss in tourism attributable to water quality.[356]

Semi-structured interviews undertaken by MJA with approximately 15 dive operators across the GBR in 2008 indicated that any deterioration in reef and marine condition has a negative impact in the sector in two main ways. Firstly, operators are often forced to travel further offshore to find quality dive sites increasing operating costs and reducing profits. Secondly, if water quality is poor, dive tourists are less inclined to undertake subsequent dives during their current holiday or return to the region for dive holidays in the future.[357]

Agriculture

The key industry already the focus of best management practice is agriculture. Table 97 depicts the value and share of agricultural production for the eleven SLAs included in the Barron-Trinity Inlet catchment. The analysis shows:

- tropical crops (sugarcane and banana) are an important agricultural product in the Barron-Trinity Inlet region, consisting of 68.8% of the value of agricultural production, equivalent to $141.2 million. This indicates a significantly disproportionate reliance on sugar in the Barron-Trinity region. Crops make up a much less significant proportion of the value of agricultural production for Queensland as a whole, at 47.9%;
- livestock slaughterings are also a significant agricultural product in the Barron-Trinity region, accounting for 25.5% of the value of agricultural production, valued at $51.7 million. Livestock slaughtering comprises a much larger share of the value of agricultural production for Queensland as a whole at 47.4%; and
- livestock products make up only 6.1% the value of agricultural production in the Barron-Trinity Inlet region, valued at $12.4 million. Livestock products comprise a lower proportion of the value of agricultural production in Queensland as a whole, at 4.8%.

355 Barron HWMP – Main Document.

356 GBPMPA, 2008, unpublished data.

357 MJA, 2008, *The economic contribution of the dive industry to the GBR.*

Table 97: Value of agricultural production by statistical local area, Barron-Trinity Inlet Region, 2005–06

Statistical local area	Crops		Livestock slaughtering		Livestock products		Total
	$M	%	$M	%	$M	%	$M
Atherton (S)	43.9	69.8	12.6	20.0	6.4	10.2	62.9
Cairns (C) - Barron	4.9	99.8	0.0	0.2	0.0	0.0	4.9
Cairns (C) - Central Suburbs	0.2	100.0	0.0	0.0	0.0	0.0	0.2
Cairns (C) - City	0.0	. .	0.0	. .	0.0	. .	0.0
Cairns (C) - Mt Whitfield	1.4	98.0	0.0	0.0	0.0	2.0	1.4
Cairns (C) - Northern Suburbs	0.4	100.0	0.0	0.0	0.0	0.0	0.4
Cairns (C) - Pt B	2.9	98.8	0.0	1.2	0.0	0.0	3.0
Cairns (C) - Trinity	14.3	98.8	0.2	1.2	0.0	0.0	14.5
Cairns (C) - Western Suburbs	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Eacham (S)	0.9	9.1	3.5	34.8	5.7	56.1	10.1
Mareeba (S)	72.2	66.9	35.4	32.8	0.3	0.3	107.9
Barron-Trinity Region	141.2	68.8	51.7	25.2	12.4	6.1	205.3
Queensland	4,167.9	47.9	4,125.2	47.4	415.8	4.8	8,708.9
Region as % of Qld	**3.4**	**. .**	**1.3**	**. .**	**3.0**	**. .**	**2.4**

Source: OESR Regional Profile, citing: Australian Bureau of Statistics, Agricultural Commodities, Australia, 2005-06, cat. no. 7125.0.

Note: . . = not applicable

Because some agricultural activity occurs in the Barron-Trinity Inlet region, some attention should be placed on prioritisation and development of programs to address reductions in nutrient load, particularly as the community may have more scope to adapt to these changes. Analysis of other key headline agriculture data indicates:

- Barron-Trinity Inlet accounts for around 1.5% of the total cropping area in the GBR;[358] and
- it is estimated that the Barron-Trinity Inlet region accounts for 1.2% of the GBR's fertiliser use.

15.3 Pollution loads

Pollution loads in the Barron-Trinity are both from natural sources, as well as from the consequences of changes in land use and land management. Load estimates are shown in Table 98.

Table 98: Estimated pollution loads in the Barron-Trinity (tonnes/year)

Load	TSS	TN	TP
Natural load	250	224	26
Baseline	770	480	50
Total	1,020	704	76
Total - % of natural loads	408%	314%	292%
Total - % of Wet Tropics	**8%**	**55%**	**4%**

Source: Kroon F, Kunhert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J and Joo M, 2010, Baseline pollutant loads to the Great Barrier Reef. CSIRO.

While this data is only for a subset of pollutants, the key points to note are that sediment and nutrient loads are now in excess of three times natural loads, and that the Barron-Trinity is a relatively significant source of pollutants in the Wet Tropics region, particularly for phosphorus (33% of regional loads). The major contributors to the loads above are primary industries (particularly grazing and sugar) and, to a lesser extent, more intensive land uses such as urban development, industrial development, mining, and linear infrastructure development (e.g. roads).

15.4 Potential actions

As noted above, HWMPs are currently being developed for the Barron-Trinity, Johnstone, Russell and Mulgrave catchments. HWMPs will build on the significant work already completed and work underway to:

- update land use data to better understand the sources of loads; and
- assess key management actions and the potential efficacy of changing practices. The focus is on the grazing, cane, banana and pawpaw industries and sub-catchment specific practices are being developed in conjunction with each catchment community.

The HWMPs will then form the basis of a detailed set of implementation activities to reduce pollution loads from rural activities.

In addition, actions to mitigate the risk of loads from other sources should also be developed, specifically urban diffuse loads and point source loads from regulated emitters (e.g. wastewater treatment plants, mines).

358 ABS, 2008-09, *Land Management Practices in the Great Barrier Reef Catchments, Preliminary, 2008-09* (cat. no. 4619.0).

15.4.1 Scenario One: Do nothing more

Under this scenario:

- no further actions are undertaken within the auspices of the HWMP to address sediment and nutrient loads; and
- no specific actions are undertaken with respect to addressing urban diffuse and point source loads.

15.4.2 Scenario Two: A suite of changes to practice

This scenario would build on the current actions being undertaken in the region (often at least partially funded by Reef Rescue or Caring for Our Country). The current actions could be summarised categorised into two broad categories.

Firstly, there are a number of research, planning and governance activities that have been undertaken or are continuing. This includes research into the sources of loads, effective means to reduce loads, the identification of environmental objectives and values, and the establishment of plans and policies to underpin on-ground actions.

The second suite of actions that will make a direct impact on pollution loads is the provision of rants to underpin practice change. This includes grants to assist with initiatives such as improved herbicide management (e.g. hooded sprayers in sugar), improved nutrient management (e.g. subsurface fertiliser application, stool splitters in sugar), improved soil management (e.g. zero till, GPS controlled traffic farming), improved groundcover (e.g. for horticulture and cattle), soil detention basins, laser levelling (sugar and horticulture), riparian plantations and rehabilitation, permanent fencing and watering points (dairy and cattle), effluent reuse systems (dairy).[359]

The focus in developing the HWMP to date has been very much on rural diffuse loads. Urban diffuse loads are largely being managed through initiatives such as the Environmental Protection (Water) Policy 2009, while significant point-source loads are managed as environmentally relevant activities under the *Environmental Protection Act 1994.*

The environmental values and water quality objectives for the region are currently being finalised through a process of scientific analysis and consultation. Under the HWMP, a further suite of actions will be prioritised and proposed to reduce pollutant loads from diffuse and point sources. These actions will enhance water quality in the freshwater and marine environment and enhance relevant environmental values across the region and adjacent areas of the GBR. Given the fact there are no finalised actions and targets for the region, MJA has assessed a number of actions, specifically:

- for rural diffuse loads, a progressive increase in the proportion of landholders adopting current best management practice (B practices) and moving from what are currently considered poor practices to more acceptable practices (i.e. D practice to C practice). It should be noted that there is insufficient detail in existing data to distinguish the benefits and costs of individual practices. Rather, broad incremental movement between suites of practices are assessed;
- future urban developments will need to consider the Healthy Waters State Planning Policy. This will largely involve implementing best practice urban design for water

359 For a comprehensive list of funded projects see: www.terrain.org.au/programs/production/reef-rescue-wqig.html

quality and drainage recommended in the Urban Stormwater Queensland Best Practice Environment Management Guidelines; and

- where identified, point source loads will be addressed via upgrades to wastewater treatment plants and actions by mines in the region.

15.5 Potential impacts of HWMP

As part of the planning processes priority waterway assets and the values derived from those assets have been identified through the Barron Trinity Inlet WQIP.[360] Investment under this plan will have a number of positive environmental, social and economic impacts on the extent and condition of those assets. Key impacts are briefly outlined in Table 99. The extent to which those benefits can be achieved will be determined by the resources available and the efficiency of interventions and investment under the HWMP.

[360] Barron, F. and Haynes, D. (2009).Water Quality Improvement Plan for the catchments of the Barron River and Trinity Inlet. Terrain NRM.

Table 99: Potential benefits of HWMP

Key benefits	Key elements and values
Maintenance of wetlands	The region has approximately 1,460 ha of wetlands, approximately 2% of all wetlands in the Wet Tropics. The HWMP will reduce risks to the extent and quality of many of those wetlands.[361]
Water treatment	The benefits in avoided or deferred water treatment are not known, but are likely to be positive. Evidence from analysis in SEQ indicates that changes in turbidity impact on short-run costs (changes in electricity and chemical usage and changes in sludge management costs), but that the long-term costs of avoiding treatment plant augmentations are often more significant.[362]
Wastewater treatment	Where actions up the catchment enable avoiding or deferring future investment in wastewater treatment, benefits are in the range of $77,000 to $200,000 per tonne of nutrients per annum.
Commercial fishing	Maintenance of ecosystem functions to underpin the commercial fishing industry.
Recreational fishing	Maintenance of ecosystem functions to underpin recreational fishing.[363]
Tourism	Enhancements in water quality would provide benefits to several areas of the tourism sector to maintain the region's attractiveness to visitors, particularly given the region's high proportion of reef-based tourism activities.
Visual amenity	Positive impact on visual amenity and housing prices in relevant areas.
Improved gross margins for farmers	Analysis undertaken by CSIRO indicates that gross margins can actually be increased in the longer term through improvements in practices, particularly incremental improvements from D practices to C practices, and C practices to B practices.[364]
Maintaining ecosystem function	Previous research indicates that a 1% enhancement in GBR coastal water quality is worth around $7.82 per household per year. This translates to around $450-500,000 per annum for the residents of the Barron-Trinity alone.[365]

Source: MJA.

15.6 Potential costs of HWMP implementation

This section briefly outlines our estimates of some of the more significant costs of reducing water pollution loads in the Barron-Trinity region. Because the HWMP process is yet to determine the preferred suite of actions, MJA has modelled a number of costs that would relate to some of the more likely actions under the HWMP.

361 Anon 2011. Reef water quality protection plan report card.

362 KBR 2009. Valuing the natural asset investigating the impact of water quality changes on water treatment plant costs.

363 Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

364 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

365 MJA estimates based on Windle and Rolfe 2006, *Non-market values for improved NRM outcomes in Queensland*.

15.6.1 Costs of rural diffuse actions

Rural diffuse actions will primarily relate to actions by cane producers, beef producers and horticulture producers. Table 100 shows the estimates of uptake of management practices by growers in 2009 which relate to rural diffuse loads (the dominant source of loads).

Table 100: Adoption of management practices – % of growers (Wet Tropics)

Load	Sugar %	Horticulture %
A – cutting edge practices	1	37
B – current best practice	9	37
C – common or code of practice	44	15
D – practices considered unacceptable by industry or community standards	46	11

Source: Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

While there is significant variability in the results depending on particular types of management regimes (e.g. nutrient management, herbicide management and soil management), the key point to note from the data is that there is significant scope for enhancing practices and consequently reducing pollutant loads.

MJA has developed an economic model to estimate the potential cost of achieving load reductions from rural diffuse sources. The model is based on:

- data on the area of each major production system (e.g., sugar) under different management regimes (A, B, C, and D) as outlined in the table above;
- previous modelling of the potential efficacy of different management regimes (measured as pollution load (runoff & leached)); [366] and
- data on likely changes in gross margins[367] attributable to different production systems transitioning between different state conditions.

Scenarios of management actions that result in higher proportions of farmers undertaking improved management practices can then be modeled to develop broad estimates of changes in loads (TSS, TN, TP) and the likely costs[368] of achieving those load reductions.

Sugar

For the purposes of this report, it is assumed that the area of sugar production in the Barron-Trinity is 31,600 ha (based on State land use mapping analysis) and that the dominant soil type for sugar production is well drained sandy loam. Furthermore, it is assumed that the adoption rates of management practices are currently the same as for the broader Wet Tropics region. Using the economic model developed for this report, MJA has modeled a number of scenarios. These scenarios are outlined in Table 101 below. They reflect a number of feasible paths of

366 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship.

367 Gross margins are simply the difference between sales revenue and the production costs, excluding fixed costs such as overheads, interest payments and tax. Changes in gross margins will be the net impact of both any changes in yields (and subsequent revenues) and changes in inputs costs.

368 It should be noted that the costs included in this model are the substantive costs of practice change (i.e. additional capital expenditure and changes in operating costs). They do not include administrative and other transaction costs.

improvement over time as growers progressively improve from their current practices to current best practice (B practice) and beyond (A practice).

Table 101: Hypothetical scenarios modelled – changes in practice regimes

	% of area			
Scenario	**A**	**B**	**C**	**D**
Current	1	9	44	46
Scenario 1	1	20	55	24
Scenario 2	1	50	45	4
Scenario 3	1	80	19	0
Scenario 4	1	99	0	0

Source: MJA analysis.

Table 102 below shows MJA's estimates of changes in annual nutrient loads and the cost of achieving those load reductions.

Table 102: Scenarios modelled – changes in practice regimes

Scenario	Approximate regional load reduction (kg/N/annum)	% Change from current loads	Change in region's annual gross margin ($ million)
Current	N/A	N/A	N/A
Scenario 1	120,000	-8	+1.1
Scenario 2	250,000	-17	+3.1
Scenario 3	310,000	-20	+4.7
Scenario 4	330,000	-22	+5.6

Source: MJA analysis.

The analysis shows that significant reductions in nutrient loads from cane could be achieved without necessarily impacting on regional productivity and gross margins. The analysis shows that a program of continuous improvements in practice would actually increase total regional gross margins. This is largely due to the fact that CSIRO analysis suggests that yields per hectare are approximately 3-4% higher for A and B practices than for inferior practices.[369] Our modelling indicates that it may be theoretically possible to reduce nutrient loads from cane production by 50% if all producers were implementing A practices.

However, the analysis does not consider the capital investments that are often required to enhance practices. Analysis undertaken by CSIRO suggests that, even when capital costs are also included, there is still a net financial benefit over a 10-year period from incremental improvements between categories of practice (e.g. C to B). The exception to this rule is moving from B practices to A practices, where the capital investments to move from B to A practices are almost twice the investment from moving from C to B practices. Table 103 below summarises the net economic costs over a ten year period to transition between classes of practice and the annual cost of pollution abatement.[370]

369 Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship.

370 Based on a typical 120 ha farm.

Table 103: Costs of transition between classes of practices (120 ha farm)

Transition	Present value practice change ($/ha)	Pollution abatement – N ($/kg/year)	Comments
B to A	-489	-31	Transition investment approx. $90,000 plus significant savings in nitrogen use
C to B	615	39	Transition investment approx. $60,000 plus significant savings in nitrogen use
D to C	611	38	Significant savings in nitrogen use

Source: MJA based on Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National Research Flagship.

The key point to note from this analysis is that there appears to be significant and sufficient private financial gains for most producers to move to current best practice. This could reduce nitrogen runoff and leaching by around 20%. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as insurance-like approaches), and action to overcome problems in accessing capital.

However, reducing nitrogen loads beyond around 20% from current levels would result in significant costs to producers and change should not be expected beyond that point without more costly policy interventions (e.g. financial incentives).

Cattle

State land use mapping data indicates that grazing potentially accounts for about 65,000 hectares or 25% of the landmass of the Barron-Trinity region. Data for groundcover in pastoral areas indicates that the mean dry season groundcover over the 1986-2009 period is 93%, significantly above the Reef Plan target of 50%. Furthermore, only around 1.2% of grazing lands had groundcover below 50%.[371] For this reason, specific analysis of the economic impacts of enhancing grazing practices in the Wet Tropics is very limited. However, studies undertaken elsewhere have shown that there are significant environmental (lower loads) and economic (high margins) from maintaining appropriate groundcover and undertaking best practice grazing management.[372]

The data overall indicates that there is likely to be more potential gains in focusing on sugar and horticulture growers to reduce loads, as opportunities in grazing may be limited.

Horticulture

State land use mapping data indicates that horticulture potentially accounts for about 4,300 hectares (1.7%) of the landmass of the Barron-Trinity region. Bananas and papaw are probably the dominant crops in the region and bananas are typically used as the default crop for assessments of options to reduce water pollution from horticulture.

[371] Anon, 2011, Reef Water Quality Protection Plan. First Report 2009 Baseline. Chapter 7.

[372] For example, see Roebeling., P, and Webster. J, 2004, Financial-Economic Analysis of Management Practices in Beef Cattle Production in the Douglas Shire. Report on the Cost-Effectiveness of BMP Implementation for Water Quality Improvement.

As with sugar and grazing, an A, B, C, D framework has been developed for horticulture management practices.[373] Furthermore there are a number of key management practices that can be adopted such as inter-row management[374] and efficient fertiliser application rates that can result in reductions in fertiliser application by almost 50% from around 520 kg/ha to 225 kg/ha.[375] Much of these improvements are already underway, reflected in the fact that almost 75% of producers in the Wet Tropics are already implementing A or B practices.

Table 104 below summarises the net economic costs over a ten year period to transition between classes of practice.[376] To date, there is insufficient data to estimate the actual cost of abatement such as nitrogen (i.e. $/kg/annum) although research is progressing in this area.[377]

Table 104: Costs of transition between classes of practices (60 ha farm)

Transition	Present value practice change ($/ha)	Comments
B to A	-6,600	Transition investment approx. $420,000 plus significant savings in nitrogen use
C to B	15,600	Transition investment approx. $160,000 plus significant savings in nitrogen use.
D to C	21,700	Significant savings in nitrogen use.

Source: Van Grieken, M. E., Webster, A. J., Poggio, M., Thorburn, P., Biggs, J., Stokes, C. and McDonald, C., 2010. Implementation costs of agricultural mainstream practices for water quality improvement in the GBR. Water for a Healthy Country National research Flagship.

The key point to note from this analysis is that there are likely to be significant and sufficient private financial gains for the 26% of producers at C or D practice levels to move to current best practice (i.e. B practice). This would further reduce sediment, nitrogen and other chemical runoff without negatively impacting on the industry's profitability. Given these potential private gains, interventions should be targeted at overcoming impediments to changed practice – for example, information and extension, actions to underpin the risk of practice change (such as insurance-like approaches), and action to overcome problems in accessing capital.

15.6.2 Cost of urban diffuse actions

Actions to mitigate the risk of water pollution from urban diffuse loads are also likely to be a focus. In a practical sense this involves the establishment of WSUD as an underlying approach to future urban development.

373 Van Grieken, M.E., Webster, A.J., Coggan, A., Thorburn and P. Biggs, J., 2010. Agricultural Management Practices for Water Quality Improvement in the Great Barrier Reef Catchments. CSIRO: Water for a Healthy Country National Research Flagship.

374 Roebeling, P. C., Webster, A. J., Biggs, J. and Thorburn, P, 2007, Financial-economic analysis of current best management practices for sugarcane, horticulture, grazing and forestry industries in the Tully-Murray catchment. Report to the Marine and Tropical Sciences Research Facility.

375 Armour J, and Daniells J, 2001, Banana nutrition in north Queensland. Final Report FR95013 to Horticulture Australia Ltd.

376 Based on a typical 60 ha banana farm.

377 For example, see Armour, J., Davis, D., Masters, B., Whitten, M and Mortimore, C. (2011). Paddock Scale Water Quality Monitoring: Interim Report 2009/2010 Wet Season, Wet Tropics Region. Queensland Department of Environment and Resource Management, Australian Centre for Tropical Freshwater Research and Queensland Department of Employment, Economic Development & Innovation for Terrain Natural Resource Management, Australia.

The costs of urban diffuse actions will largely relate to the cost of implementing WSUD in new developments. Based on estimated population growth for the region and the current makeup of households, it is likely that around 1,350 new dwellings will be established each year over the next 10 years. Census data indicates that around 80-90% of residential dwellings in the region are detached houses. MJA has estimated the potential pollution loads reductions and related costs for WSUD implementation over the next 10 years Table 105 below).[378]

Table 105: Estimated cost of WSUD implementation in new developments and impacts on loads over next 10 years

Measure	Value
Number of new dwellings over next 10 years	13,500
Cost of establishing WSUD over next 10 years	$50-60 million
Reduction in TSS from business as usual after 10 years	2,000-2,200 tonnes per annum
Reduction in TN from business as usual after 10 years	10,000-11,000 kg per annum
Reduction in TP from business as usual after 10 years	3,000-3,500 kg per annum
Levelised cost of TSS abatement ($/tonne/annum)	$1,750-$2,150
Levelised cost of TN abatement ($/kg/annum)	$360-$450
Levelised cost of TP abatement ($/kg/annum)	**$1,110-$1,360**

Source: MJA analysis.

Urban diffuse actions in new developments have the potential to significantly reduce regional loads from a business as usual estimate after 10 years, at a cost of around $50-60 million. Estimations of levelised costs of abatement (that include both capital and operating expenditures) indicate that urban diffuse actions are significantly less cost effective than rural diffuse actions at reducing pollution loads.

15.6.3 Costs of other actions – focus on point sources

In addition to diffuse actions, there are likely to be options to reduce loads from point sources such as wastewater treatment plants and the limited mining activity in the region.

Point sources – wastewater treatment plants

There are major wastewater treatment plants in the region servicing larger population areas including Cairns, Kuranda, Mareeba and Atherton. Due to population growth, capital investment in augmentation of these plants is likely to be necessary in coming years. Most other areas are services by either wastewater pumps are by site-specific septic systems.[379]

The establishment and upgrades to WWTPs are often a key action of governments to meet multiple regulatory requirements. The costs of WWTP upgrades are driven by the engineering capital and operational costs and are specific to the actual plant.

378 Estimates of load reductions and capital costs are based on MUSIC modelling estimates for small-detached housing developments in the Cairns climatic zone – specifically the use of bio-retention basins. See Water by Design (2010) A Business Case for Best Practice Urban Stormwater Management. Costs were derived from the same study and inflated to current terms using the Brisbane consumer price index. Levelised costs are based on all estimated capital, operations and maintenance, and refurbishment costs over a 25 year period.

379 Cairns Regional Council (2008) Local Disaster Management Plan.

MJA undertook analysis of expenditure data[380] for recent upgrades from secondary to tertiary treatment for several WWTPs in South East Queensland (data for other WWTPs was not available). MJA estimates the costs of treatment ranges from $76,000 to $200,000 per tonne of nutrients per annum.

Point sources – other environmentally relevant activities

The sugar sector on the region is serviced by sugar mills including the Tableland Mill near Mareeba. There is some mining activity in the region that will also be regulated. There will be other relatively point source emitters in the region, particularly industrial firms around Cairns. However, data on emissions and related expenditure is not available at the scale of the Barron-Trinity region.

15.7 Economic and social considerations for implementation of the HWMP

The analysis in previous sections indicates there is significant scope to reduce water pollution from changes in land management. This is particularly for sugar cane where there is significant scope to reduce nutrient and other loads. Horticulture also accounts for a relatively high proportion of land use within the context of the sector in the Wet Tropics and there are already a very high proportion of growers that are meeting current best practice. Opportunities for load reduction from grazing are limited due to the very high proportion of graziers who are already meeting best practice groundcover targets.

A major driver of growth in loads will be the rapid and substantial growth in urban diffuse loads and point source loads attributable to population growth.

While there is only cost information for a subset of actions to reduce loads, available data indicates there is very significant variation in the cost effectiveness between actions and industries. This is shown in below Table 106.

Table 106: Relative costs of water pollution abatement - nitrogen

Source	Approximate costs ($/kg/annum)	Comments
Rural diffuse – cane BMPs	-$31-+38	Significant scope for reductions and enhancing industry commercial outcomes
Urban diffuse - WSUD	$360-450	Limited scope to contribute material reductions in loads
Point sources - WWTPs	$76-200	Implementation will form part of infrastructure provision for regional growth

Source: MJA analysis.

380 Data provided by Queensland EPA.

The key lesson for the implementation in the Barron-Trinity is that, because there are multiple sources of water pollutants and variability in the cost of abating water pollution, there are likely to be significant economic efficiency gains from targeting public investment at lower cost abatement opportunities and harnessing market-like opportunities where available, specifically:

- sugar provides the greatest opportunity for reducing nutrient loads at the lowest cost to the community;
- horticulture also presents significant opportunities to reduce loads at little or no cost to the community; and
- for both sugar and horticulture, the key area of focus should be to facilitate producers at C or D practice levels to move to current best practice (i.e. B practice). This would further reduce sediment, nitrogen and other chemical runoff without negatively impacting on profitability.

The other area where efficiency gains could be made would be to consider the development and use of water quality offsets where some of the growth in loads from urban diffuse loads could be offset by on-ground actions in sugar. This would enable regional load reduction to be achieved at a lower cost.

Given the opportunities in sugar and horticulture, policies should be specifically designed to overcome impediments to practice change.[381] Given the fact that moving from D to B practices pay financial dividends in the longer term, impediments to change are likely to be:

- *knowledge-based*: some producers may not be fully aware of the economic benefits of enhancing practices. This would indicate information and capacity development approaches would be most appropriate such as agronomic and economic extension.
- *risk:* many producers may perceive the commercial risk of changing practices to be too risky. These risks could be mitigated through demonstration farms in conjunction with extension. Furthermore, the use of approaches such as an insurance-like product to underpin the risk of practice change would be worth considering. Such an approach would only make a payment to a producer where their implementation of new practices actually reduced yields (when benchmarked against district averages). This approach has most applicability in sugar; and
- *Capital*: moving from C to B practices and B to A practices both require capital investments. However, these capital costs are recouped over time. Therefore, it should be possible to accelerate practices through the provision of low cost or no-interest loans to overcome any impediments to practice change due to limitation of access to capital.

In the longer-term, the public funding of these approaches would largely be limited to program design and delivery as any investments in on-ground change would be ultimately financed by producers themselves. This would be significantly more cost effective than current approaches being adopted under the Reef Rescue initiative.

These approaches, in conjunction with harnessing market-like approaches such as water quality offsets should enable the objectives of the HWMP.

381 Greiner., R and Grieg., D, (2010) Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. Land Use Policy Volume 28, Issue 1, January 2011, pages 257–265.

Part C: Appendices

Appendix A: Key sector snapshots

Appendix A provides some high-level snapshots of key sectors that either impact on water quality in the WQIP catchments, or are impacted by changes in water quality. The purpose of this appendix is to provide information on the economic and market context within which the WQIPs were assessed. Sectors covered include:

- primary industries including beef, sugar, horticulture, commercial fishing and aquaculture;
- tourism; and
- other industrial users.

Primary industries

There are a number of primary industries that act as both a risk to water quality values and are reliant on water quality to maintain production values. In some industries this can occur often simultaneously. Agricultural prospects in the GBR catchments are driven by a number of factors including: international and domestic market environments (e.g. exchange rates, competition, market access); demand–pull factors (e.g. population growth, incomes, tastes); supply–push factors (e.g. productivity trends, biotechnology, R&D); institutional factors (e.g. quarantine); and natural resource management issues (e.g. BMPs and regulations).[382]

Beef production

The beef cattle industry has both an impact on water quality via land management and land use and is reliant on water quality as a business input, essentially for stock watering. The beef cattle industry is the largest agricultural producer in Queensland, and is a key industry in the GBR. There are over 4.6 million beef cattle in the WQIP regions, with an estimated value in excess of $1.1b.[383] The Queensland beef industry is forecast to have a gross value of production of $3.5b in 2006–07. [384]

The growth in the beef sector in recent years has heightened the level of interest in land management and the impacts on water quality. While the average size of cattle properties in Queensland has remained relatively stable in past 15 years,[385] the intensity of land use has increased as cattle numbers per property has increased.

Figure 42 indicates the growth in average heard size over the past 15 years. Herd sizes fluctuate in response to market conditions and physical issues such as drought. The risk to water quality is that in the absence of improved natural resource management practice, an increasing intensity of grazing is likely to lead to lower ground cover and greater risks of erosion.

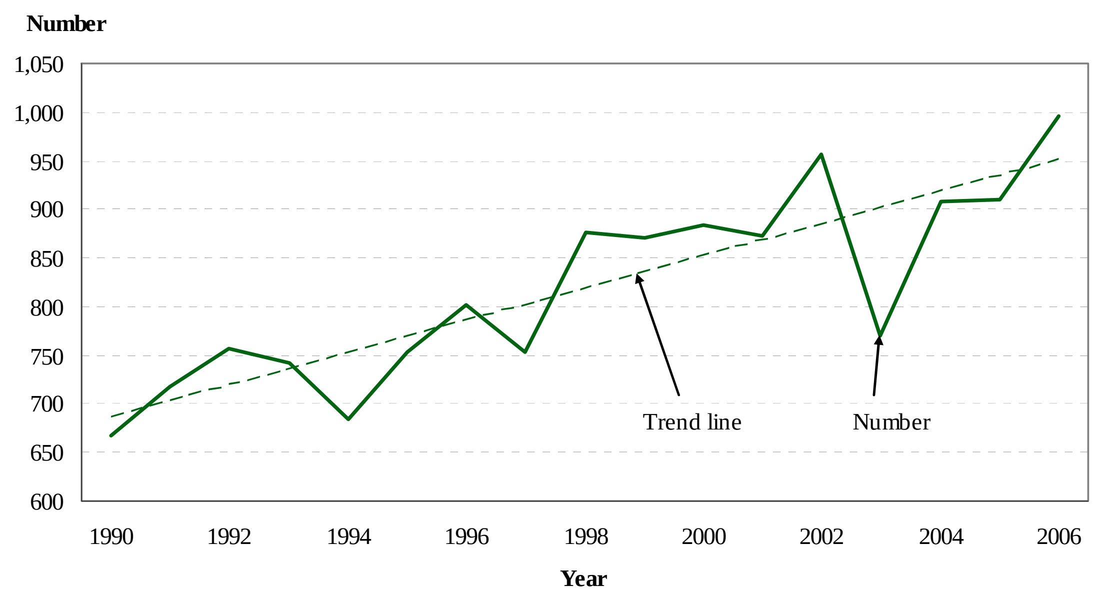
382 DPI&F, 2007, Future drivers of the Queensland food and fibre industry.

383 AgCensus 2001, MJA estimate.

384 DPI&F, 2006, Prospects for Queensland's primary industries 2006–07 March edition.

385 ABARE 2007, *AgSurf database*.

Figure 42: Average herd size



Source: MJA. Derived from ABARE AgSurf data.

Recent favourable beef prices are one of the main drivers behind the increasing intensity of cattle on the land. In real terms, Australian sale-yard prices are projected to average 230 cents per kilogram (in 2006–07 dollars) in 2011–12.[386]

Debt levels have also increased significantly in recent years. Interest payments are primarily a fixed cost and, while there are some opportunities to rearrange payments between periods by, for example, using farm management deposits, interest payments must generally be met, even during downturns. Servicing this higher level of debt might increase grazing pressure during drought and could also serve as a constraint to improved natural resource management.

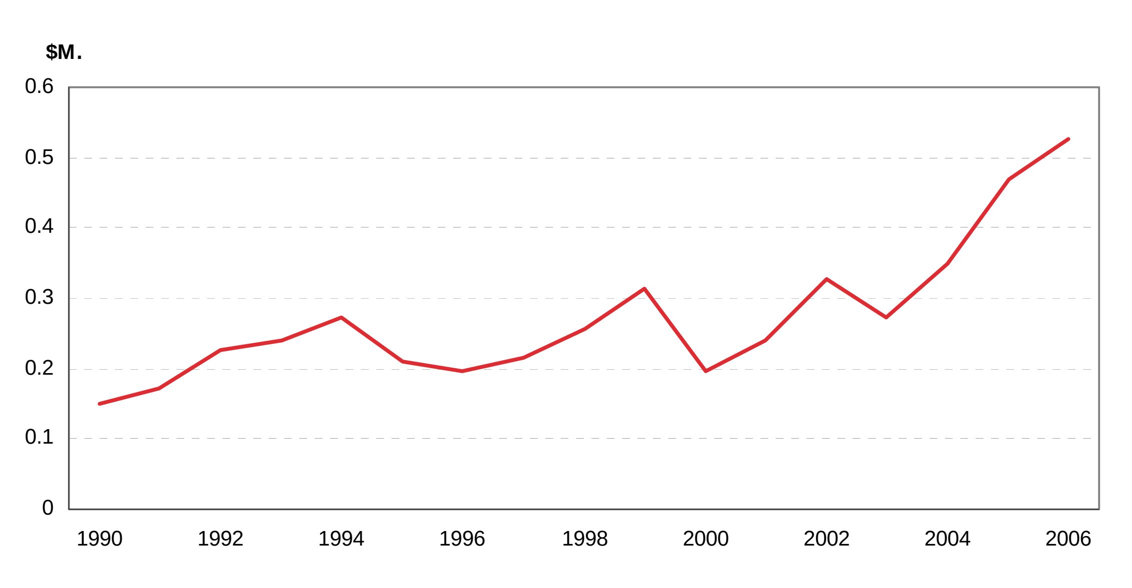
Higher fixed costs create both a driver of erosion risk, via pressure to work the country harder, and a financial constraint on implementing management practices that negatively impact on farm cash flows. This theory was supported by a strong negative correlation between grass cover and farm debt in the Burdekin.[387] However, there is also some evidence that landholders also see farm debt as a business management tool that minimises their income tax liability and maximises their assets.[388] If farm debt is part of a farm business plan, and is manageable, then it may be less likely to have an impact on natural resource management practices.

386 ABARE, 2007, *Australian Commodities: March 2007.*

387 Greiner et al., 2007, Incentives to enhance the adoption of ‘best management practices’ by landholders.

388 Greiner and Lancaster, 2006, *Debt-for-conservation swaps — a possible financial incentive for on-farm biodiversity conservation?*

Figure 43: Average farm debt ($m)



Source: MJA, derived from ABARE AgSurf data.

The higher debt also reflects changes to the capital value of farms. While average rates of return based on farm cash flows, which should underpin capital appreciation, typically fluctuate in the -2% to +3% range, rates of return including capital appreciation have been significantly higher for several years. In effect, capital values do not reflect farm cash-flows.[389] ABARE analysis of interest payments as a proportion of average farm receipts indicates a significant increase in the relative impact of interest payments in northern Australian operations, where interest payments now account for almost 12% of farm receipts, compared to long-term averages of around 8%.[390]

There are significant economic drivers forcing an intensification of land use for pastoral activities, which, in turn, can increase the risks of land uses that cause erosion. In addition, the higher levels of fixed costs associated with pastoral enterprises constrain the ability of farmers to adopt practices that reduce erosion impacts, particularly in periods of low income, including drought.

Sugar production

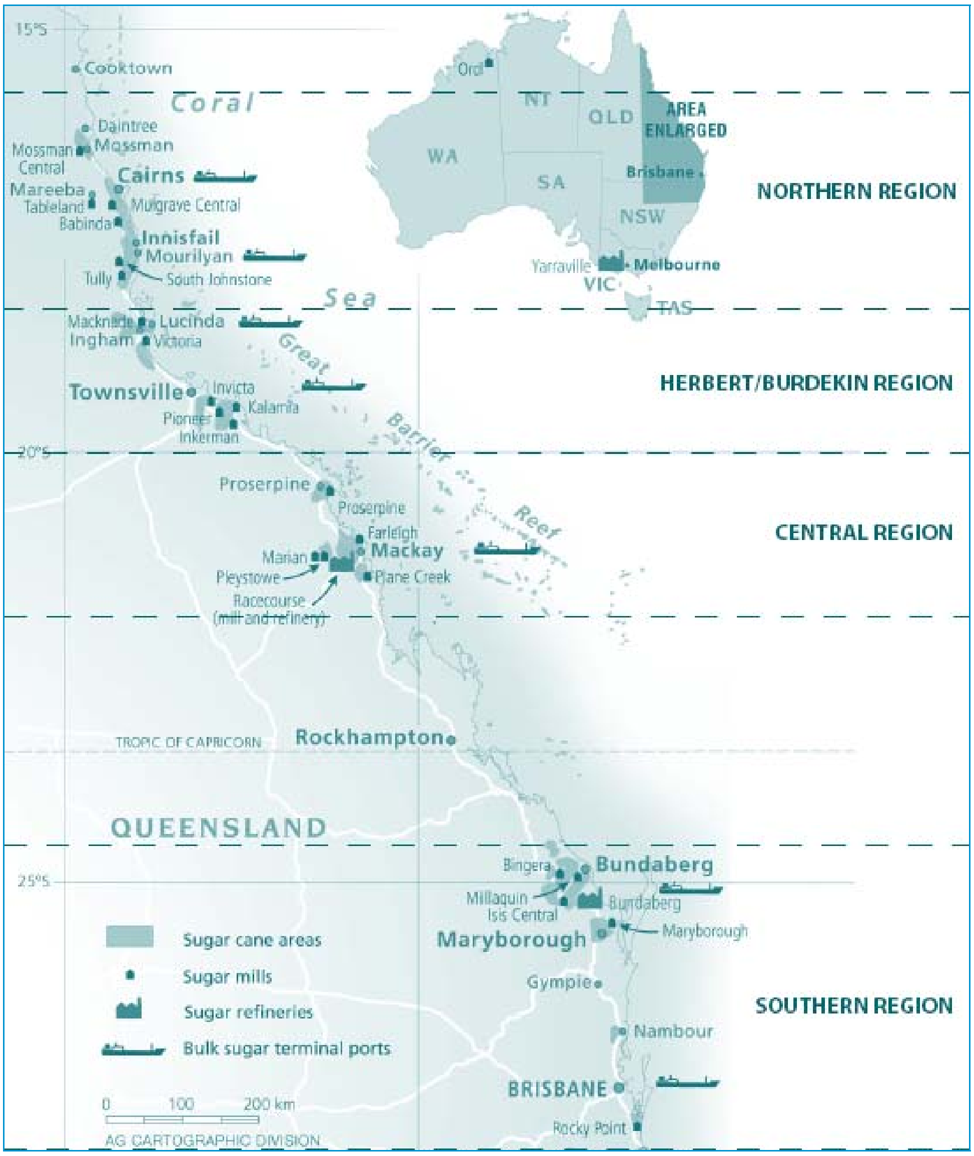
Similar to pastoral activities, sugarcane production provides both a risk to water quality, particularly nitrogen and phosphate associated with fertilisers and other chemical associated with pesticides. However, the sector also relies on good water quality to ensure yields are maintained. Sugarcane is another major industry in the GBR. The last agricultural census showed that almost 845,000 hectares of land in the WQIP regions is under sugarcane production. [391]

389 ABARE, 2007, *AgSurf.*

390 ABARE, 2007, *Australian Beef 07.2*

391 MJA estimate, *Ag Census 2001.*

Figure 44: Queensland sugar producing regions



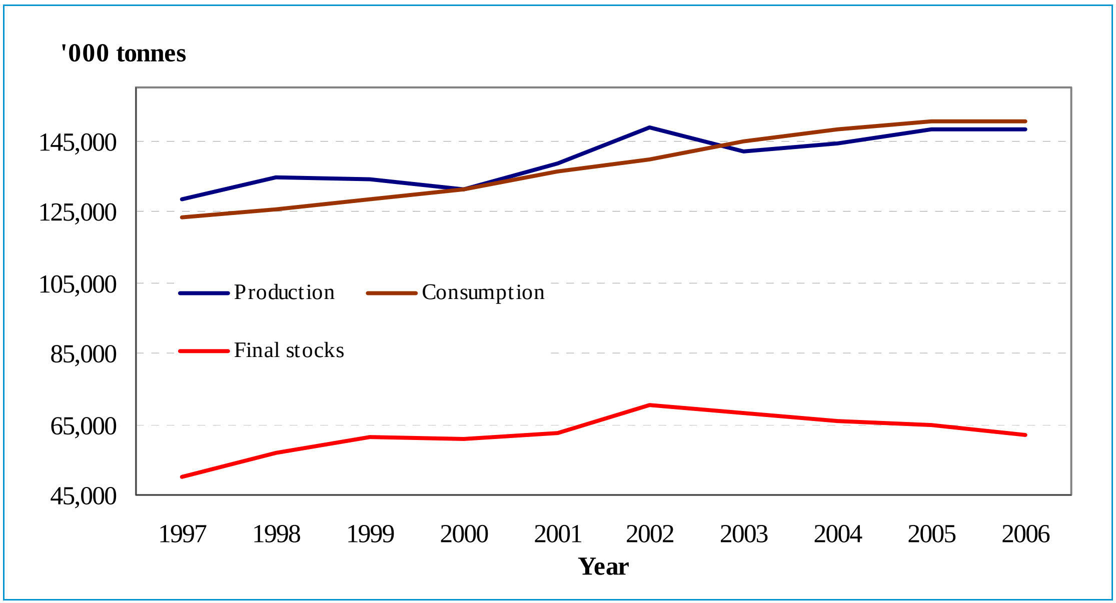
Source: Australian Sugar Million Council.

The Queensland sugarcane industry was forecast to have a gross value of production of $1.095b in 2006/07 (DPI&F, 2007).[392] Sugar is an internationally traded commodity and prices, and often production levels, are driven by development in the world market. Annually, around 40 million tonnes of raw sugar is traded on the world market. Australia, along with the European Union, Brazil, Guatemala and Thailand dominate sugar export trade.

Figure 45 shows the world sugar balance – production, consumption and stocks in thousand tonnes of raw material. It shows that consumption growth, typically around 2% per annum, in the last 3-4 years has marginally outstripped production growth, resulting in a draw-down in worldwide stockpiles and maintenance of reasonable prices.

392 DPI&F, 2006, Prospects for Queensland's primary industries 2006–07, March edition.

Figure 45: World sugar balance

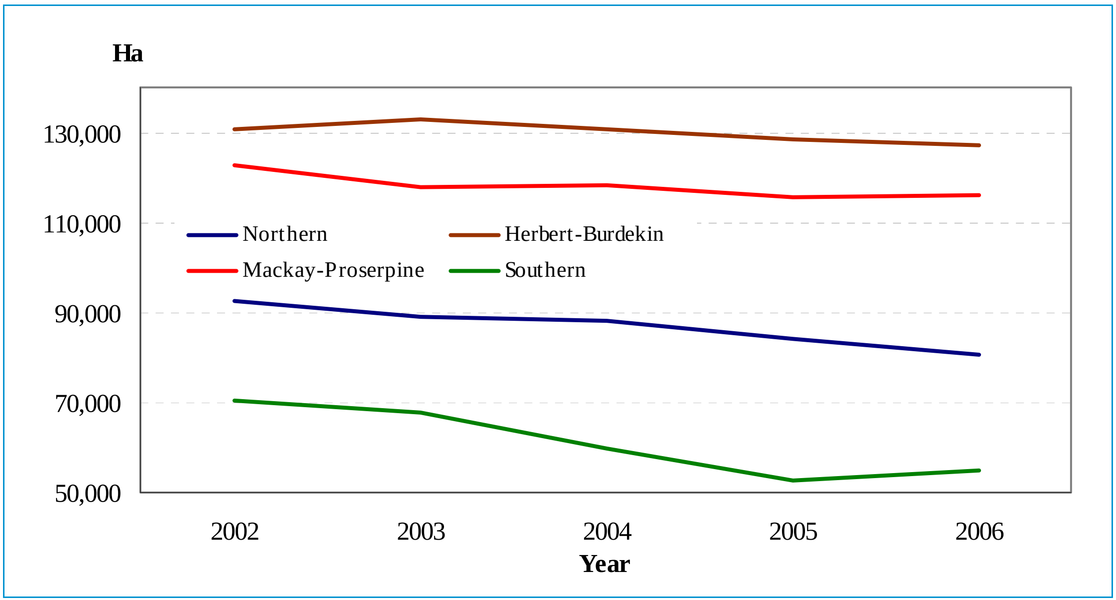


Source: Australian Sugar Million Council.

Figure 46 shows the recent trends in areas harvested for milling. The data shows a downward trend in production, particularly in the southern region in response to the recent slump in the sector and the closure of the Moreton Mill.

However, the northern region has also demonstrated a decline in areas under production. This is despite a general increasing worldwide trend in production over the same period.

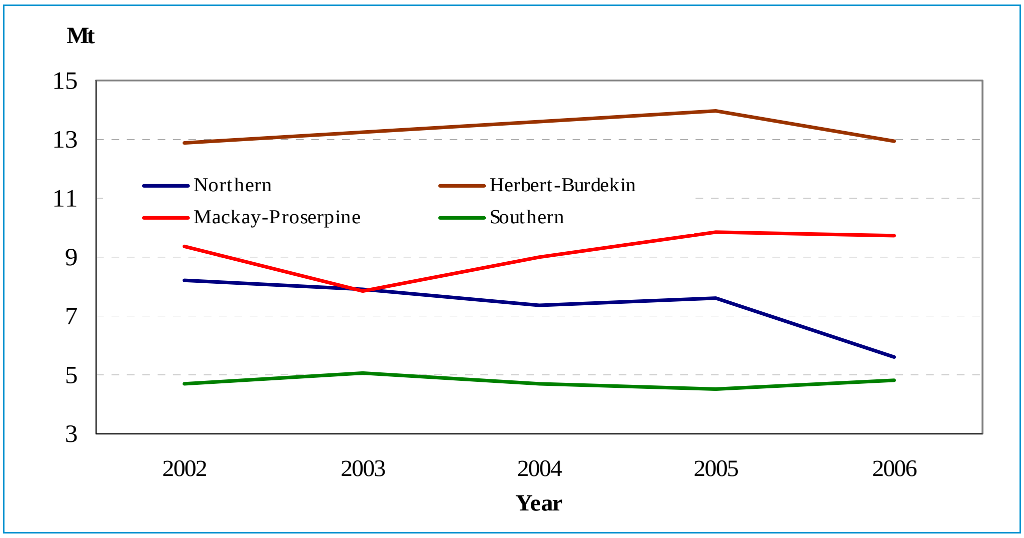
Figure 46: Area harvested for milling (ha)



Source: Australian Sugar Million Council.

Figure 47 shows the recent trend in production (cane crushed) across Queensland. Unlike the areas of cane harvested, total production has remained relatively steady in recent years, with the exception of the northern region. Recent growth in production levels in the Herbert–Burdekin and the Mackay–Proserpine regions have been attributable to higher yields per hectare, not a change in land use from other uses to irrigated sugar production. Current sectoral forecasts provide little evidence (if any) that there is likely to be any material changes in land use towards sugar in the short- to medium-term, despite significant suitable soil and water availability in regions such as the Burdekin.[393]

Figure 47: Cane crushed (Mt)

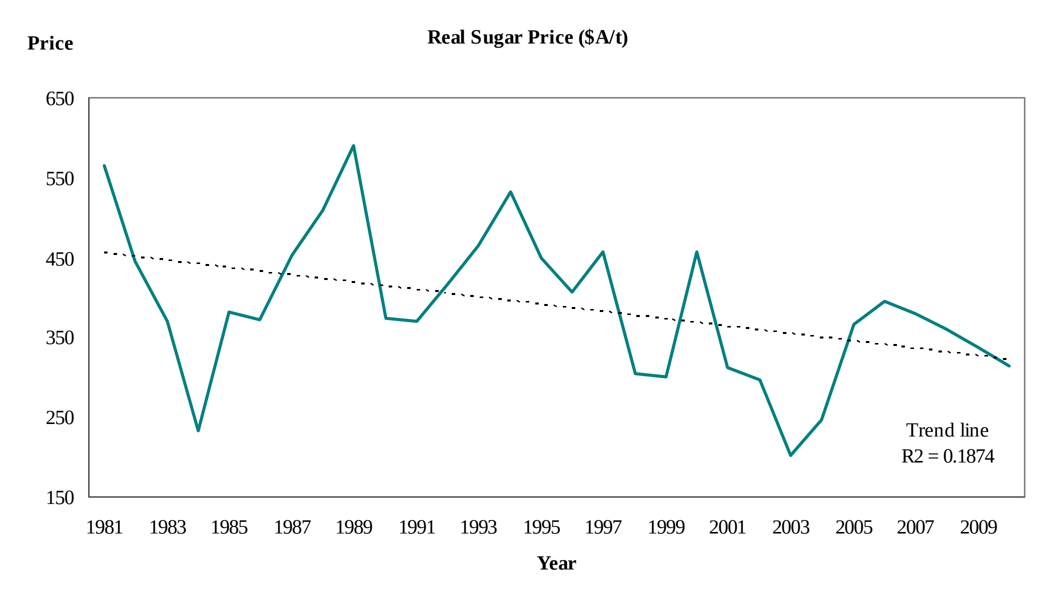


Source: Australian Sugar Million Council.

As the majority of Australian sugar is exported, the price that cane producers receive is dictated by global trends in sugar demand and production. In particular, the supply of sugar from Brazil controls the global price. Figure 48 shows the real price of sugarcane from 1981 until 2009 (projected). Despite the price increases between 2003 and 2005, the overall trend is still declining.

[393] Marsden Jacob Associates, 2007, *Burdekin horticulture processing industry development strategy: 'investment ready' by for major tropical and semi-tropical horticulture processing by 2010.*

Figure 48: Long-term trend in sugar prices



Source: Marsden Jacob Associates, 2007.

ABARE forecast[394] that Australian sugar production will increase by 10 per cent to 5.1 million tonnes in 2007-08 as a result of recovery from Cyclone Larry and the disease sugar smut.[395] Despite the lower prices and constraints on expansion, in the longer term, sugar production is expected to continue rising slowly. A 4% increase in sugar production is predicted by 2011-12 due to higher yields and sugar content (CCS), not from material increases in areas under production.[396]

If this increase in productivity is achieved without intensified use of resources such as fertiliser, or major expansions in the area under production, then the pollutant loads from the sugar sector in the absence of positive actions are likely to remain stable in the short- to medium-term.

Horticulture production

The horticulture production sector has seen significant change in recent years due to changes in domestic and international demand, changes in competition and changes in industry structure. This has been accelerated by a move towards greater levels of 'product transformation' to enable producers of normally perishable products to access markets further from the production source. There has been significant growth in horticultural production across the GBR catchments in recent years. Figure 49 shows the growth of total fruit and total vegetables for Queensland over the past 10 years, much of which has occurred in GBR catchments. The value of production in the GBR catchment in 2001 was $860.5m.[397]

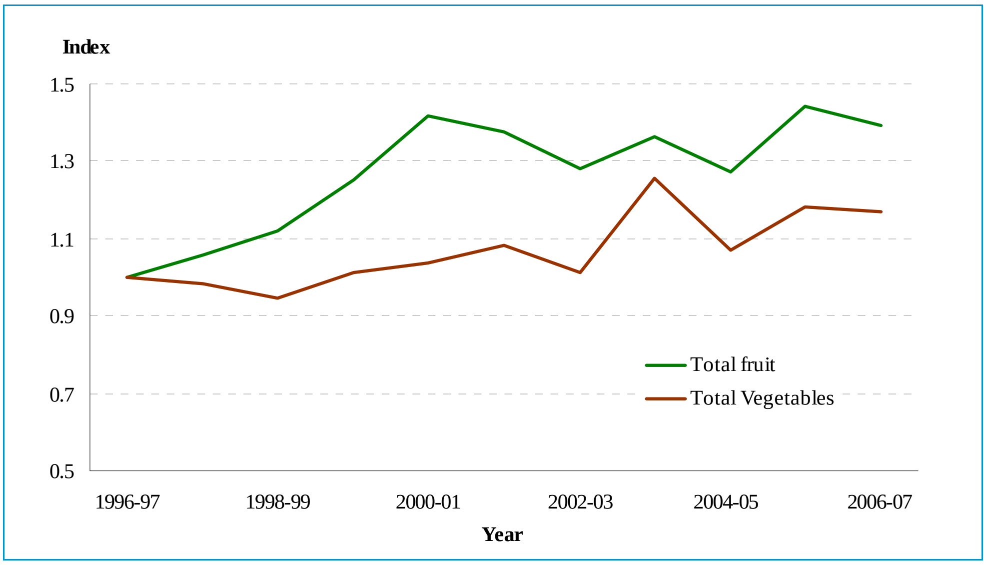
394 Underlying data for this forecast was sourced from ABARE, *Australian Commodities—Forecasts and Issues*. Various issues. In addition, contextual information from a number of other sources was considered including the *Independent Assessment of the Sugar Industry* by Clive Hildebrand in 2002 and research by the Centre for International Economics including the papers *Cleaning up the Act: the impact of changes to the Sugar Industry Act 1999* and *Unshackling Queensland Sugar*. Note: The statistical fit of the trend line is relatively poor, reflecting the significant variation in sugar prices from year to year.

395 ABARE, 2007, *Australian Commodities*, March 2007.

396 ABARE, 2007, *Australian Commodities*, March 2007.

397 CDI Pinnacle Management and Street Ryan Associates, 2004, *The economic contribution of horticulture to the Queensland Economy*.

Figure 49: Index of horticulture production growth



Source: MJA analysis based on ABS and DPI&F data.

Horticulture production provides both a risk to water quality, particularly nitrogen and phosphorus associated with fertiliser and other chemical use associated with pesticides, as well as relying on good water quality to ensure yields are maintained.

Commercial fishing

The GBR supports commercial fishing operations. Commercial fishing had a gross value (direct and indirect) of $106m in 2004–2005 and supported around 1,000 full-time equivalent jobs.[398]

Key fisheries in the GBR[399] include the:

- East Coast Otter Trawl Fishery, of which about 70% occurs in the GBR marine park. Key sectors of the fishery include the tiger and endeavour prawn fishery (primarily between Cape York and Cape Conway); the northern king prawn fishery (predominantly north of Shoalwater Bay); saucer scallops (in the southern zone of the GBR); bugs and over 60 additional species of molluscs, crustaceans and finfish are taken as limited by-product. Most product is export-orientated;
- East Coast Reef Line Fishery primarily between Cooktown and the southern zones of the GBR. A mix of commercial, commercial charter and recreational fishing occurs for species such as coral trout, tropical snappers, red throat emperor, red emperor, and reef cod;
- East Coast Inshore Finfish Fishery, primarily operating in estuaries and tidal rivers and on the foreshore and adjacent waters. The commercial value of this fishery is estimated to be around $15m per annum, while there is also significant fishing effort from recreational and Indigenous fishers;
- commercial net fishery comprises some 300 fishing vessels operating in the GBR Marine Park and landing around 2,800 tonnes per year, valued at $15m; and

[398] Access Economics, 2005, *Measuring the economic and financial value of the Great Barrier Reef Marine Park.*

[399] GBRMPA, 2007, Fisheries — Great Barrier Reef Marine Park Authority, www.gbrmpa.gov.au/corp_site/key_issues/fisheries. Accessed 8 November 2009.

- East Coast Dive-Based Fisheries, primarily rock lobster, aquarium fish, and sea cucumber. The total value of the fishery is also estimated at around $15m per annum.

In July 2004, the GBR was re-zoned so that 33.3% of the Marine Park became a 'no-take zone'.[400] These zones represented areas with 10.51% of the historic catch, with a value of $13.68m.[401]

The principal benefits of enhancing water quality in the GBR catchments are the maintenance of ecosystem function for key fisheries.

Aquiculture

Aquaculture is another rapidly growing industry that is reliant on water quality to maintain commercial production, but also places significant risks on water quality, particularly via nutrient discharges. The industry is very sensitive to water quality, and while in the short term the main cost of water quality deterioration are increased treatment costs, in the longer term it is more likely that aquaculture enterprises might relocate to areas where water quality standards are maintained.

The industry, therefore, is likely to reap substantial benefits from actions and programs that protect or enhance water quality.

In the year ending June 2004, the Gross Value of Production (GVP) of the Queensland aquaculture industry was $72.5m, of which around $57.1m occurred in statistical divisions that are partly or fully within the GBR catchments. Employment in these areas equated to in excess of 560 full-time equivalent positions. This is shown in Table 107.

Table 107: 2003–04 Queensland aquaculture gate value, production, area and employment by Statistical Division partially or fully within the GBR

Statistical Division	FTE	%	Prod'n. (tonnes)	%	Area (ha)	%	Values ($m)	%
Wide Bay	88	16	268	7	149	14	6.1	11
Fitzroy	16	3	21	1	19	2	0.6	1
Mackay	64	11	516	13	262	25	7.7	13
Northern	174	31	1,748	43	345	33	25.4	44
Far Northern	219	39	1,500	37	262	25	17.3	30
Total	**561**	**100**	**4,053**	**100**	**1,037**	**100**	**57.1**	**100**

Source: Queensland Department of Primary Industries & Fisheries 2005.

GBR-related tourism

The tourism sector is a vital sector to the GBR catchments as much of the tourism activity is directly related to the enjoyment of natural areas, including those reliant on quality freshwater and marine environments.

Tourism is the most important commercial activity in the GBR catchments, outside of mining, when judging by GVP.[402] The total economic value (direct and indirect gross value) from

---

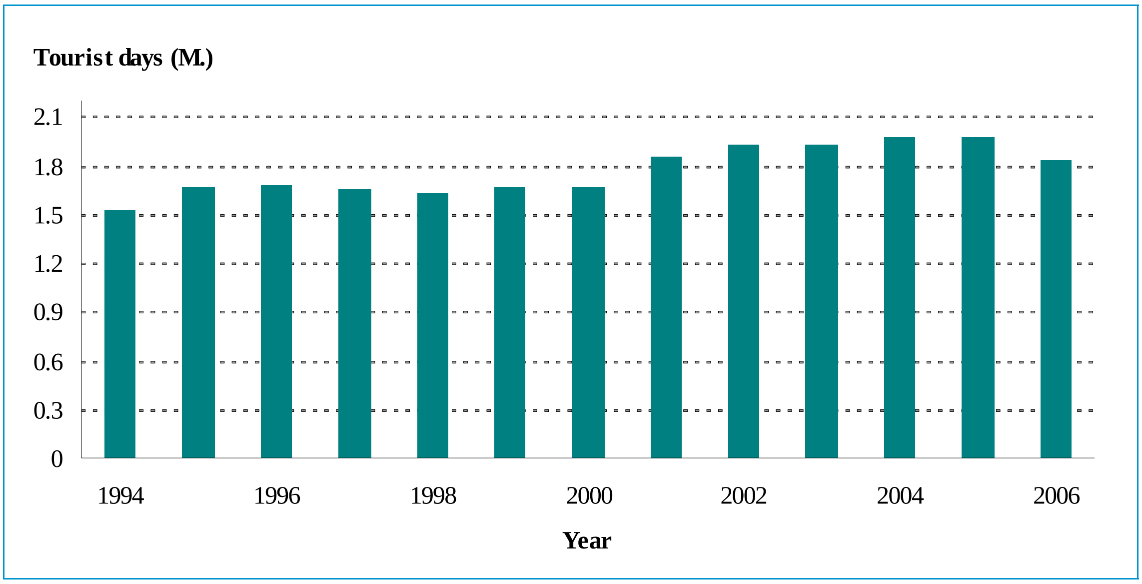
400 Access Economics, 2005.

401 Hand, T., 2003, *An Economic and Social Evaluation of Implementing the Representative Areas Program by Rezoning the Great Barrier Reef Marine Park.*

402 Hand, T., 2003, *An Economic and Social Evaluation of Implementing the Representative Areas Program by Rezoning the Great Barrier Reef Marine Park.*

tourism in the GBR was estimated at $3.6b in 2004-2005.[403] There were 43,000 full-time equivalents jobs associated with the industry in the same period. Approximately 1.9 million tourists visit the GBR each year.[404] There are approximately 840 tourism operators in the GBR with 1,700 tourism vessels.[405] Visitor day numbers have steadily increased since the mid-1990s, as can be seen in Figure 50.[406]

Figure 50: Visitor days to GBR



Source: GBRMPA.

Industry water use

Water use by industry is also significant in GBR regions. Major users include sugar mills, mines, and it is used as input to other manufacturing and industrial processes such as electricity generation, metals manufacturing and food and beverage manufacturing.

While some industries are highly reliant on good quality water, particularly those associated with food manufacturing, or where water must be certain specifications for cooling processes, water quality is probably less important to some other users such as coal mines where water is primarily used for washing coal and dust suppression.

There is also a trend in manufacturing towards greater levels of water reuse and recycling in the manufacturing sector across Australia. Water reuse across the sector doubled between 2000-01 and 2004-05 to 2% of total use. However, water reuse is highly concentrated in the petroleum, coal and chemical product sectors (59% of total reused water) and metal products (30% of total reused water).[407]

---

403 Access Economics, 2005, *Measuring the economic and financial value of the Great Barrier Reef Marine Park.*

404 http://www.gbrmpa.gov.au/corp_site/key_issues/tourism Accessed 8 November 2009.

405 http://www.gbrmpa.gov.au/corp_site/key_issues/tourism/tourism_and_recreation_in_the_great_barrier_reef_marine_park

406 http://www.gbrmpa.gov.au/corp_site/key_issues/tourism/management/gbr_visitation/numbers

407 ABS, 2006, *Australian Water Account 2004-05.*

Appendix B: Indicative cost schedules – site acquisition, rehabilitation, ongoing management and administration

Acquisition of site

Cost item/unit	Lower-bound estimate ($/unit)	Medium estimate ($/unit)	Upper bound estimate ($/unit)	Comments
Purchase site	Market value	Market value	Market value	Determined by market value.
Secure covenant (if applicable) (per land parcel)		120		Registry fee under the *Land Act 1994*. Fixed cost.
Purchasing land or permanent covenant—dairy (opportunity cost/ha).*	0	0	18	This is based on the present value of the estimated profit at full equity for Queensland. Variance is driven by suitability of country and commodity prices. These costs would be capitalised within land/covenant values for outright purchase or permanent arrangements. Variance is driven by suitability of country and commodity prices.
Purchasing land or permanent covenant—beef (opportunity cost/ha). *	0	27	110	This is based on the present value of the estimated profit at full equity for Queensland. These costs would be capitalised within land/covenant values for outright purchase or permanent arrangements. Figures are relevant for stewardship arrangements.
Purchasing land or permanent covenant—wheat and other crops (opportunity cost/ha).*	0	27	105	This is based on the present value of the estimated profit at full equity for Queensland. These costs would be capitalised within land/covenant values for outright purchase or permanent arrangements. Variance driven by suitability of country and commodity prices.
Purchasing partial land rights (cost per ha).* Far North QLD Central and South Grazing Lands South-East QLD	 544 40 50	 12,406 3,628 11,159	 71,825 14,362 121,306	This is based on the submitted bids to a program that included a perpetual covenant and a five year management plan. Costs vary depending on the level of agricultural production on the property, potential for sub-division, the region, the complexity of the management plan and the landholder themselves. As this was a competitive tender landholders were able to submit any price they chose, which means the prices might not be supported by local land values or true opportunity cost of joining the program.
Legal costs (per land parcel).*	555	2,223	3,889	Includes title searches (e.g. for encumbrances on the property), sale administration (e.g. conveyancing of land title) and registration. 1–7 days work for a legal officer.

Source: ABARE's annual farm surveys 1990–2005, as reported in http://www.abareconomics.com/interactive/agsurf/.

*Notes: * Based on the mean per farm for the period. Lower values truncated at zero. Lower and upper bounds within 1.6 standard errors of the mean, i.e. within a 90% confidence interval. A discount rate of 6% has been applied.*

Administration and transaction costs – site acquisition

Cost item/unit	Lower bound estimate ($/unit)	Medium estimate ($/unit)	Upper bound estimate ($/unit)	Comments
Search/negotiation/site plan establishment (small—medium size project) (per land parcel)[1]	3,065	9,196	15,327	Search costs may be high due to uniformed market. Costs are primarily based on time taken for negotiations. Significant variance depending on complexity of transaction (ranging from 40–200 hours input for a covenant agreement). Highly influenced by existing data and access/availability of information. Developers that are more familiar with the offset process and the land market are likely to face lower search costs. Larger/more valuable/multiple sites or properties with more than one owner tend to take longer (e.g. more meetings required). Significant cost efficiencies through centralised information management to reduce search time and costs.
Search/negotiation/ site plan establishment (large size project) (per land parcel)[2]	166,659	361,095	555,531	Same as for smaller sites.
Detailed site assessments (vegetation focus) and site management plan establishment (per 20 - 100 ha land parcel)[3]	2,000	2,500	3,000	Often incorporated into negotiation process. Site assessment includes a visit to the property (ranging from 2 hours to 2 days). Cost depends on the remoteness of the site, the condition of the property, the number of visits required the size of the property, the complexity of the management plan required to maintain desired ecological functions and prior knowledge of the contractor. Standardised site assessment process and management plans can assist in improving cost efficiency.
Cursory site assessments (vegetation focus) and site management plan establishment (per land parcel)[4]	153	307	1, 226	Often incorporated into negotiation process. Site assessment includes a visit to the property (ranging from 2 hours to 2 days). Cost depends on the remoteness of the site, the condition of the property, the number of visits required the size of the property, the complexity of the management plan required to maintain desired ecological functions and prior knowledge of the contractor. Standardised site assessment process and management plans can assist in improving cost efficiency.

Sources:

1. *EPA, based on experience with nature refuge program. Estimates based on top of a PO4 salary and a multiplier of 2 (to ensure consistency with in-kind valuations for NHT and other external programs). These numbers are supported by the Catchment Care auction which paid $85/hr to contractors to negotiate and implement their site visits, plans etc. Their grant process took 14hrs/funded property and the grant process 26hrs/funded property, including negotiation, plan, site inspection and mapping (Source: Bryan et al, 2005, Catchment Care––developing an auction process for biodiversity and water quality gains).$/unit) ($/unit).*
2. *EPA, based on experience with mine offset project. Estimates based on top of a PO4 salary and a multiplier of 2 (to ensure consistency with in-kind valuations for NHT and other external programs).*
3. *SEMF*
4. *Comerford, E. PhD thesis 2006. Based on the Vegetation Incentives Program. Estimates based on time reported by field officers, on a wage based on the top of a PO4 salary and a multiplier of 2 (to ensure consistency with in-kind valuations for NHT and other external programs).*

Water treatment infrastructure costs (wastewater treatment plants)

Cost item/unit	Lower bound estimate ($/unit)	Medium estimate ($/unit)	Upper bound estimate ($/unit)	Comments
WWTP upgrades - reducing nitrogen to 2 mg/L $/tonne/year[1]	200,000	500,000	800,000	Includes operating costs and capital costs (amortised over 20 years). Significant variation depending on current concentrations and existing treatment infrastructure.
WWTP upgrades – reducing phosphorus to 2 mg/L $/tonne/year[2]	35,000	55,000	75,000	Includes operating costs and capital costs (amortised over 20 years). Significant variation depending on current concentrations and existing treatment infrastructure.
WWTP upgrades - cost of reducing phosphorus to 5 mg/L $/tonne/year[3]	150,000	230,000	380,000	Includes operating costs and capital costs (amortised over 20 years). Significant variation depending on current concentrations and existing treatment infrastructure.
Water quality abatement (cost per kg of nitrogen)[4]	600	800	1,200	Cost based on the average cost of treating nitrogen. Cost varies depending on type of development.

Sources:

1,2,3: BDA group

4. Melbourne Water: http://wsud.melbournewater.com.au/content/stormwater_quality_offsets/stormwater_quality_offsets.asp

Site rehabilitation

Cost item/unit	Lower bound estimate ($/unit)	Medium estimate ($/unit)	Upper bound estimate ($/unit)	Comments
Revegetation (total cost per ha)[1]	905	2,809	8,474	Includes cost of project management, transport costs, site preparation, seed or seedlings, labour, fencing and other commonly encountered costs such as tree guards. Depends heavily on the type of revegetation being carried out, with assisted natural revegetation being the least expensive and rainforest regeneration in moist tropical regions being the most expensive. Offsets policy may determine what type of revegetation required. Factors impacting cost include accessibility of site, availability of seedstock, and extent of site preparation and follow up care.
Weed eradication (per ha)[2]	15	1,528	4,000	Cost includes materials and labour. Variability depends heavily on type of weed eradication method chosen. For example, grazing as a method of weed eradication is far less expensive than manual removal of weeds. Variability in costs also depends on size of site, accessibility, region and terrain. Landowners are legally responsible for controlling some weeds while other weeds may need to be eradicated based on the property management plan developed.
Chemical control of weeds by industry (cost per ha)[3]				Includes fungicides, insecticides, pesticides and herbicides for crop and pasture.
Grain	57	59	61	
Dairy	7	8	8	Non-chemical costs (mainly labour) also included.
Beef	1	1	1	
Cotton	198	215	231	Variability in costs depends on size of site, commodity type, accessibility, region and terrain.
Sugar	104	108	112	
Fruit	93	190	287	
Vegetables	92	179	265	
Pest eradication (cost per ha)[4]	10	148	500	Cost includes material and labour for pest control. Cost variable depending on the pest being targeted, severity of infestation and eradication method used. For example, chemical control of insect pests is less expensive than shooting of vertebrate fauna pests.
Establishing replacement wetlands—small (cost per ha)[5]	800,000	900,000	1,000,000	Should include site preparation, removal of exotic plants, establishment of new plants and property management for the establishment of the site. Cost will vary depending on size, prior condition of site, location of site (especially the choice between urban or rural land) need for water re-routing and availability of necessary plants and expertise. Likely to be significant costs over a fairly long period, as plants are progressively introduced.

				A well-run wetland mitigation bank would probably decrease transaction costs and lead to a better environmental outcome.
Establishing replacement wetlands—medium to large (cost per ha)[6] + establishment cost of $738,607	275,130	343,913	412,696	Should include site preparation, removal of exotic plants, establishment of new plants and property management for the establishment of the site. Cost will vary depending on size, prior condition of site, location of site (especially the choice between urban or rural land) need for water re-routing and availability of necessary plants and expertise. Likely to be significant costs over a fairly long period, as plants are progressively introduced. A well-run wetland mitigation bank would probably decrease transaction costs and lead to a better environmental outcome.
Fencing to exclude stock and pests[7] (per km of fence)	1,350	2,810	6,175	Includes materials (wire, posts and gates) and labour. Cost of depends on the shape of area to be fenced, the type of stock excluded and the nature of the terrain. Cashflow requirements heavily skewed towards the short term.
Establishing watering points (per watering point)[8]	3,758	4,175	4,593	Includes capital costs of troughs, reservoir, pipes and reticulation per watering point. Number of points required dependent on riparian zone excluded, existing access to riparian zone and number of cattle. Cashflow requirements heavily skewed towards short term.
Gulley treatment to reduce erosion /km treatment[9]	5,000	27,500	50,000	Treatment costs affected by current condition of gully, soil types, slope, vegetation requirements, requirements for engineering options. Significant cost saving potential through targeted site selection. Significant potential cost savings through choice of policy instruments (potential for use of MBIs to select and secure offset sites). Cashflow requirements heavily skewed towards short term.
Salinity mitigation ($/tonne of salt removed) [10]				These figures represent the net present value of the salt mitigation options. Cost will vary depending on many factors including availability of offset projects, value of other uses for project (e.g. sale of treated water).
Evaporative Basin (100 ha)	1,800	2,158	2,516	
Reverse osmosis	1,580	2,385	3,189	
Tree plantation	4,200	7,150	10,100	
Cap and pipe bores	1,850	2,565	3,280	

Sources and notes: see next page.

Sources:

1. *Schirmer, J and Field, J., 2000, T*he cost of revegetation. These costs are based on a ten ha project. The lowest, highest and average of median costs for all types of revegetation projects are used here.
2. *Schirmer, J. and Field, J., 2000, The cost of revegetation.* The lowest, highest and average costs for all types of fences outlined are used here.
3. *Sinden, J., et al, 2005,* the economic impact of weeds in Australia.
4. *Schirmer, J. And field, J., 2000, The cost of revegetation.* The lowest, highest and average of median costs for all types of revegetation projects are used here.
5. *CRC Catchment hydrology. Inputs for MUSIC model.*
6. *Lloyd, S.D., Wong, T, Chesterfield, C., 20002, WSUD: A stormwater management perspective.*
7. *Schirmer, J. and Field, J. 2000, The cost of revegetation. The lowest, highest and average costs for all types of fences outlined are used here. A figure of $25/hr for contractor labour was cited in the paper and was used in these estimates. A sample of the recent Vegetation Incentives Programme South-East Queensland participants gave a much greater range of $1,942/km, $8,386/km and $18,351/km (Comerford pers. comm.).*
8. *Sillard and Associates, 1999, Cost–benefit study of Riparian Restoration in the Mary River.*
9. *WBM Oceanics, 2005, Diffuse Source Best Management Practices: Review of Efficacy and Costs.*
10. *Patrick, I. and Wise, R., 2005, Technical, Economic and Institutional Assessment Of Environmental Offsets to Reduce Saline Water Discharge, University of New England.*

Ongoing on-ground site management

Cost item/unit	Lower bound estimate ($/unit)	Medium estimate ($/unit)	Upper bound estimate ($/unit)	Comments
Weed management (per ha)	30	135	240	Cost includes materials and labour for spot spraying after weeds eradicated. Depends on size of site, region, accessibility, and terrain and treatment type.
Pest management (per ha)	10	148	500	Costs same as for pest eradication and includes material and labour for pest control (e.g. baiting, shooting or chemical applications). Cost variable depending on the pest being targeted, severity of infestation and eradication method used. Likely to be at lower end of range for ongoing management of pests (as compared to pest eradication).
Fire breaks (per km)[1]	200	250	300	Includes construction and maintenance of fire beaks using a bulldozer. Costs at higher end of range for establishment of breaks. Actions need to be repeated periodically (e.g. every 2 years).
Destocking (annual opportunity cost/ha) – dairy[2]	0	0	1	This is based on the estimated profit at full equity for Queensland. Figures are relevant for stewardship arrangements. Variance driven by suitability of country and commodity prices.
Destocking (annual opportunity cost/ ha) - beef	0	2	6	This is based on the estimated profit at full equity for Queensland. Figures are relevant for stewardship arrangements. Variance driven by suitability of country and commodity prices.
Cessation of growing wheat and other crops (annual opportunity cost/ha)[3]	0	26	105	This is based on the estimated profit at full equity for Queensland. Figures are relevant for stewardship arrangements. Variance driven by suitability of country and commodity prices.
Carbon sequestration (cost per tonne)[4]	12.30	12.4	12.55	Based on the Sep–Nov 2006 price in the NSW Greenhouse Gas Abatement Scheme. Price depends on level of trading and availability of carbon credits.

Sources and notes: see next page

1. *QP&WS estimates.*
2. *ABARE's annual farm surveys 1990–2005, as reported in http://www.abareconomics.com/interactive/agsurf/. Based on the mean per farm for the period. Lower values truncated at zero. Lower and upper bounds within 1.6 standard errors of the mean, i.e. within a 90% confidence interval.*
3. *ABARE's annual farm surveys 1990–2005, as reported in http://www.abareconomics.com/interactive/agsurf/. Based on the mean per farm for the period. Lower values truncated at zero. Lower and upper bounds within 1.6 standard errors of the mean, i.e. within a 90% confidence interval.*
4. *Katoomba Ecosystem Marketplace, http://ecosystemmarketplace.com/pages/marketwatch.overview.aggregate.php?market_id=14.*
5. *Patrick, I. and Wise, R., 2005, Technical, Economic and Institutional Assessment Of Environmental Offsets to Reduce Saline Water Discharge, University of New England.*

Appendix C: The economic and social impacts of protecting the environmental values of the Fitzroy Basin waters
Report for DERM by MJA, May 2011

Executive summary

BACKGROUND AND STUDY PURPOSE

Under the Queensland Government's Environmental Protection (Water) Policy 2009, environmental values (EVs) and water quality objectives (WQOs) are being established for the Fitzroy Basin. EVs relate to the values or uses that are reliant on water quality, while the WQOs represent the measured quality of water required to sustain all values and uses for that waterway (e.g., salinity or sediment concentrations etc). EVs, management goals and WQOs are key parts of the framework for managing Queensland's water environment.

Marsden Jacob Associates (MJA) has been engaged by the Department of Environment and Resource Management (DERM) to undertake a desktop study to identify and scope the economic and social implications of protecting the EVs by achieving WQOs in the Fitzroy Basin. All rural diffuse, urban diffuse and point sources of pollutants are within scope of this report.

This report also incorporates updated data and additional information that became available during the recently completed consultation process.

KEY FINDINGS

Management of pollution loads into waterways provides a wide range of benefits both within those waterways, but also in the marine environment adjacent to the catchments in the Fitzroy Basin (part of the Great Barrier Reef (GBR)). The key socio-economic benefits of achieving the WQOs are derived from managing pollution loads and avoiding the costs to businesses and the community (including environmental costs) that would accrue from a further decline in water quality. The key socio-economic costs are the monetary costs of management actions to maintain or improve receiving water quality.

At a basin-wide scale, the dominant source of sediment and nutrient loads are from rural land use, particularly grazing. However, our analysis also demonstrates that a major source of water quality degradation risk in the Fitzroy Basin stems from point sources in the mining and energy sectors, and the associated flow-on economic activity. In the case of coal mines, the conditions of environmental authorities under the Environmental Protection Act 1994 were amended in 2009 to further address contaminated stormwater discharge to receiving waters, and this is reflected in the business-as-usual case of this report.

The key challenge for the implementation of effective policy may not be the management of average pollutant loads. Rather the challenge will be to manage the more extreme loads that follow above average rainfall events as it is those events that drive much of the risk to EVs.

Key benefits of meeting water quality objectives

Key socio-economic benefits (avoided costs) in the inland and the GBR areas of the Fitzroy Basin from achieving the WQOs relate to:

- human health: ensuring human health is maintained through reducing risks to water supplies and waters where human contact is likely;
- ecosystem function and services: provision of ecosystem function and services, most of which relates to the unpriced social values of protecting biodiversity and ecosystem function. Previous studies suggest that even a 1% change in the condition of inland waters health has a social value of around $11.6 million to the local community. Furthermore, benefits attributable to enhancing marine ecosystem function and services could be significantly higher, particularly if sediment reduction targets are met;
- primary industries, as a water dependent sector: primary industries with a gross value of production of approximately $1.2 billion per annum could be adversely impacted by declining water quality, particularly where salinity levels and drought affect irrigation crops and impact on cattle production;
- industrial users: many industrial uses of water are reliant on specific water quality. Poor water quality can considerably increase the costs of some industrial processes;
- water treatment: as water quality declines, potable water treatment costs increase. Increased salinity could trigger significant water treatment costs (potentially increasing costs to $1,600 to $3,000 / ML of potable water supply). A 10% increase in the turbidity of source water for Fitzroy River Water could increase their treatment costs by as much as $120,000 per annum;
- tourism: turnover in the tourism sector in the Fitzroy Basin (both inland and in the GBR) is estimated to be worth in excess of $700 million per annum and much of the sector is strongly reliant on enjoyment and use of the region's natural resources;
- commercial fishing: commercial fishing is also partially reliant on water quality to maintain and enhance stocks. The benefits of enhanced water quality will primarily accrue to owners of the commercial fishing fleet. Across the GBR catchments, the commercial fishing sector is worth in excess of $100 million per annum (primarily in the northern GBR catchments);
- recreational fishing: recreational fishing is a major recreational pastime in the Fitzroy, enjoyed by residents and visitors alike. It is estimated that annual expenditure is approximately $35 million;
- visual and aesthetic amenity: visual and aesthetic amenity is related to maintaining waterway health, which can have an impact on property prices; and
- cultural and spiritual values: such values could be negatively impacted by declines in water quality, particularly those relating to significant sites and the connections of Indigenous communities to land and waters.

Managing diffuse loads

Diffuse loads are already a major focus of planning, management and investment in the Fitzroy, particularly in relation to:

- rural diffuse loads: a series of actions and investment to reduce erosion from agricultural activities are already underway (particularly increasing ground cover). The cost of reducing sediment loads by 750,000 tonnes over 10 years (the target) has previously been estimated at between $36 and $51 million in present value terms. There is some data available to suggest that landholders are already investing around 2% of their income in enhanced natural resource management, in addition to funding via government programs; and

- urban diffuse loads: under the Queensland Development Code (under the Building Act 1975) and the proposed State Planning Policy for Healthy Waters, there are requirements for enhanced stormwater management in urban areas, including via water sensitive urban design (WSUD) in greenfield developments. The cost of achieving this policy has previously been estimated at around $54-80 million over the next 10 years (based on anticipated dwelling growth rates). This equates to an extra 1-2% of the cost of establishing a new home.

Managing point sources

For point source loads, the benefits of meeting WQOs are often relatively modest under pollution concentrations typically experienced in recent years. This is because the impacts of cumulative discharges can often be within the assimilative capacities of the receiving waters (that is, the WQOs are not exceeded). The substantial socio-economic benefits of achieving the WQOs from managing point source loads relate to:

- mitigating the more extreme and infrequent high rainfall situations when the release of contaminated stormwater can result in high salinity concentrations in receiving waters, with potentially significant environmental and socio-economic risks;
- reducing the risks (frequency and magnitude) attributable to cumulative discharges expected under growth scenarios for the mining and energy sectors; and
- managing the nutrient emissions from wastewater treatment plants.

The issue mentioned under the first dot point above has been addressed in amended environmental authority conditions for all coal mines. Under the amended environmental authority conditions implemented in 2009, contaminated stormwater discharges from coal mines must maintain in-stream EC levels (a measure of salinity) of below 1000 uS/cm, or below 750 uS/cm depending on location. This is specifically designed to avoid potential impact on any drinking water reservoirs immediately downstream of the discharge. However, it is unlikely that existing regulations can manage for more extreme climatic events, and feasible management options are very limited.

Future policy and management challenges

The key emerging challenges for water quality management in the Fitzroy are twofold:

- for diffuse loads, the challenge will be to reduce existing loads at the lowest cost to the community, via targeted actions and investments; and
- for point source loads, the key challenge will be to manage the downside environmental and socio-economic risks associated with discharges under extreme weather events without imposing excessive compliance costs on regulated emitters and unnecessarily constraining economic growth.

Careful and robust analysis is required to ensure that the amended environmental authorities for coal mines are effective in mitigating material risks and remain economically efficient. Cumulative impact modelling of contaminated stormwater discharges by coal mines and future coal seam gas wastewater discharges will refine the approaches to managing these risks to water quality.

All rural and urban diffuse and point source emitters have a major vested interest in ensuring risks to vital natural assets that underpin regional economic activity and enhance community values are managed and these assets maintained.

Introduction

Water quality is a major focus for natural resource management policy, planning and regulation in Queensland. It is widely recognised that water quality in the Fitzroy Basin (see Figure 51) is declining due to a range of factors, including land use change, population growth and growth of the mining and industrial sectors. These risks are potentially exacerbated in the long term by climate change.

In response to the risks of reductions in water quality and waterway health for both freshwater and the estuarine and adjacent marine environment (the Great Barrier Reef – GBR), a number of initiatives have already been introduced, including direct investments in wastewater treatment plant upgrades by government, more intensive wastewater management by industrial businesses and the mining sector (underpinned by regulatory reform) and actions to reduce diffuse loads through initiatives such as the Reef Plan's Reef Rescue Program (underpinned by comprehensive planning and practice change initiatives).

Under the auspices of the Queensland Government's Environmental Protection (Water) Policy (EPPW) 2009, environmental values (EVs) and water quality objectives (WQOs) are being established for the Fitzroy Basin.

Figure 51: Fitzroy Basin

Source: DEHP.

It is the State's intention to formally schedule EVs and WQOs for the Fitzroy Basin. EVs relate to the values or uses that are reliant on water quality (e.g. stock water, primary recreation, drinking water, healthy ecosystems), while the WQOs represent the measured quality of water required to sustain all values and uses for that waterway (e.g., salinity or sediment concentrations etc). Together, the EVs and WQOs provide a framework and set of targets within which water quality can be managed in the Fitzroy Basin.

Study purpose and approach

Marsden Jacob Associates (MJA) has been engaged by the Department of Environment and Heritage Protection (DEHP) to undertake a desktop study to identify and scope the magnitude and distribution of economic and social impacts (benefits and costs) of protecting the EVs for the Fitzroy Basin waters. This report also highlights the range of potential intervention options to meet the WQOs.

The study was conducted via a desktop analysis of key issues and information. Information used is primarily publicly available, augmented with some additional information gathered through discussions with key stakeholders. Limitations on available information resources for the study have constrained the ability to undertake any sophisticated analysis (e.g. a formal benefit cost analysis, or major economic and social impact assessment). Rather, this report raises key issues, assesses relevant information and draws conclusions based on the available information.

Section structure

This section is structured as follows:

- Section 2 outlines the social and economic profile for the region.

- Section 3 outlines key water quality issues.
- Section 4 outlines the key benefits of improving water quality to achieve water quality objectives.
- Section 5 outlines the costs of improving or maintaining water quality to achieve water quality objectives.
- Section 6 outlines a number of issues relevant to implementing actions to achieve the water quality objectives.
- Section 7 summarises key findings from the study.

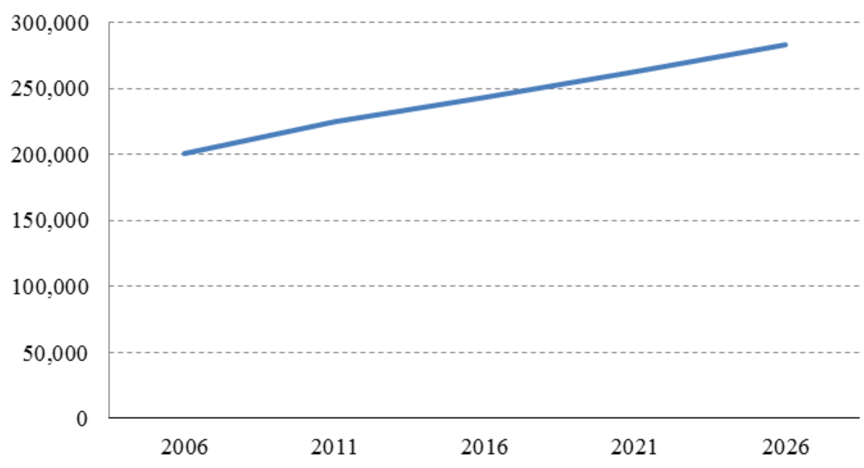
Regional social and economic profile

There is a significant amount of demographic, social and economic data and information that could be used in a regional profile. This section summarises some of the key information relevant to the Fitzroy Basin. The Fitzroy Basin is over 156,000 km2 and can be separated into six principal catchments. The main land use in the region is agriculture, with almost 90% of the area under agricultural production. Other major land uses include forestry, with approximately 900,000 hectares of land in Central Queensland under State Forestry. Mining and other extractive industries such as quarries use about 56,000 hectares in Central Queensland. Approximately 6% of the region's land is under conservation management.

Population and population growth

The estimated resident population for the Fitzroy Basin as at 30 June 2008 was 209,340, representing about 4.9% of Queensland's population. The preliminary estimate for 2009 is 214,380. The average annual population growth rate for Fitzroy between 2004 and 2009 was 2.2%, compared to 2.6% for the State for the same period.

Figure 52: Fitzroy population projection 2006 to 2026



Source: Office of Economic and Statistical Research (OESR), Fitzroy Regional Profile, generated 17 May 2010.

The population of Fitzroy is expected to grow to approximately 285,000 by 2026. This represents a 1.7% projected average annual growth rate, and compares to a projected rate of 1.8% for Queensland for the same period. The current ratio of persons per household in Central Queensland is 2.63. Based on this ratio, the number of households in central Queensland is estimated at 82,000 and is expected to increase to around 116,000 by 2026 (based on the State Government's expected ratio of 2.45 for Central Queensland). Economic and population growth in the region is being driven by the demands of high growth industries and the broader trends of lifestyle and location choices. However, unlike much of the population growth anticipated to occur in GBR catchments, much of the growth is anticipated to be inland. Areas forecast to experience the highest rates of population growth to 2026 are Emerald (2.6%), Fitzroy (2.4%) and Livingstone (2.4%).

Employment and labour force

Regional employment in the Fitzroy is significantly different to the broader Queensland economy, and also has significant differences to the broader GBR catchments. Labour force statistics show a relative high reliance on primary industries (particularly the beef industry) and mining as sources of employment. Mining is relatively more important in the Fitzroy than for the rest of the GBR catchments and six times more important when compared to the State statistics.

Table 108: Labour force statistics

	Number			Percentage		
	Fitzroy	GBR	Qld	Fitzroy	GBR	Qld
Primary industries	7,555	23,790	76,532	8.6	9.4	4.9
Mining	6,605	10,015	19,286	7.5	3.9	1.2
Manufacturing	8,828	24,421	167,380	10.1	9.6	10.7
Utilities	1,643	3,105	12,359	1.9	1.2	0.8
Construction	6,127	17,410	111,209	7.0	6.8	7.1
Wholesale Trade	4,444	12,710	79,718	5.1	5.0	5.1
Retail Trade	11,986	37,291	239,615	13.7	14.7	15.3
Accom., cafes, rest.	4,337	13,540	88,381	4.9	5.3	5.6
Transport and Storage	5,071	13,911	77,587	5.8	5.5	4.9
Communication Services	788	2,696	23,016	0.9	1.1	1.5
Finance and Insurance	1,451	4,550	44,562	1.7	1.8	2.8
Property /business serv.	5,830	17,609	153,864	6.7	6.9	9.8
Government admin	3,006	13,604	75,048	3.4	5.3	4.8
Education	7,096	19,581	118,896	8.1	7.7	7.6
Health /community services	6,859	22,016	151,029	7.8	8.7	9.6
Cultural / recreational services	1,246	4,373	37,341	1.4	1.7	2.4
Personal / other services	2,770	7,989	57,662	3.2	3.1	3.7
Total	**87,617**	**254,290**	**1,568,864**	**100.0**	**100.0**	**100.0**

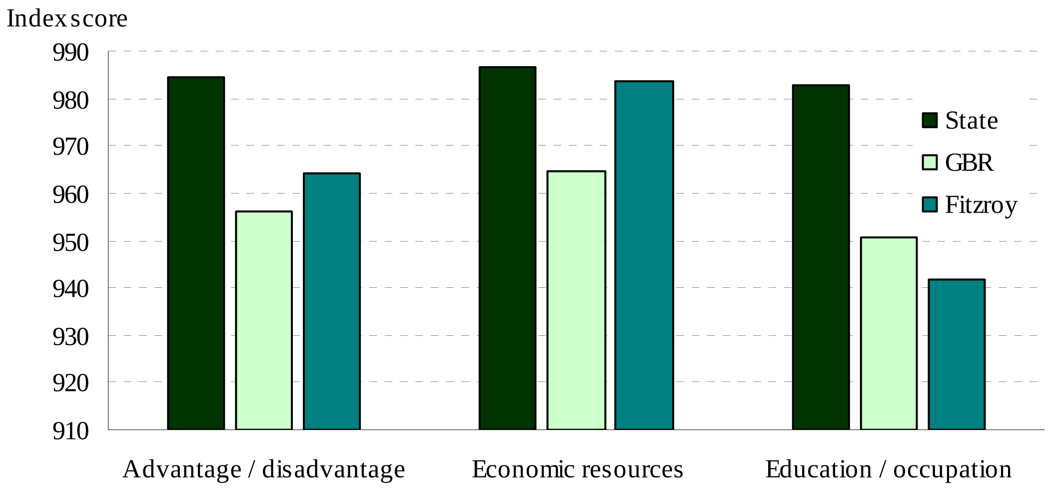
Source: ABS census.

Social capacity to adjust

The ABS Social and Economic Indices for Areas (SEIFA) is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. This provides some indication of the region's capacity to adjust to any changes required to meet WQOs. These indices are prepared using census data and provide a broad means of making relative comparisons of social and economic resources between regions. Three indices are of most relevance:

- the Index of Advantage–Disadvantage is a continuum of advantage to disadvantage. Low values indicate areas of disadvantage and high values indicate areas of advantage;
- the Index of Economic Resources includes variables that are associated with economic resources. Variables include rent paid, income by family type, mortgage payments and rental properties;
- the Index of Education and Occupation includes all education and occupation variables only; and
- these indices were compared for the Fitzroy, the GBR and the State to enable a greater understanding of the region's capacity to cope with changes required to meet WQOs. The results are shown in Figure 53.

Figure 53: SEIFA indices



Source: MJA based on ABS 2001 Census SEIFA indices.

Analysis of the SEIFA and other relevant Census data indicates:

- relative to the State, the Fitzroy is at a disadvantage, but generally has better resources than the GBR as a whole;
- rather than diversifying, census employment data indicates that the structure of the economy is actually becoming more highly concentrated in a few industries, making the region less resilient to major shocks to key sectors such as mining or gas;
- economic resources in the Fitzroy are almost on par with the State and higher than the GBR as a whole, perhaps indicating reasonable economic resilience to changes necessary to meet WQOs. However, there is significant variation within the Fitzroy. At one end of the spectrum, there is a high proportion of employment in mining (with higher incomes) and low unemployment. However, the Fitzroy also has a higher incidence of low-income families than the State as a whole. Approximately 10.9% of families in the Fitzroy are on low incomes (i.e., < $500 per week) compared to 3.2% for the State. This is typical in regions with higher proportions of agricultural enterprises;

- the relative financial impact of projects or policies that impact on costs must be considered because the burden may be relatively greater for lower-income families. Household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In the Fitzroy, approximately 64% of homes are owned or are being purchased. This compares to a State average of 76%; and
- there is some statistical evidence to suggest relatively high levels of community social capital, indicated by a high proportion of the population involved in community activities. Approximately 21% of adults (>18 years old) participate in voluntary work. Females had higher levels of participation in volunteer work (25%), compared to males (at 18%). However, the ABS Census data does not indicate what type of volunteer work (e.g. environmental management) was undertaken.

Excluding the actual costs of meeting the requirements of the WQOs, the above information broadly implies that the Fitzroy region’s greater social and economic wellbeing may make it less difficult to implement the requirements for WQOs than in other regions. However, a relatively low level of diversification of occupations indicates the potential capacity of the community to adapt to change could be a constraining factor and measures to address this constraint (along with economic costs) may be necessary.

Economic structure

Formal estimates of economic values for key sectors are not available on a comprehensive or consistent fashion. The structure of the Fitzroy is characterised by the dominance of mining and agriculture, particularly when compared to the State as a whole. Key points to note include:

- mining: mining (particularly high-grade coking coal) is the major economic activity in terms of values of production and exports, but linkages to the regional economy are often relatively indirect and much of the benefits from mining flow to regions outside the Fitzroy. Production values are approximately $20 billion per annum and are increasing rapidly as growth in major markets such as China and India has continued, even during the global financial crisis;
- coal seam gas: extensive coal resources within the region also provide the basis for significant coal seam gas development, with potential to supply an emerging liquefied natural gas (LNG) export industry. Production first started in the 1990s (e.g., fields near Moura, Fairview–Spring Gully and Wandoan). However, it is recent expansions in production in areas around Moranbah that have seen a very sharp increase in activity and investment in recent years;
- tourism: tourism is also an expanding market, particularly in the coastal zone. It is estimated that total expenditure on tourism in the Fitzroy is around $716 million; and
- beef and other agriculture: beef production is the dominant agricultural activity. While values fluctuate significantly with market conditions, it is generally understood that the sector is worth in excess of $730 million per annum. While beef dominates the agricultural landscape, it is estimated that cereal grains contribute in excess of $180 million to the regional economy annually. There is also a degree of horticulture production (e.g., citrus) in some sub-regions.

A review of relevant documentation indicates that, in the short to medium term, economic growth in the region will be predominantly reliant on further growth in the mining and energy sectors. A summary of growth prospects for key sectors is outlined in Table 109.

Table 109: Short to medium-term relative economic growth prospects

Sector	Growth Prospects	Rationale
Irrigated agriculture	Moderate	Growth constrained by water availability & price & land suitability. Competitiveness of export orientated production (e.g., cotton) constrained by high Australian Dollar (AUD). Growth in horticulture constrained by limited access to markets on a competitive basis.
Beef cattle	Moderate	Growth in export orientated production constrained by high AUD in the short term. Longer term worldwide and domestic demand growth is strong, leading to further expansion and intensification (e.g. feedlots).
Coal (coking and thermal)	Very significant	Rapid expansion of sector to continue on back of worldwide demand (particularly from China & India). Several projects already in feasibility and trial mining status.
Minerals (e.g. gold, copper, nickel)	Moderate	Some new projects due to start production in 2010 to 2012. Growth in export orientated production may be constrained in short to medium term by high AUD & worldwide commodity prices.
Energy	Very significant	Growth already occurring in the sector, with investigations and investment already underway for several new projects (including pipelines). Further growth is expected for this industry, with coal seam gas being proposed as feedstock for an export LNG industry, based mainly at Gladstone in Central Queensland. Potential for significant expansion of the sector in the medium to long term providing appropriate commercial arrangements can be established.
Manufacturing	Significant	This sector will be the major beneficiary of a rapid expansion of the coal and gas sectors.
Construction	Significant	Significant non-residential construction on the back of coal and energy growth. Significant residential construction in areas of mining/gas expansion, while growth will be moderate in other areas.
Tourism	Moderate	Tourism activity is primarily concentrated in the coastal zone. International tourism to the GBR will be constrained by broader market conditions.

Source: MJA based on: Department of Employment, Economic Development and Innovation (DEEDI) (2009) Prospects for Queensland's Primary Industries. ACIL Tasman (2007) Queensland Mining Industries: A report on the economic significance of the mining and processing to the Central region, for the Queensland Government, Department of Mines and Energy. DEEDI (2010) Queensland's Coal Seam Gas Overview, Brisbane. ABARE (2010) Australian energy projections to 2029-30, ABARE Research Report 10.02, Canberra. Tourism Forecasting Committee - Forecast 2009 Issue 2, Tourism Research Australia, Canberra.

Water quality in the Fitzroy

This section briefly outlines some of the key water quality issues relevant to the Fitzroy region. It should be noted from the outset that while much of the focus of water quality management is based on the catchments of the Fitzroy Basin, the benefits of that action are received in both the waterways and the GBR itself.

Estimates of loads

Currently, there is no comprehensive set of pollutant load data for the Fitzroy Basin that includes all key pollutants and sources of pollutants (e.g., land uses). Nor is there an entirely clear picture of the dose-response relationships between pollutant loads and their impacts on EVs. The most comprehensive set of estimates relating to different land uses relates to sediment and nutrient exports compiled by Brodie et al in 2003. This data is presented in Table 110.

Table 110: Contribution of land uses in the Fitzroy River basin to sediment and nutrient exports

	Parameter	Forest/ savannah	Grazing	Other crops	Other	Total	Total export
	Area ('000 ha)	1,362	12,078	743	91	14,275	-
	Area (%)	10	85	5	1		-
Delivery to coast	SS (kt/y)	131	2,668	101	20	2,920	2,920
	DIN (t/y)	120	1,079	52	7	1,258	1,251
	DON (t/y)	135	1,280	47	6	1,468	1,314
	PN (t/y)	1,417	15,985	400	80	17,882	5,506
Delivery to stream	Total N (t/y)	1,672	18,344	499	93	20,608	8,071
	DOP (t/y)	8	63	3	0	74	66
	FRP (t/y)	22	253	10	1	286	17
	PP (t/y)	388	5,440	147	30	6,005	2,057
	Total P (t/y)	418	5,756	160	31	6,365	2,140

Source: Brodie et al (2003) Sources of Sediment and Nutrient Exports to the Great Barrier Reef World Heritage Area.

Note: SS = suspended solids; DIN = dissolved inorganic nitrogen; DON = dissolved organic nitrogen; PN = particulate nitrogen; N = nitrogen; DOP = dissolved organic phosphorus; FRP = filterable reactive phosphorus; PP = particulate phosphorus.

The focus of previous load estimation work has been on loads attributable to diffuse loads and the main pollutants attributable to those land uses (i.e., sediments and nutrients). However, in addition to the sediment and nutrient loads identified above, there are also other pollutants occurring in the region's waters, such as salt, aluminium, arsenic, boron, cadmium, cobalt, copper, iron, lead, manganese, nickel and zinc. While many of these pollutants may be occurring naturally, the focus of management of these pollutants has been on intensive land use activities such as mining, where discharge levels are monitored and managed at a site scale. However, these estimates are not available at a catchment scale.

Significant efforts are currently underway to enhance data on key sources of loads through the implementation of the Healthy Waters Management Plan (due for completion in 2011).

Enhancing this information is vital as, without a better understanding of the relative risks to EVs posed by different sources of pollutants from all point and diffuse sources, there is a risk that interventions can be poorly targeted and may be inadequate/excessive to meet WQOs (particularly when cumulative impacts are considered).

Loads by source

There are three main sources of pollution loads into the Fitzroy Region's waters and ultimately the GBR: rural diffuse loads; urban diffuse loads; and point source loads. These are discussed in more detail below.

Rural diffuse loads

Rural diffuse loads are sourced from approximately 99.4% of the region's land area (84.6% grazing, 9.5% forest/savannah and 5.2% other cropping). Contributions to rural diffuse loads of sediment and nutrient loads are generally in line with land use. However, there are a few points worth noting:

- while grazing accounts for approximately 84.6% of the land mass, grazing accounts for higher estimated proportions of sediment into stream systems and to the coast. Other estimated pollutants are generally in line with proportional land use;
- for forest/savannah and cropping land uses, sediment losses are relatively lower, but other pollutants are generally in line with land use; and
- there are no estimates of contributions to other major pollutants (e.g., salinity concentrations or heavy metals).

Put simply, if any material impact is to be made to reduce sediment and nutrient loads at a Basin scale, the only way to achieve this would be to undertake actions to reduce rural diffuse loads.

Urban diffuse loads

An analysis of sediment, nutrient and phosphorus loads by land type undertaken by Brodie et al in 2003 indicates that urban land uses account for less than 1% of the Basin's land and produces a comparable proportion of the total sediment, nitrogen and phosphorus loads. There are no available estimates of other loads (e.g., heavy metals) from urban diffuse sources.

While some areas of the Fitzroy Basin are experiencing relatively rapid population growth and urban diffuse loads will be growing in line with this population growth, the relative contribution of urban areas to Basin-wide loads will never be significant. However, urban areas can have significant impacts on localised water quality. The impact of this growth will also constrained by recent policy measures such as the draft State Planning Policy for Healthy Waters, which addresses stormwater management for development across Queensland in order to protect the environmental values of waters. A key mechanism by which it does this is setting design objectives for the management of stormwater quality, waterway stability and frequent flows that can be achieved through the adoption of water sensitive urban design (WSUD).

Point source loads

The major pollutants from point sources are nutrients (e.g., from wastewater treatment plants), salinity (e.g., contaminated stormwater discharge from coal mines), heavy metals (e.g., from mine discharges) and acidity/alkalinity attributable to significant soil disturbance (from several point source developments).

The importance of these discharges will differ between load types, volumes/concentrations and locations and assimilative capacities of receiving waters. While the contribution of point sources to these pollutants at a regional scale is only partially understood, they are generally understood to be relatively major contributors for pollutants such as salt, particularly in some sub-regions (e.g., the Isaac Catchment).

The water quality objectives (WQOs) being established

The WQOs being established represent the measured quality of water required to sustain all values and uses for that waterway (e.g., salinity or sediment concentrations etc). An example of the draft WQOs is in Table 111 below shown for the Upper Nogoa River, with the most stringent requirements underlined. WQOs are being established for all catchments and river systems in the Fitzroy Basin.

Table 111: Draft water quality objectives (Upper Nogoa River)

Draft environmental values	*TSS*	*EC*	*SO4*	*TN*	*TP*	*pH*	*pH*
Measure	*Mg/L*	*µS/cm*	*Mg/L*	*µg/L*	*µg/L*		
Aquatic ecosystems	155	275	15	1,000	350	6.5	8.5
Irrigation		600-4,200		5,000	50	6	8.5
Farm use						6	8.5
Stock water		<7,500	1,000				
Human consumption							
Primary recreation						6.5	8.5
Secondary recreation							
Visual appreciation							
Drinking water							
Industrial use							
Cultural/spiritual values							

Source: DEHP.

Notes: Water quality guidelines for each environmental value, based on State and National water quality guidelines. TSS = total suspended sediments, EC = electrical conductivity; SO4 = sulphate; TN = total nitrogen, TP = total phosphorus. Blank cells indicate no specific guidelines.

Working within these quantitative targets becomes the challenge for emitters of pollutants, particularly as objectives can only be achieved through the efforts of many. It should also be noted that the WQOs vary for sub-catchments and river systems in the Fitzroy as they reflect relevant local water quality guidelines and the environmental values associated with different water systems across the Fitzroy Basin.

Actions to address loads and protect environmental values

There are a number of actions in place to protect environmental values, by managing loads and ensuring WQOs can be met.

Rural diffuse loads

A series of actions and investment are already underway to reduce erosion and soil loss from agricultural activities (particularly increasing ground cover). While there are already regulatory measures in place to ensure major land use change does not inadvertently increase loads (e.g., vegetation management clearing and management regulations), the focus of forward-looking actions is to cumulatively reduce sediment delivered to in-stream aquatic habitats by 4,100,000 tonnes over 10 years from 2005–06. This will be achieved through practice change encouraged by programs coordinated by the Fitzroy Basin Association (FBA). In 2005–06, the FBA's programs resulted in enhanced management practices over approximately 102,000 hectares. In terms of the uptake of land management practices associated with water quality, a survey of the relevant landholders participating in FBA programs indicates:

- 44% report undertaking actions to retain appropriate ground cover (only 32% on smaller properties), and generally landholders believe they have knowledge of the issue;
- 15% report undertaking riparian stock management (only 10% on smaller properties);
- 33% report retaining riparian vegetation (23% on smaller properties);
- 47% report farming on contour (lower on small farms, but significantly higher on large mixed enterprises); and
- 52% report minimum till practices.

General conclusions from the survey results indicate that smaller landholders are more likely to derive their principal sources of income from off-farm sources, are less likely to be aware of natural resource management issues and are less likely to practice natural resource management on their farms.

For the modelling to underpin target setting, these actions are based on an assumption that average ground cover will be increased from around 55% to 70% in project areas. Other actions proposed also involve enhancing cropping practices and wetland management. Based on the water quality modelling outcomes, targets of reducing sediments by a further 75,000 tonnes per annum have been established.

Urban diffuse loads

There is significant policy and planning development currently underway by the State Government and local governments to address urban diffuse sources of sediment and nutrient loads, specifically for greenfield developments (e.g., the State Planning Policy for Healthy Waters). The key mechanism to mitigate the urban diffuse load risks to waterway health from future urban growth will be WSUD. WSUD is a planning and design approach that addresses the impacts of urban development on the hydrological cycle and aquatic ecosystem health. Objectives of WSUD are to:

- minimise the impact on existing natural features and ecological processes (e.g., through site planning and the reduction of pollutants entering waters);
- minimise impact on the natural hydrologic behaviour of catchments and protect the quality of surface and ground waters;
- incorporate the collection, treatment and/or reuse of runoff, including roofwater and other stormwater;
- reduce run-off volumes and peak flows from urban development;

- increase social amenity in urban areas through multi-purpose greenspace, landscaping and integrating water into the landscape to enhance social and ecological values; and
- harmonise water cycle practices across and within the institutions responsible for waterway health, flood management, pollution prevention and protection of social amenity.

WSUD practices typically adopted to achieve these aims are site planning/design, rainwater tanks, swales, porous pavements, bioretention systems (raingardens), constructed wetlands, infiltration systems and stormwater harvesting and reuse schemes. The practices typically used would be dependent on the specific urban site and regional characteristics (e.g., rainfall, soil types, typography etc.).

Point source loads

The current approach to managing loads from point sources is via regulatory environmental authorities under the Environmental Protection Act 1994 (EP Act). These are specific to each regulated emitter and each has its own requirements (pollutants, loads, discharge location, timing, monitoring, reporting etc.).

At the scale of individual developments, water quality impacts are generally managed under conditions set out in environmental authorities (EAs). The EAs establish limits on water quality indicators such as pH, electrical conductivity or total dissolved solids and total suspended solids. Amendment to these requirements is only possible under several specific triggers outlined in the EP Act (Section 294). Where emission levels exceed authorised levels, transitional environmental programs (under Section 330 of the EP Act) are established to mitigate and minimise environmental damage.

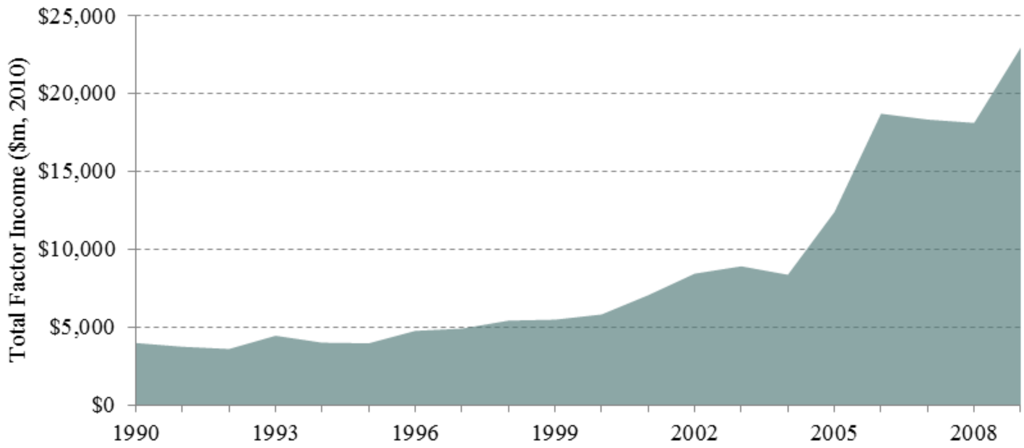
In addition to the previously amended regulated emission requirements for coal mines' contaminated stormwater discharges, which were implemented in 2009, there has also been investment in wastewater treatment plant upgrades to reduce concentrations of discharges of key pollutants into receiving waters.

Future load increases and risks to EVs

Our analysis outlined above demonstrates that the principal sources of economic growth in the Fitzroy Basin are the mining and energy sectors and the related support sectors (e.g., transport, water provision, building etc). Growth in these sectors will stimulate flow-on economic activity.

The recent growth in the mining sector is shown in Figure 54, expressed in terms of total factor income.

Figure 54: Growth in the mining sector



Source: ABS National Accounts Cat 5220.0 Table 4 - Mining (Total factor income).

Growth in mining and sectors attributable to mining will also create additional water use and may increase dewatering activities and discharges into the Fitzroy Basin. Growth in coal mining, mining water consumption and discharges are shown in the table below.

Table 112: Coal mining production, water use and discharge

Year	Coal production (million tonnes)	Water consumption (ML)	Discharge (ML)[408]
2000-01	139	25,317	6,350
2004-05	172	44,152	8,456
2008-09	191	54,866	14,267

Sources: DEEDI (2010) Queensland's Coal – mines and advanced project; DME (2007) Queensland's world-class coals – mine production and developments; ABS Water Accounts Cat 4610.0 (2000-01, 2004-05, 2008-08 editions); BOM.

While there is no direct relationship between coal production, mine water consumption, dewatering and discharge and the available data is sparse, a number of observations from the data can be made including:

- absolute discharges between 2000-01 and 2004-05 largely grew in line with production. During this period, water consumption grew at a faster rate than coal production;
- however, between 2000-01 and 2004-05, discharges per unit of coal production remained largely unchanged. This may be partially explained by improvements in water and wastewater management by the mining sector where a lower proportion of water consumed is ultimately discharged into receiving waters under relatively normal operating conditions; and
- absolute volumes of discharge increased significantly between 2004-05 and 2008-09. Discharges per unit of tonne of coal production in 2008-09 were in excess of 1.5 times those in 2004-05. However, discharges in 2008-09 coincided with significantly above

[408] Refers to water discharged after use where that discharge does not match the natural flow of the receiving water body.

average rainfall events, flooding and management responses (e.g. Ensham) that have been documented elsewhere.

In effect, the data provides some indication that the absolute levels of discharges are generally growing in line with production. However, despite significant gains in water and wastewater management, discharges can be significantly higher in very high rainfall years such as 2008-09 and can trigger the need for further management arrangements to be implemented to meet underlying regulatory standards (such as those under Transitional Environmental Programs (TEPs) for Fitzroy Basin coal mines. For this reason, management of water needs to be undertaken within the context of long-term climate sequences that allow for management within climate extremes.

It is likely to be the periods following significantly above average rainfall events that will result in significantly higher volumes of discharge, even under current improved management regimes. This is consistent with the views of industry that have stated in their submission to the State on the draft EVs in the Fitzroy Basin.

> *The factor that determines whether a discharge occurs is the rainfall (cumulative, frequency and intensity).*

Given the significant data constraints and inherent levels of uncertainty in analyses, it would be prudent to undertake a significantly more detailed and sophisticated analysis to better understand the risks growth in the mining sector poses to EVs and WQOs – particularly under different climatic conditions.

Potential growth in loads under a business as usual scenario

Based on the information in Section 2.4, key points to note include:

- load growth attributable to agriculture: it is relatively unlikely that agricultural intensification will be a major driver of future growth in loads, unless discharges by area increase (e.g., as a consequence of declining ground cover). Growth in loads from agriculture is relatively unlikely. However, grazing will continue to be the most significant source of sediment and nutrient loads, and hence the greatest source of sediment and nutrient risk at a Basin-wide scale;
- load growth attributable to population growth: growth in sediment and nutrient loads at a Basin scale attributable to urban growth will also be relatively negligible, given the relatively small size of areas to be developed; and
- load growth attributable to mining and energy development: while Basin-wide estimates of loads from mining are not available, it should be realised that while loads attributable to mining and energy development may be growing rapidly, the relative contribution of those sectors to overall Basin sediment and nutrient loads will be relatively minor under any growth assumptions. They have potentially increased in excess of 50% in the past 10 years, but probably still contribute less than 2% of total Basin loads. It is the growth in salinity loads that are likely to create the most significant risks to EVs from mining and energy developments. However, these risks were addressed in revised environmental authority conditions for the release of contaminated stormwater in 2009.

The bottom line is that anticipated growth in sediment and nutrient loads at a Basin scale attributable to land use change is likely to be negligible in the short to medium term (say the next ten years) and the subsequent changes in risks to inland and GBR waters would also be negligible. While the area under urban and mining land use will increase relatively rapidly, it is unlikely to account for any more than 2% of land use in the foreseeable future. These risks will be negligible at the Basin scale, but may create more significant risks to EVs at a more localised scale. Therefore, the existing focus of reducing sediment and nutrient loads from rural diffuse sources is entirely appropriate.

The outlook for other pollutants such as salt is significantly less certain and the risks are relatively poorly understood (particularly cumulative impacts and risks). With respect to contaminated stormwater (high salinity) discharges from coal mining operations, existing regulations and management are already in place to mitigate risks, and the cumulative risks, including coal seam gas waste water emissions, will be assessed in cumulative impact modelling in the near future.

Benefits of improving water quality to achieve WQOs

There are a wide range of benefits attributable to achieving the WQOs being considered. This section outlines:

- a framework for identifying and classifying the spectrum of benefits (the total economic framework);
- some of the key benefits associated with meeting the WQOs, particularly the benefits of avoiding the risks of excessive pollution loads into waters; and
- where possible, economic estimates of the value of some key benefits of achieving the WQOs.

Total economic value framework

The economic and social values relating to EVs are varied. Resource economists often use the concept of total economic value (TEV) as a means to categorise and (sometimes) aggregate values attributable to natural resources (e.g., waters). There are a number of different types of values that comprise TEV. These include:

- direct consumptive use values. These values relate to the use of natural resources as a factor of production or direct consumption. This includes values attributable to irrigation and human consumption;
- indirect use values. These values relate to uses that are indirect in nature, such as visual appreciation of waters for recreation or to underpin tourism;
- option values. These values relate to the preservation of options to either use or preserve a natural resource in the future, such as not allocating water for consumptive use to maintain the option to ensure more water for environmental flows in future;
- non-consumptive use values. These values relate to the use of a natural resource where the quantity or quality of the resource does not decline with use, such as swimming or kayaking in waters; and
- Non-use values. These values represent preservation of natural resources for their own sake, even if the resource will never be consumed. Typically, these values relate to EVs such as the protection of ecosystem functions or cultural values.

While some of these values are revealed through market prices (e.g., the margin from the use of an extra ML of irrigation water), not all are revealed through market transactions (for example, the value of biodiversity). To establish estimates for many values is often highly complex and expensive.

Table 113outlines the relationship between EVs and the TEV framework. The table indicates that many of the EVs relate to multiple types of economic values. There is a distinct lack of data and information to enable estimation of most of these values for the Fitzroy Basin. For example, there are no estimates available for cultural and spiritual values attributable to maintaining EVs.

Table 113: EVs in a Total Economic Value Framework

		Total economic value framework									
		Consumptive use values	Indirect use values	Option Value	Non-consumptive use values				Non-use values		
					Recreational	Aesthetic	Educational	Distant use	Existence	Bequest	Philanthropic
Primary industries	Irrigation	✓		✓							
	Farm use	✓		✓							
	Stock water	✓		✓							
Recreation	Primary recreation			✓	✓						
	Secondary recreation	✓		✓	✓						
	Visual appreciation		✓	✓		✓		✓			
Human consumption		✓		✓							
Industrial and mining use		✓		✓							
Cultural and spiritual values		✓	✓			✓	✓	✓	✓	✓	✓
Aquatic ecosystems		✓	✓	✓			✓	✓	✓	✓	✓

Source: MJA based on Greiner, R & Hall, N (2006) Social, Economic, Cultural and Environmental Values of Streams and Wetlands in the Burdekin Dry Tropics Region.

15.7.2 Water quality risks to EVs and their economic and social impacts

The focus of managing discharges from all sources (rural diffuse, urban diffuse and point source) is essentially to mitigate the risks of EVs being materially impacted by emissions. Previous work to identify the risks to EVs from declining water generally relate to three broad categories of risk:

- human health. Declining water quality, particularly to levels below Australian drinking water guidelines, can have a number of direct and indirect detrimental impacts on human health;
- ecosystem function. Many ecosystems are reliant on suitable water quality levels to maintain key ecosystem function, maintain resilience, provide ecosystem services and maintain cultural values; and

- water dependent sectors. Many sectors and industries in the region (including downstream in the coastal areas) are directly and indirectly impacted by changes in water quality.

Many risks to EVs will also have economic and social impacts (right across the TEV spectrum) depending on the nature of the risks, cumulative impacts, assimilative capacities of receiving environments and key thresholds, how those risks impact on productivity and resources, and the costs of avoiding or mitigating those risks.

Because the material risks to the EVs tend to relate to concentration levels of pollutants, the risks are particularly high where there are high discharges of pollutants (single source or cumulative) into waters. The timing and location of major discharges of pollutants from point sources is a critical driver of physical, economic and social risk. The greatest risks will tend to relate to the more extreme or infrequent events, not to typical operating circumstances. This is a major consideration in the Fitzroy Basin as it is dominated by waterways that have highly variable flow rates or are ephemeral in nature. These matters have been addressed in the amended environmental authority conditions for contaminated stormwater discharge for all coal mines in the Fitzroy Basin that were implemented in 2009.

Table 114 summarises key risks to EVs from reductions in water quality and the subsequent economic and social impacts that may occur. MJA has attempted to indicate the frequency and magnitude of the economic impacts to better understand the circumstances under which impacts are greatest.

A key general point to note from the analysis is that many economic and social impacts may be negligible under normal conditions. However, some economic and social impacts could be significant under higher pollutant concentrations associated with more extreme or infrequent events.

Table 114: Water quality risks from point and diffuse source loads and the associated economic and social impacts

Risk class	Risks attributable to poor water quality	Example economic & social impacts	Frequency and magnitude of economic & social impacts
Human health	Poor taste triggered by sediments/turbidity, salinity.	Water treatment costs will be higher during events with high concentrations of pollutants. Typically, this would be largely via increased variable costs (chemicals & energy). However, permanent increases in loads may trigger augmentations in water treatment capital expenditure as current treatment thresholds of existing plant are exceeded. Social costs associated with poor tasting water, potentially triggering expenditure on alternatives (e.g., bottled water).	*Frequency:* Infrequent, but frequency may increase as cumulative loads increase and treatment thresholds are exceeded more often. *Magnitude:* Generally relatively low costs for low frequency events. High frequency events would trigger significant costs.
Human health	Health problems associated with excessive concentrations of salt (e.g. cardiovascular disease) and metals such as sodium.	Costs associated with direct and indirect treatment.	*Frequency:* Infrequent. *Magnitude:* Generally considered a low impact.
Human health	Parasites of particular concern are giardia and cryptosporidium often triggered by excessive nutrient levels.	Costs associated with direct treatment for water borne illnesses.	*Frequency:* Infrequent. *Magnitude:* Generally considered a low impact.
Ecosystem function	Excessive sediments, salinity & nutrients or poor pH levels can trigger physiological stress causing losses of aquatic biodiversity and losses in ecosystem function (e.g., fish breeding).	Loss of aesthetic appeal and recreational impacts (including recreational and tourism activity). Loss of social values (e.g., existence values attached to biodiversity). Loss of ecosystem services.	*Frequency:* Constant impact attributable to rural diffuse loads, but with significant variation. *Magnitude:* Variable across Fitzroy Basin. Currently high level of sediment magnitudes from rural diffuse loads. Low levels of relative magnitude from other land uses, but could be major under ongoing higher concentration levels.

Water dependent sectors			
Primary industries	Salinity levels can lower irrigated crop yields and suitability for stock watering. Nutrients impact on ecosystem function upon which many industries rely.	Reduced primary industry productivity (e.g., salinity droughting crops). Potentially higher input costs (e.g., due to shorter irrigation asset lives). Reductions in asset values (e.g., farms) reflecting capitalised losses. Flow-on impacts through regional economies in response to lower levels of economic activity.	*Frequency:* Generally infrequent. *Magnitude:* Variable across Fitzroy Basin. Currently low magnitude of impacts but could be more significant under ongoing higher concentration levels.
Industrial use (e.g., power plants)	Increased pollutant levels may trigger need to improve water quality to meet requirements as an input to production (e.g., cooling towers).	Capital and operating costs of water treatment. Pollutants such as salinity levels may decrease asset lives and increase maintenance costs.	*Frequency:* Infrequent. *Magnitude:* Variable across Fitzroy Basin. Currently low magnitude of impacts but could be major under ongoing higher concentration levels.
Tourism	Increased pollutant levels impact on water quality and ecosystem appearance and function.	Reduced tourism amenity for primary and secondary recreation-based tourism. May trigger lower visitation and expenditure levels.	*Frequency:* Impacts likely to be infrequent. *Magnitude:* Low relative importance of tourism in inland catchments in the Fitzroy (but growing sector). Impacts in GBR relatively lower than northern GBR catchments due to concentration of tourism further north than the Fitzroy.

Source: MJA analysis.

Key economic benefits from reducing loads

The benefits of meeting the WQOs and protecting EVs are essentially the avoided costs attributable to declining water quality and waterway health that could be attributable to existing and future loads.

These benefits are outlined below. It should be noted that there is very limited information (particularly quantitative dose-response relationships) to guide this analysis, especially for point sources of loads. Therefore, all estimates should be considered indicative only.

Avoided health costs

The risk assessment outlined in Section 4.2 showed that there are likely to be economic benefits in the form of avoided health costs. There are a variety of costs that might be incurred, such as medical treatment costs, government control, avoidance and remediation costs, lost labour productivity and the individual suffering costs borne by residents. While these benefits are extremely difficult to quantify, some of the more common health costs that could be avoided include:

- increased nutrient loads (e.g., from a wastewater treatment plant) often increase the likelihood of aquatic weeds, creating a public health risks from contact through primary recreation activities. Typical symptoms include skin itchiness, sore eyes and skin redness. While there is no economic research undertaken on these costs in the Fitzroy Basin, research undertaken in South East Queensland found that the public health risks were relatively low, and that the economic costs were typically negligible;
- increased nutrient loads can also increase the likelihood of pathogens, such as giardia or cryptosporidium, entering water supplies. These pathogens can cause severe gastro-intestinal illness, subsequently resulting in medical treatment costs and inconvenience for the remainder of water uses (e.g., the need to boil water). Remediation of water supplies to remove pathogens can be extremely expensive;
- where salt concentrations are increased significantly in water supplies, there could be impacts for people who need to limit their daily salt intake (e.g., severely hypertensive, diabetic and renal dialysis patients); and
- increases in industrial and mining activity will increase concentrations of heavy metals in waters (e.g., copper, zinc, etc.), which will reduce the quality of source water for potable water supplies. Continued exposure to excessive concentrations can have detrimental health impacts.

Because the frequency and magnitude of these risks are probably both relatively low, the health benefits of meeting the WQOs are relatively minor at present. However, the health benefits are likely to grow significantly given the levels of development expected in some parts of the Fitzroy Basin.

In summary, the health economic and social benefits of achieving WQOs are relatively modest.

Maintaining ecosystem function and services

Community consultation undertaken as part of the establishment of the draft EVs and WQOs indicates the importance of maintaining ecosystem function and services in the Fitzroy Basin. In addition, previous academic research also indicates that the Fitzroy community values maintaining ecosystem function and ecosystem services highly.

There is little information on the dose-response relationships between pollutant loads/ concentrations and their impact on economic values of ecosystem function. In addition, because environmental goods and services are typically not traded in markets (i.e., they are non-market values), estimating their worth is difficult. In 2006, Rolfe and Windle estimated the marginal values of changes in environmental condition across the GBR catchments including inland waterway health.

Based on their estimates and estimates of current and future households, MJA has calculated indicative benefits of avoiding 1%, 2%, 5%, and 10% declines in ecosystem function in the Fitzroy Basin (a range of potential outcomes over the medium term depending on interventions and funding choices).

Table 115 shows these estimates, both in terms of annual estimates for the current population and capitalised estimates to represent the value of avoiding permanent loss.

Table 115: Indicative benefits of maintaining inland waterway health ($ millions)

Avoided decline in environmental function / condition	1%	2%	5%	10%
Annual value to current population in Fitzroy Basin	0.5	1.1	2.7	5.5
Capitalised value[409]	11.6	23.3	58.4	117.0

Source: MJA indicative estimates.

One of the key objectives of the rural diffuse water quality improvement plan for the Fitzroy was to reduce sediment loads by 16.5%. If the sediment loads translated to similar proportional improvements in the condition of the reef adjacent to the Fitzroy catchment, the value of the plan could be as high as $96 million.

While the figures are only broadly indicative of the benefits of maintaining ecosystem function and health, they do demonstrate that the values may be significant. This is particularly the case where permanent losses in ecosystem function are avoided.

In addition to the values above, a number of other ecosystem services are reliant on waterway health in the Fitzroy Basin:

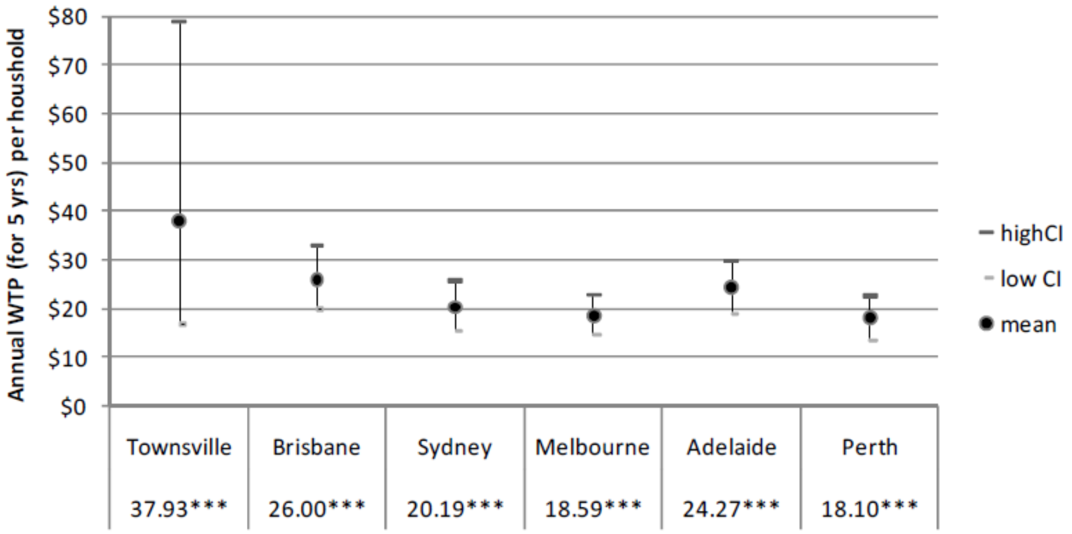
- the maintenance of ecosystem functions in waterways will provide significant benefits to recreational fishing (estimated annual expenditure for the broader Fitzroy region is around $35 million (primarily occurring in more coastal areas)). In addition, similar benefits would also accrue to the GBR commercial fishery, estimated to be worth in excess of $100 million per annum (primarily in the northern catchments of the GBR);
- the provision of flow regimes and ecosystem function underpins Indigenous values and some traditional practices; and
- significant recreational activity and nature-based tourism activity in the Fitzroy Basin is directly or indirectly reliant on the maintenance of waterway health.

In addition to the benefits that accrue to the regional population from maintaining the health of waterways, the health of the GBR is also a key economic priority for the community.

409 To estimate capitalised values, annual estimates were calculated for each year to 2026 and a perpetual value was then calculated for the period beyond 2026 assuming no more population growth. These annual estimates were then converted to a present value assuming a real discount rate of 5.5%.

Recently completed research by Rolfe and Windle has found that the value on a 1% improvement in the health of the GBR is between $433 and $811 million. Furthermore, values are also significant for much of the population that actually reside outside the GBR catchments, indicating the community's willingness to pay to preserve the GBR asset for future use and for its existence value. This is shown in the figure below.

Figure 55: Community willingness to pay for a 1% improvement in GBR condition



Source: Rolfe & Windle (2010). Assessing national values to protect the health of the GBR.

In summary, while the majority of economic and social benefits from maintaining ecosystem function and services are non-market values, these values are likely to be very significant and will not simply be restricted to the region.

Avoiding negative impacts on primary industries

Another issue of particular concern that has arisen through the community consultation for the development of the draft EVs and WQOs is the potential impact of discharges on primary industries.

The key concerns primarily relate to elevated salinity levels in waters and, potentially, groundwater systems that impact on both yields for irrigated agriculture and water for cattle. Table 116 summarises areas under crops, irrigation and water use for irrigation. Cotton is the dominant irrigation crop, although there are also large areas under irrigated pasture and cereal crops.

Table 116: Area of crops, irrigation and water use for irrigation

Pastures and crops	Area of agricultural holding '000 ha	Area irrigated '000 ha	Application rate ML/ha
Pasture for grazing	12,967	7	2.2
Cereal crops for grain or seed	263	8	2.9
Cereal crops not for grain or seed	64	2	2.0
Cotton	23	21	7.2
Other broadacre crops	32	2	4.1
Horticulture	4	2	2.1-3.9
Nurseries, cut flowers or cultivated turf	0	0	6.0
Grapevines	1	1	7.3

Source: ABS (2008) Water Use on Australian Farms 2005-06, and Queensland Government: DEHP (2009) Irrigation water quality—salinity and soil structure stability.

Note: 1 dS/m= 1,000 µS/cm.

Elevated salinity levels can have a detrimental impact on productivity by essentially mimicking the effects of drought on the crops. Table 117 provides indicative electrical conductivity (EC) tolerances for crops typically grown in the Fitzroy Basin.

Table 117: Irrigated crops and tolerance of plants to salinity in irrigation

Pastures and crops	Electrical conductivity (EC) (dS/m) threshold for yield reduction for crops growing in irrigation		
Pasture for grazing	1.8-12.8	1.0-7.3	0.6-4.2
Cereal crops for grain or seed	9.4 (wheat)	5.3 (wheat)	3.1 (wheat)
Cotton	12.1	6.9	3.9
Other broadacre crops	4.4 (peanut)	2.5 (peanut)	1.5 (peanut)
Horticulture	2.9 (orange)	1.7 (orange)	1.0 (orange)
Grapevines	3.3 (grape)	1.9 (grape)	1.1 (grape)

Source: ABS (2008) Water Use on Australian Farms 2005-06, and Queensland Government: DERM (2009) Irrigation water quality—salinity and soil structure stability. Note: 1 dS/m= 1,000 µS/cm.

While the extent and concentration of EC in irrigation water supplies is largely unknown at present, achieving WQOs will provide some benefits to irrigated agriculture through the maintenance of productive yields and by ensuring that remediation costs are not incurred by irrigators in the future. Based on studies elsewhere, because of the time lags between undertaking remediation activities and productivity being restored, remediation is rarely economically viable.

The dominant primary industry in the Fitzroy Basin is beef cattle, with an estimated 2.8 million head in the Fitzroy NRM region. Some of this production is intensive, with the estimated number of cattle in feedlots at approximately 160,000. The cattle and feedlot sectors are major users of water and productivity (i.e., live weight gain) can be severely negatively impacted as EC levels approach 6 dS/m.

While the relationships between environmental risks and economic risks attributable to salt discharges are not quantitatively known in the Fitzroy Basin, primary industries are a significant source of employment (over 5% of the region's total employment) and economic activity.

There will be significant economic benefits from ensuring primary industries are not adversely impacted by discharges into waters. This is particularly the case as the Fitzroy Basin's long term outlook for primary industries (particularly beef) is very positive due to the region's competitiveness and the very positive long-term demand growth estimates.

These matters have been addressed in the amended environmental authority conditions that were implemented in 2009 for contaminated stormwater discharges, arising from extreme and infrequent events, for all coal mines in the Fitzroy Basin.

In summary, any material decline in water quality creates a significant risk to productivity and trade prospects for primary industries. There are significant economic and social benefits to be gained from avoiding this risk.

Avoiding increases in potable water treatment costs

As has previously been observed, even temporary declines in water quality can have relatively significant impacts on potable water treatment costs. The risks to water quality, particularly from cumulative loads, could have a very detrimental impact on the local government sector water treatment costs. There will be very material benefits from achieving the WQOs in the form of avoiding water treatment costs.

Table 118 outlines some indicative increases in water treatment costs that may be incurred by water service providers (primarily Fitzroy River Water) if water quality declines considerably. It should be noted that declining water quality will trigger both increases in operating costs and potentially major capital investment if pollution concentration thresholds are exceeded.

These costs would be passed onto water users via higher water prices. This will have both economic and social impacts across the region.

Table 118: Indicative water treatment costs

Pollutant	Treatment	Potential costs
Salinity	Desalination plant (reverse osmosis)	$1,600 – $3,000 / ML potable water for constant supply (higher if plant only used intermittently). Highly dependent on source water quality, which will drive technology choice, the capital investment required and operating costs.
Sediment / turbidity	Increased treatment (chemicals)	Based on an annual supply of around 12,000 ML from Fitzroy River Water, a 10% increase in sediment / turbidity could increase treatment costs by $100,000-$120,000 per annum.

Source: MJA.

Other benefits

There are a number of other benefits that may accrue from achieving the WQOs. These include maintaining a number of the economic and social values identified in Section 4.1. Key benefits include:

- maintaining tourism appeal. The maintenance of water quality will reduce the likelihood of adverse risks to the tourism sector from primary and secondary recreation contact and losses to visual amenity values. Based on GBR-wide estimates and regional estimates of guest nights across the GBR, it is estimated that tourism in the Fitzroy Basin is worth approximately $716 million per annum, dominated by domestic tourism;
- visual and aesthetic amenity. Water quality can have a positive impact on visual and aesthetic amenity, particularly in areas with water views. These values can translate to higher property values;
- maintaining cultural values. Significant cultural values relate to water flows, water quality, culturally significant sites and connections of Indigenous communities to land and seas.
- reducing costs for industrial processes and mine input costs. Quality water is also a major requirement for some industrial processes (e.g., power plants) and for mines. Where water quality can be maintained, input costs will be lower and opportunities for beneficial reuse will be greater; and
- maintaining asset lives. Lower levels of salinity will reduce the risks of asset lives being shortened by accelerated corrosion processes.

While the economic value of many of these benefits is not known given current information and data availability, these values can be significant.

Costs of improving or maintaining water quality to achieve WQOs

This section outlines some of the key types of costs faced by businesses and the community in improving or maintaining water quality to achieve WQOs. Wherever possible, quantitative estimates are provided.

Types of costs

In deciding ways to improve water quality, there will be a number of different types of costs:

- changes to operating costs and cashflows. Where a polluting entity (farm, factory, mine or waste water treatment plant) reduces their loads/concentrations to improve discharge water quality, which may contribute to an improvement in receiving water quality, they may face additional operating costs (e.g., chemicals for treatment). Unless these costs can be passed onto customers (unlikely for bulk commodities), these costs will directly impact on business profitability – without offsetting efficiency/productivity improvements;
- capital investment. Best practice environmental management for activities generating both point source and urban diffuse source emissions may require significant capital investment for both existing and new activities, which will be written off against future incomes over the life of the asset; and

- impact on viability and investment. If an environmentally relevant activity under the Environmental Protection Act 1994 is required to change practices, this may impact on the cashflows, project viability and potentially future investment.

In addition to the costs incurred directly by firms required to change practices, there may be flow-on impacts, both positive and negative. For example, where meeting a WQO constrains operations (temporarily or permanently), there may be flow-on impacts on suppliers of inputs (e.g., transport operators) or reduced waste disposal costs from re-use and recycling initiatives.

These issues are considered for key stakeholder sectors below.

Costs to primary industries

Rural diffuse loads are primarily attributable to grazing activities and the costs to graziers result from changes in production practices (e.g., practices that increase ground cover such as spell grazing) and land remediation (e.g., bank stabilisation).

Even in the absence of major recent policy initiatives such as the National Heritage Trust and the National Action Plan for Salinity and Water Quality, farmers have often undertaken actions to reduce erosion and maintain waterway health. Expenditure data on NRM management is not available at a regional level. However, available ABARE data for NRM expenditure and the beef sector indicates that average expenditure on natural resource management in 2004 was around 2% of total cash costs, of which half is ultimately directed at management of erosion and other actions that would reduce rural diffuse loads.

As part of the broader regional NRM planning initiative, a significant planning and consultation exercise has already been undertaken in the Fitzroy Basin to identify and prioritise interventions and investments to reduce rural diffuse loads. This initiative was led by the FBA. This has formed the basis of much of the investment in reducing pollution loads from rural diffuse sources funded under major initiatives such as the Reef Plan programs.

The targets established by the FBA involve reducing annual sediment loads by 750,000 tonnes (approximately 16.5%) within a 10 year period, excluding lag effects. The modelling undertaken as part of the planning process indicates significant decreases in sediment loads can be achieved from increasing average ground cover. It was estimated that that the long-term strategy could reduce annual sediment loads by 1,450 Mt, and reduce nitrogen and phosphorus loads by approximately one-third.

MJA has overlayed the data from the loads modelling used for the planning exercise with economic estimates of changing ground cover estimated by Donaghy et al. (2007) and program administration and operating costs provided by the FBA. Assuming that the FBA are able to target and achieve changes in average cover from 55% to 70%, MJA estimate that the potential cost of achieving the FBA's target reduction in sediment loads of 750,000 tonnes is in the order of $36–51 million, or around $48-68 per tonne.

The analysis demonstrates a significant cost in achieving the sediment reduction targets. However, analysis by Donaghy et al. indicates that the long-term costs and benefits of managing for target ground cover levels vary significantly depending on the starting pasture condition. That research indicated that there was likely to be a potential optimal pasture utilisation rate in the long run. Utilisation rates above that level were actually detrimental to farm financial performance and ultimately the value of the farm asset. Donaghy found that:

> *By lowering the pasture utilization rate from 60% to 50% utilization, the land holder…will achieve a significant reduction in sediment of… 40% over 20 years. This implies an opportunity cost of only $3 per tonne....*

More recent work by Rolfe and Windle based on the outcomes of water quality tenders have found significant variation in the cost of pollution abatement from rural diffuse sources, such as:

- the annual costs of sediment reductions ranged from $162 to $89.22 per tonne;
- the annual costs of nitrogen reductions ranged from $0.23 to $4.56 per kilogram; and
- the annual costs of nitrogen reductions ranged from $1.78 to $10.80 per kilogram.

While the work undertaken by Donaghy et al. was essentially a modelling exercise based on a representative enterprise, and the results were constrained by the capabilities of the models used, there are a number of key messages relevant to reducing loads from grazing including:

- the likely private costs to graziers of reducing sediment loads will differ depending on the current and target ground cover levels.
- there are likely to be financially optimal long-term levels of ground cover, depending on farm characteristics.
- increases in cover in the long term can be financially beneficial for some enterprises, but for many graziers there will be private costs in achieving groundcover targets, constraining the likelihood of voluntary adoption of such practices.
- further research into the economic and environmental tradeoffs between pasture utilisation, groundcover and sediment export would enhance policy and program design; and
- given the current levels of uncertainty regarding the private benefits and costs of achieving enhanced ground cover, providing well-designed incentives is a useful policy tool to achieve targets and to better understand the likely costs of achieving targets.

The costs of reducing sediment export from grazing activities are a significant impediment to achieving sediment reduction targets. This is consistent with findings from a survey of landholders in the Fitzroy (Preston et al., 2007) which indicated that cash flow considerations, the costs of inputs and the costs of machinery and equipment were among the greatest constraints to adopting new practices, as they impacted on net profits. Cash flow and input costs considerations ranked as the greatest constraints of all resource, financial, social and information constraints considered. Delays in financial returns on new practices were also seen as a significant constraint.

Other constraints and impediments

In addition to the financial impediments, the Preston survey revealed a number of land resource, social and information factors that were seen as impediments to the adoption of new practices. Key impediments included:

- concerns over climate variability;
- the need for support from family;
- the need to be able to access reliable information on practices;

- stage of life (e.g., approaching retirement) or intentions regarding properties. for example, 10% of landholders surveyed intended to sell the property in the short to medium term, that is, the next 10 years; and
- general landholder values, where working the land, a rural lifestyle and investment are seen as more important than bushland, habitat and nature conservation.

Interestingly, the need to reorganise a property layout was not seen as a major factor. In effect, it would appear that landholders are relatively keen to better configure their properties, but other constraints, particularly financial constraints, impede these investments.

These constraints are not of uniform importance across all landholders. This situation should influence the design and implementation of any policy or program to reduce sediment loads.

Urban diffuse costs

The most typical approach to address urban diffuse loads is the implementation of WSUD in greenfield developments. MJA has estimated the potential impacts of implementing WSUD in all future greenfield developments in the Fitzroy using our previous economic analysis for the business case for best practice urban stormwater management. Based on the load reductions and cost estimates for an efficient set of WSUD infrastructure to meet the policy objectives developed in that study, and applying estimated population growth for the Fitzroy, implementation costs are likely to be around \$54–\$80 million over the next ten years. These costs would translate to marginally higher costs for urban development being passed on to consumers in the form of higher house establishment costs. This equates to around a 1.1% to 1.3% increase in the cost of building a new home, including the requirements of the Queensland Development Code.

Point sources – town wastewater treatment costs

One of the key regulated point source polluters are wastewater treatment plants, where there are a number of requirements relating to treatment, monitoring and reporting (contingency planning, etc). Where WQOs trigger more stringent treatment standards, the costs can be significant. Based on previous analysis undertaken by BDA consulting, MJA has estimated the range of costs involved in augmenting treatment standards. Costs are outlined in Table 119 and show the range of annualised whole of life costs required to remove a tonne of nitrogen and phosphorus via treatment. These costs represent the amortised capital costs and annual operating costs (chemicals, labour, energy, etc).

The costs vary widely depending on the quality of the source material and the regulated standards for emissions. Treatment plants such as the Glenmore plant operated by Fitzroy River Water may require additional expenditure to meet best practice nutrient emission standards to protect estuarine and marine environmental values. However, the additional costs (primarily amortised capital costs) would be passed on via customer charges and the net costs to the service provider may be negligible.

Table 119: Indicative wastewater treatment costs ($ per tonne of pollutant removed)

Annual wastewater treatment costs	Low	Mid	High
Unit annual $ / tonne nitrogen	188,000	522,500	857,000
Unit annual $ / tonne phosphorus	82,000	342,000	602,000

Source: MJA based on BDA Group (2006) Scoping Study on a Nutrient Trading Program to Improve Water Quality in Moreton Bay.

Point sources – power stations

Power generators are also a major regulated source of point source loads. The major power station in the region is the 1,400 megawatt Stanwell station, approximately 20 km west of Rockhampton, which uses large volumes of water from the Fitzroy River for cooling. It also has a number of regulated emissions under its environmental authority relevant to water quality, including controls over suspended solids, salt, pH levels and chloride.

Point sources – mines and energy developments

There are almost 50 operating mines in the Fitzroy Basin and each of these has made a significant investment in the management of water use and associated regulated discharges. There are a plethora of costs involved in the use and management of water, dewatering and discharges including:

- bore fields, pipelines and other supply options;
- overburden dumps, tailings dams and tailings management etc.;
- water treatment (sometimes involving desalination, storage, dosing etc). saline discharge water is an issue for more than 50% of mines, and is becoming a major environmental management issue for the emerging coal seam gas industry;
- waste stream disposal costs;
- mitigation and remediation costs in the event of spillage or illegal discharge;
- rehabilitation costs;
- monitoring, reporting and stakeholder liaison; and
- labour costs associated with all of the abovementioned activities.

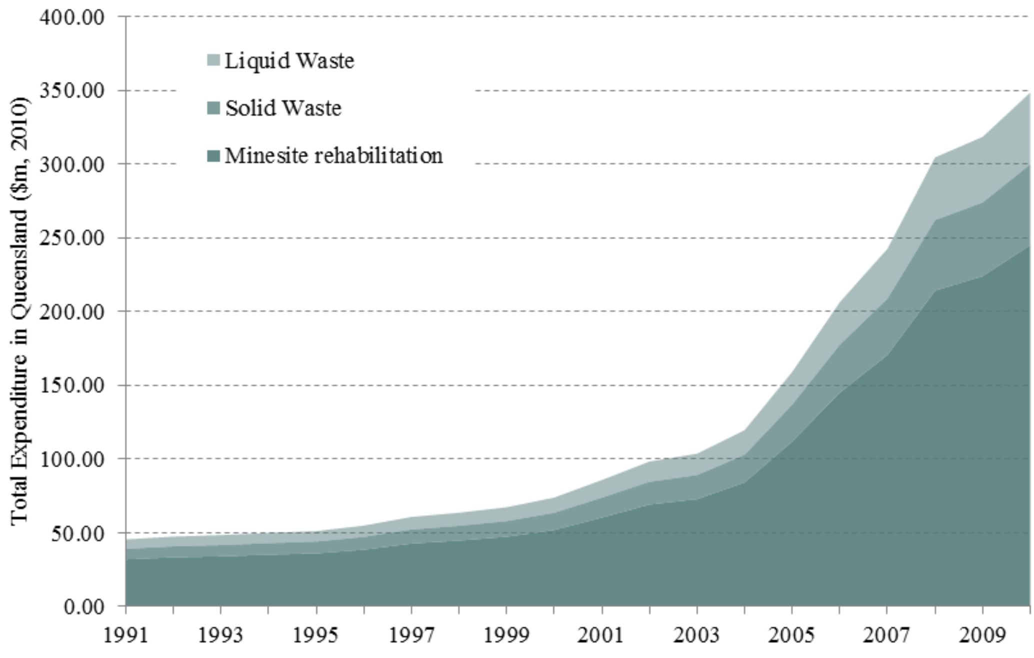
Publicly available information on water treatment costs is both very limited and highly aggregated. For example, ABS data provides an indicative estimate of the yearly expenditure by the mining industry on environmental protection measures in Australia, disaggregated by states. Estimates produced by MJA utilising the most recent data are illustrated in Figure 6 below. When linked with aggregate level production data (by state), the resulting estimates provide an indicative estimate of environmental expenditure and the impost of environmental management on mine costs.

Information on cost structures for mines is not publicly available, although what limited data that is available indicates that while water expenditure in mining is significant in absolute terms (capital and operating costs) it is not one of the most significant cost drivers for the industry in general. Using the last ABS survey of environmental expenditure and ABARE production and price data for the same period, the data indicates that environmental expenditure in the coal industry was less than 0.5% of the value of production.

While the proportion of costs attributable to environmental management would have increased since the time of this data, it is unlikely the changes in environmental regulatory requirements would have had a material impact on the sectors viability except for the most marginal of operations. However, there will be significant variation in the cost attributed to policy-induced costs. Industry sources have provided some anecdotal evidence to suggest that capital expenditure in one mine to meet their amended regulatory requirements was as high as $50 million.

MJA estimate that total environmental expenditure by the Queensland mining industry is now around $250 million per annum. This expenditure has been growing at a faster rate than production growth as environmental management cost increases are driven by multiple factors, including relatively higher regulatory requirements and voluntary improvements in practice as corporate social responsibility initiatives become more mainstream. Of this expenditure, approximately 14% is attributable to liquid waste management, which is of most relevance to the establishments of EVs and WQOs.

Figure 56: Estimated expenditure on environmental management by the Queensland mining industry, 1990-2010



Source: MJA analysis based on ABS 4603.0 Table 2.4, ABS 5220.0 Table 4 and MJA estimates.

Environmental costs vary considerably (depending on site conditions, commodity, loads, regulatory requirements etc), but they rarely likely to exceed more than 2% of total factor income for the mining sector. Liquid waste management, a significant ongoing cost, is typically around 0.2% of factor income. While aggregate level estimates can be produced, region-specific cost estimates remain commercially sensitive to mine operators, as information on potential cost changes may impact on mine viability and potentially on future investment. However, general conclusions include the following:

- the costs of reducing loads/concentrations can be relatively higher for brownfield applications compared with new operations, where higher waste management standards can be incorporated into the mine site design from the outset;
- available ABS data indicates that liquid wastewater management for coal tends to require relatively lower capital inputs (around 60% of total wastewater management costs) when compared to oil and gas (around 85%). However, the trend towards coal seam gas extraction is likely to both increase the overall costs of wastewater treatment for the

energy industry in Queensland, and result in a more capital intensive wastewater management cost profile;

- there is significant variability of costs, driven by multiple site characteristics and other physical aspects of mine production, and there are likely to be relatively unique solutions to meeting regulatory requirements for each mine. For example, meeting concentration limits and flow constraints can prove problematic where dilution to concentrations that meet release conditions does not align with favourable low conditions for releases. This will impact on mine configuration and costs; and
- passive water treatment systems generally have lower capital and maintenance costs than active treatment systems. However, it is significantly more difficult and costly to incorporate passive treatment into existing operations.

In addition to cost-related constraints on improving receiving water quality, there are often a number of technological and market constraints that can inhibit voluntary investment in environmental technologies by mining companies, particularly perceived commercial and operational risks of environmental or water management processes. Wastewater management matters have been addressed in the amended environmental authority conditions addressing contaminated stormwater discharge for all coal mines in the Fitzroy Basin, implemented in 2009. They are now a part of the business-as-usual case for future operations and the investment climate.

In addition to the ongoing costs outlined above, also of concern to the mining sector is the potential disruption to production where meeting regulatory requirements restricts the ability of mines to release excess water during flooding (essentially blending with the flood flows) which may result in productions being temporarily halted. This has occurred in some mines as a result of very high rainfall in both the 2008 and 2010 wet seasons. The Queensland Resources Council estimate Queensland coal exports may be 30% lower than expected because of the recent flood events. ABARES have also estimated impacts on production, but have indicated the constraint on exports will be partially offset by an increase in the spot price.

It is estimated that Queensland's coal exports between December 2010 and March 2011 could be around 15 million tonnes lower than previously anticipated. This represents a reduction in export earnings of around $2–2.5 billion. However, it is anticipated that coal prices could be settled at higher levels, partially offsetting the adverse impact on coal industry revenues.

However, while the spot price may partially offset the impacts for the sector as a whole, the impacts will still be felt by mines directly impacted.

Implementation issues

This section outlines some of the key issues for implementing policies, programs and projects to meet the WQOs and protect the EVs.

Intervention choice

There are a number of potential intervention options available to address water quality issues in the Fitzroy Basin, including regulatory, suasive/information, or market approaches. No one approach is universally better, and the choice of intervention should depend on the most cost effective means to improve or maintain water quality to achieve the WQOs. Different interventions (singularly or jointly) are required for different sources of loads and risks.

Regulatory approaches

The current approach to managing loads from point sources is via regulatory environmental authorities under the Environmental Protection Act 1994 (EP Act). Regulatory approaches include prohibitions, limits, standards and permits to undertake certain activities that impact water quality. Common identified advantages of regulatory approaches include:

- regulation can be a simple and universal application, such as prohibiting activities that create a risk to water quality in certain geographical areas;
- it can have low administrative costs of implementation, with broad and immediate effects on the targeted action; and
- it provides some certainty to affected parties by providing clear information on legal requirements and specifying property rights and obligations.

Despite the potential advantages of regulation as a policy tool, a number of disadvantages of regulatory approaches have been identified including:

- regulation often involves high opportunity costs, usually development opportunities foregone, together with a lack of flexibility in application and the potential for higher cost solutions. By providing a 'one size fits all' approach, often regulation does not provide incentives to find lower cost solutions or to go beyond the compliance standards set by regulators; and
- there is a high cost to governments in terms of ongoing monitoring and enforcement to ensure compliance with regulations. Monitoring is often insufficient and enforcement of regulations is limited.

Most jurisdictions now apply a test of regulatory 'best practice' to ensure that regulation is both necessary and appropriate, and that alternatives to regulation have been considered.

Regulatory approaches are often a prerequisite for alternative approaches (e.g., market creation for ecosystem services where volume-based market mechanisms are to be used) as regulations establish the underlying property rights and minimum obligations with respect to natural resource management and use.

Suasive or information approaches

Other government approaches, such as providing information, unregulated duty of care, voluntary 'best practice' codes and removing impediments to practice change, tend to provide less certain outcomes than regulated approaches. However, they can prove effective where regulation is less likely to be effective and where there are net private gains to be made from practice change.

Suasive and information approaches are often used in conjunction with regulatory and/or market approaches.

There are already a number of relevant industry best practices guidelines and technical experts available to underpin enhanced practice by farms, mines and other polluters. However, because many practices impose costs on polluters that cannot be recovered, best practice is often an insufficient policy tool on its own to achieve policy objectives.

Market approaches

Market approaches harness the ability for polluters (e.g., landholders, developers, wastewater treatment facilities) to achieve gains from trade by participating in markets that enhance overall environmental protection at a lower cost. The most common market approaches typically fall under the following broad categories:

- price-based approaches that set or modify prices to reflect the cost of providing or enhancing environmental outcomes. This includes charges, incentives, taxes etc.; and
- quantity-based approaches that set binding targets on emissions to achieve certain environmental targets. The most common approaches are cap and trade mechanisms, for example, water trading and tradable pollution licences.

Market approaches generally work best in situations where the costs and benefits of targeted management actions differ substantially between different polluting enterprises. Identified advantages of market approaches include:

- flexibility in applying market approaches can result in lower cost outcomes when compared to regulatory approaches. This is perhaps the key advantage of market approaches. Many market approaches are specifically designed to provide the most cost effective outcomes — that is, the greatest change at the lowest cost;
- they create positive, and often continuous, incentives to enhance water quality outcomes that can drive innovation;
- market approaches can reveal the realistic split between private and public benefits from actions to enhance water quality;
- voluntary participation of these approaches can result in lower monitoring and enforcement costs; and
- the use of commercial contracts can sometimes result in greater certainty than regulatory or suasive approaches.

Identified disadvantages include:

- market approaches are not suitable for all circumstances. For example, where there is very little variability between potential market participants, there will be limited gains from trade; and
- information and transaction costs for market mechanisms can be relatively high compared to some other policy approaches. These costs must be weighed up against any efficiency gains from using market approaches.

Market approaches provide an important and often complementary tool to regulation for achieving water quality objectives. However, market approaches require significant consideration before they are implemented to ensure their appropriateness to the environmental problem.

Enhancing intervention efficiency

There are a number of issues that need to be considered when looking at options to enhance intervention efficiency.

Better science and information

There are physical and socio-economic information gaps that, if addressed, will enable more effective and efficient intervention design. These include enhanced understanding of physical risks, intervention options and socio-economic consequences.

Improved information on loads and water quality will assist in understanding current and potential cumulative ambient loads and the assimilative capacities of at-risk waters. Key information requirements include:

- the relative contribution of all point source and diffuse loads by activity (e.g., mining, grazing) that create risks to EVs. This will assist in understanding the scale of risks and in prioritising actions. While there is some reasonable coverage of sediment and nutrient loads at a Basin scale, there are currently major gaps in information, particularly with respect to salinity and heavy metals;
- enhanced understanding of cumulative risks and assimilative thresholds for key regional EVs, given the expected growth of key sectors. At the moment, the cumulative impacts and thresholds are only partially understood. This creates the risk of overshooting or undershooting when establishing WQOs;
- an enhanced understanding of quantitative dose-response relationships between loads and physical impacts (e.g., relationships between heavy metal concentrations and potable water treatment requirements);
- the effectiveness of alternative risk mitigation activities and rehabilitation actions across all sources of loads and key pollutants; and
- economic analysis will be required to estimate the quantitative relationships between physical and socio-economic risks and the benefits and costs of avoiding those risks.

Once these risks and relationships are better understood, it will then be possible to establish more effective and efficient management options.

Rural diffuse loads

There has been a major focus on diffuse loads in recent years, driven by the Reef Plan and initiatives such as the Coastal Catchment Initiative, the National Heritage Trust, the National Action Plan for Salinity and Water Quality and, more recently, Reef Rescue. To date, the focus has rightly been on voluntary and incentive approaches to accelerate adoption of best management practices. However, it would be prudent to consider a number of issues with respect to rural diffuse loads, including:

- adequacy of current interventions. The adequacy of the current suite of interventions (interventions, uptake, reductions in loads etc.) needs to be assessed, particularly as information on targets is enhanced and information on the efficacy of practice change is better understood;
- effectiveness of actions. While the effectiveness of individual types of actions (e.g., changing stocking regimes) is broadly understood, there are still major gaps in information. This creates a risk of misdirected policy and incentive interventions. It would be prudent to undertake additional work to establish a better quantitative understanding of the relationships between practice change and pollutant loads, such as the paddock scale projects in the current Reef Plan Paddock to Reef Program;
- intervention choice. Only limited research and analysis has been undertaken to measure the effectiveness and efficiency of alternative intervention options. For example, while there is currently a tendency to favour extension and incentive approaches, is the structure of incentives optimal to overcome financial barriers to practice change at the lowest cost to society? It would be prudent to undertake more detailed evaluations of alternative interventions to ensure the most cost effective approaches are being adopted; and

- cost effectiveness of load reductions. It is generally understood that rural diffuse loads offer the lowest cost pollution abatement opportunities. This raises the possibility of rural areas becoming a source of water quality offsets for regulated requirements for urban diffuse and point source loads where actions in those environments is either not possible or where the costs are excessive; and
- consideration of climate change. Climate change will have a major impact on rainfall (volumes and variability), temperature, evaporation, pasture production, stock watering requirements etc. It would be prudent to consider the potential risks posed by climate change when establishing an efficient suite of interventions for rural diffuse loads.

Urban diffuse loads

The draft State Planning Policy for Healthy Waters, which advances stormwater quality management (such as WSUD), is a major policy initiative targeted at addressing urban diffuse loads. However, there are still gaps in knowledge and interventions to address urban diffuse loads including:

- management of runoff from road infrastructure;
- runoff from the construction phase of buildings and infrastructure and whether this runoff can be reduced in any cost effective manner;
- establishing cost effective options for areas that are already established (if any cost effective actions actually exist); and
- the effectiveness of existing actions when compared to the alternatives (e.g., rural diffuse actions). There may be options to meet environmental objectives at a lower cost in some circumstances via policies such as water quality offsets.

However, given the relatively low absolute contribution of urban diffuse loads at a Basin scale, a major emphasis on urban diffuse actions beyond current policy settings may only be warranted where specific local circumstances require further action.

Point source loads

The current approach to managing loads from point sources is via regulatory environmental authorities under the Environmental Protection Act 1994 (EP Act). These are specific to each regulated emitter and each has its own requirements (pollutants, loads, discharge location, timing, monitoring, reporting etc). However, the current arrangements may not be sending appropriate economic signals that provide incentives to reduce loads and cumulative risks. Consequently, cumulative impact modelling will be undertaken to refine the current approaches. Specific options worth investigating for both existing and future regulated emitters include:

- Improved information and scheduling of discharges. DEHP’s analysis of the cumulative impacts of mine discharges indicates that discharges from several mines are often undertaken concurrently, increasing the likely of material risks to EVs. While this is largely dictated by the fact multiple mines are impacted by the same rainfall event simultaneously, where climatic conditions allow it, potentially low cost option to partially mitigate the risk of cumulative discharges in some catchments (e.g., the Isaac River) could be to improve information systems to enable individual mines to coordinate the volume and timing of discharges to reduce the cumulative risks of WQOs being exceeded.

- Improved pricing signals. Current fees for environmentally relevant activities are based on a standardised aggregated environmental score for each activity type. Discounts on fees can be obtained through specific actions that reduce loads. ,
- While the current fee structure and discounts provides some form of price signal to reflect environmental damage from emissions, the fees are not an accurate reflection of the environmental risks and costs of emissions at a regional/community scale, particularly where the cumulative impacts may be critical. Significant improvements to pricing signals could be established through approaches such as load-based licence pricing (where fees directly reflect loads – not the business activity). This would then provide a continuous economic signal to reduce loads where the cost of abatement is less than the licence fee. Fee structures such as inclining block tariffs (e.g., based on concentrations) could also be considered, particularly where the risks of cumulative loads grows exponentially.
- Tradable discharge rights. Where there are several emitters into the same river system and there are obvious physical thresholds to its assimilative capacity, it would be worthwhile exploring options for tradable discharge rights in some areas (e.g., salinity discharges in the Isaac River for coal mines around Moranbah). This has the potential to simultaneously ensure EVs are protected and to reduce environmental compliance costs. The Queensland Resources Council recently indicated it would consider a feasibility study to investigate a salinity trading approach to salinity discharges. This has proved to be a successful intervention option in some circumstances, such as the Hunter Salinity Trading Scheme in NSW.
- Offsets. Often the costs of treatment at point sources can be significantly higher than potential actions outside the project site. Therefore, the use of offsets may be possible. Previous analysis by MJA has identified the potential economic opportunities for water quality offsets where enhanced land management actions can substitute for augmentations of treatment standards for wastewater treatment plants. However, it should be noted that current regulatory frameworks do not yet allow for these options. In addition, the current licence fee structure for environmental authorities may create an economic impediment to more sophisticated management approaches such as offsets.

  A variant of an offset approach could include offset-like arrangements where point source emitters establish commercial arrangements to enable the dilution of loads to ensure WQOs are not exceeded (e.g., a mining company purchases water entitlements in the water market and uses the water to mix with mine emissions).
- Beneficial reuse to reduce treatment costs. Water treatment is an expensive exercise for emitters, and opportunities for treatment and beneficial reuse on-site and off-site need to be explored in depth (e.g., reverse osmosis to remove salt and dosing for background quality before using treated water for irrigated tree crops). The coal seam gas sector has already undertaken significant research and application of this option.

It would be prudent to review and assess the abovementioned options to determine what options (and in what catchments) may simultaneously enhance environmental outcomes and deliver cost effective management options. Initially these arrangements could be tested under a pilot arrangement and at a fairly modest scale.

Ultimately, there may be a number of management actions or combinations of actions that can be undertaken to achieve the policy outcome. Consideration of the potential efficient portfolio of arrangements should be made where possible.

15.7.3 Other policy considerations

A number of other policy issues have also been identified through this project that may warrant consideration. These include:

- Policy responses need to be commensurate with risks to EVs. More consideration should be given to the assessment of relative risks associated with sources of different pollutants. It needs to be recognised that the biggest manageable source of sediment and nutrient loads is grazing and this should be the focus area for those loads. While there is little hard data, it would appear the biggest manageable source of salinity and heavy metal risk is from the mining and energy sectors. This should probably be the major focus for their regulation and actions. In short, policy responses need to be commensurate with the risks to EVs posed by each sector, firm, or farm.
- Contingencies for extreme events. There may be situations where elevated concentrations result in extreme events, even under the existing management arrangements. It may not be practicable or economically viable to establish preventative actions for these extreme and rare events and a better solution may be to establish robust contingency plans and actions.
- The need for cost-effective options. The fact that there is a significant variation in the effectiveness and cost effectiveness of different options to reduce pollution loads into receiving waterways indicates a need to ensure policy and institutional frameworks enable the most cost-effective policies to be undertaken first. This is particularly the case where some interventions may result in net economic costs to society (i.e. the cost of the improved practice exceeds the benefits derived from the improved practice).
- Retrospective or forward looking regulation? There are already a large number of regulated emitters in the Fitzroy Basin that, under some circumstances and some sub-catchments (particularly Anna Creek in the Isaac sub-catchment), could create high levels of environmental and economic risks to the broader community. However, in most sub-catchments, the risks are relatively low or negligible.

There is an economic risk of retrospectively imposing very stringent discharge requirements on existing mines (particularly for sediment loads), when the sediment discharges may pose little risk to WQOs (singularly or cumulatively), given their relative contribution to loads. Policy decisions that retrospectively impose high compliance costs on producers for little environmental gain are potentially very inefficient.

- Heavy metals. Current information on heavy metal loads, concentrations and their cumulative risks in receiving environments is incomplete. Therefore, establishing efficient targets will be difficult in the short term. The existing receiving environment monitoring program is partially addressing this issue, while significant additional effort is required to understand the environmental and economic risks before efficient policies can be designed.
- Transition paths. There are few realistic opportunities for low cost options for point source emitters to reduce pollution loads. Most options require significant capital investments, potential reconfigurations of site design and high operating costs. Therefore, it may be necessary to establish transition paths for the introduction of new requirements for existing operators.
- Groundwater quality. Consultation and analysis to date has been largely silent with respect to groundwater quality. Given the region’s reliance on groundwater and the

potential risks to groundwater from activities such as coal seam gas developments, it would be prudent to establish robust procedures and policies to manage this risk.

While resolving these policy issues is beyond the scope of this project, these issues should be addressed in order to ensure that actions to mitigate risks to EVs are both effective and efficient and do not unnecessarily jeopardise the commercial viability of existing and future developments.

Conclusions

This report has outlined and assessed the economic and social risks to water quality in the Fitzroy Basin. The key economic benefits of maintaining or improving receiving water quality to meet the WQOs and protecting the EVs will be the value of the risks avoided. While there is insufficient data and information to quantitatively estimate many of the benefits and costs of achieving the WQOs, some generalised conclusions are listed below.

- The greatest risks associated with sediment and nutrient loads come from rural diffuse loads, particularly grazing. Grazing should be the principal focus for reducing these loads.
- The risks associated with point source loads tend to be significantly different (including salinity and heavy metals). The former has been the principal focus for intervention to address coal mines point source discharges of contaminated stormwater to receiving waters.
- Not all environmental risks identified may create economic risks of a similar magnitude. Many of the economic and social risks of declining water quality may only be material under extreme and infrequent events.
- Economic risks to ecosystem functions and services could be potentially significant, but are largely non-market in nature (e.g., impacts on biodiversity). In addition, these risks will not be uniform across the Fitzroy Basin and adjacent GBR waters as the cumulative loads and assimilative capacities of each sub-catchment and stream/river system will be different.
- The economic risks faced by water-dependent sectors are also highly variable and uncertain. Generally, risks are only likely to become material where critical thresholds or concentrations are met. The most material risk to inland waterways would appear to be high concentrations of salt that may impact on yields for irrigated agriculture and potentially trigger significant cost increases in water treatment for downstream urban centres (e.g., Rockhampton). The most material risks to the GBR are largely attributable to sediment and nutrient loads, primarily attributable to existing agricultural land uses.

While there are potentially major social, economic and environmental benefits from achieving WQOs, the costs of actions to meet the WQOs can be significant — but they avoid the degradation of aquatic ecosystems and the services they provide, and the human use and public health risks from declining water quality. Protecting the environmental values for the waters of the Fitzroy Basin prevents abrupt and adverse changes in water quality that would affect livelihoods and lifestyles at a local and regional level.

Available evidence suggests that the grazing industry is already investing up to 2% of their costs in NRM, plus any funds accessed via government NRM programs. This is similar to the cost impost on households (via costs of WSUD and upgrades to wastewater treatment standards) and lifecycle wastewater management costs for mining and gas developments.

Accordingly, careful consideration will be necessary to ensure that any policies implemented are effective in mitigating material risks to EVs and are also economically efficient. To do this will require additional investment in knowledge and careful policy design.