
The economic and social impacts of protecting the environmental values of the Fitzroy Basin waters

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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.

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 2009¹ to further address contaminated stormwater discharge to receiving waters, and this is reflected in the business-as-usual case of this report.

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.

¹ Final Model Water Conditions for Coal Mines in the Fitzroy Basin, Department of Environment and Resource Management, August 2009, Pers. Comm.

- **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.
- **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.
- 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.

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.
- For point source loads, the key challenge will be to manage the downside environmental and socio-economic risks associated with current and future economic activity, 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.

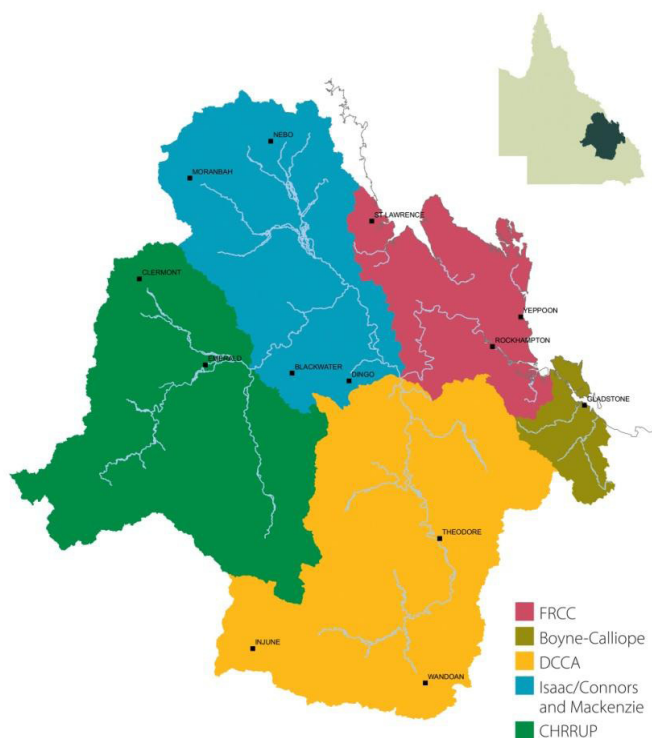
1. Introduction

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 1) 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 1: Fitzroy Basin



Source: DERM

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.

1.1. Study purpose and approach

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 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.

1.1.1. Report structure

This report 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.

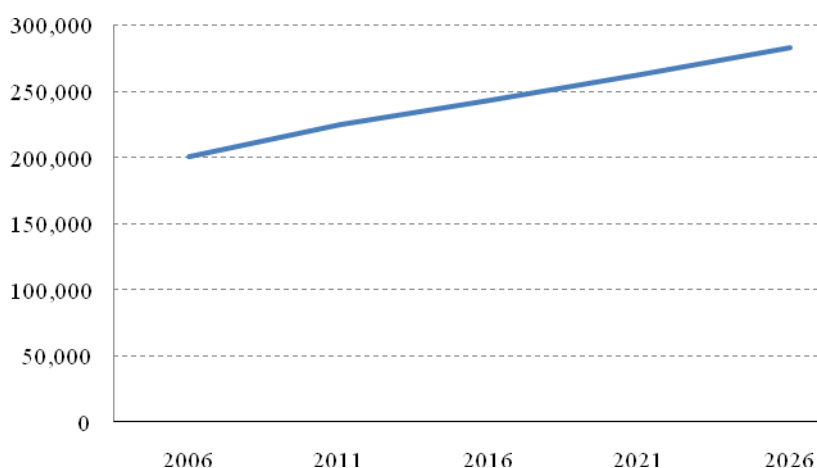
2. Regional social and economic profile

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.

2.1. 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.² The preliminary estimate for 2009 is 214,380.³ 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 2: 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).⁴ Economic

² Note: This area does not match the study area perfectly and up to date ABS data is not available specifically for the Fitzroy Basin. Therefore, this population estimate will be an overestimate.

³ Fitzroy Statistical Division, derived using 2006 Local Government Area data. Source: OESR (2010) *Fitzroy Regional Profile*, generated 17 May 2010.

⁴ OESR (2010) Household and dwelling projections Queensland Local Government Areas 2010, Brisbane.

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.⁵ 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%).⁶

2.2. 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 1: 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 services	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

⁵ Queensland Government (2007) Fitzroy and Central West Queensland: An economic powerhouse, Brisbane.

⁶ These are 2006 Local Government Areas (LGAs), which have subsequently been reformed.

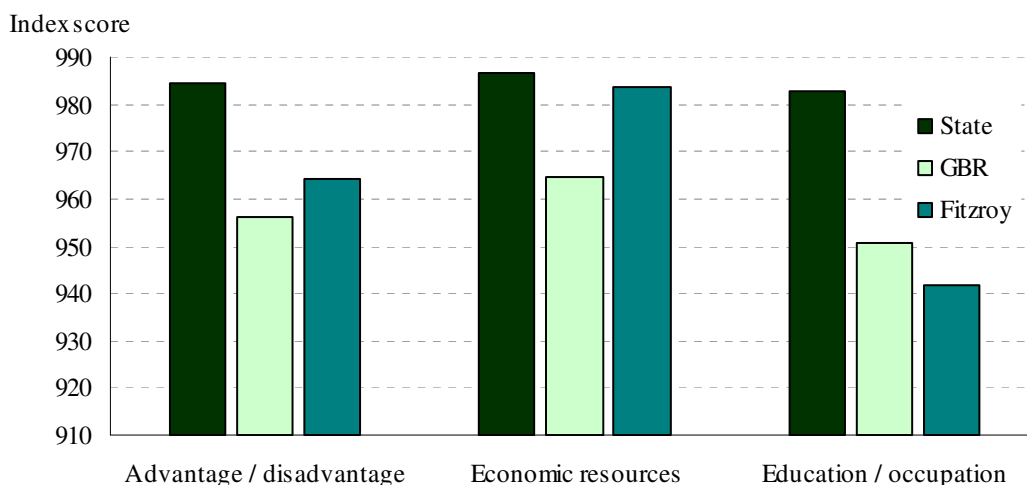
2.3. Social capacity to adjust

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.

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 3.⁷

Figure 3: 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.

⁷ Note. This is the most recent data available at the scale necessary to establish these estimates.

- 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.⁸ 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%.
- 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.

2.4. 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 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.⁹

⁸ ABS, 2006 Census data.

⁹ DEEDI, 2010, Central Queensland Mineral and Energy Projects.

- **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.¹⁰
- **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.¹¹

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 2.

Table 2: Short to medium-term relative economic growth prospects

<i>Sector</i>	<i>Growth prospects</i>	<i>Rationale</i>
Irrigated agriculture	Moderate	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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.

¹⁰ MJA (2010) Economic and Social Impacts of Water Quality Improvements Plans in the Great Barrier Reef Catchments.

¹¹ MJA (2010) Economic and Social Impacts of Water Quality Improvements Plans in the Great Barrier Reef Catchments.

<i>Sector</i>	<i>Growth prospects</i>	<i>Rationale</i>
Energy	Very significant	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ This sector will be the major beneficiary of a rapid expansion of the coal and gas sectors.
Construction	Significant	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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.

3. 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.

3.1. 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 2003.¹² This data is presented in Table 3.

Table 3: Contribution of land uses in the Fitzroy River basin to sediment and nutrient exports

	<i>Parameter</i>	<i>Forest/ savannah</i>	<i>Grazing</i>	<i>Other crops</i>	<i>Other</i>	<i>Total</i>	<i>Total export</i>
	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
	Total N (t/y)	1,672	18,344	499	93	20,608	8,071
Delivery to stream	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.

¹² Brodie et al (2003) Sources of Sediment and Nutrient Exports to the Great Barrier Reef World Heritage Area.

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).

3.1.1. 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.
- 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

Analysis of sediment, nutrient and phosphorus loads by land type undertaken by Brodie et al in 2003¹³ 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 be 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

¹³ Brodie et al (2003) Sources of Sediment and Nutrient Exports to the Great Barrier Reef World Heritage Area.

stormwater quality, waterway stability and frequent flows that can be achieved through the adoption of water sensitive urban design (WSUD).¹⁴

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),¹⁵ heavy metals (e.g., from mine discharges) and acidity/alkalinity attributable to significant soil disturbance (from several point source developments).

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 and heavy metals, particularly in some sub-regions (e.g., salt in the Isaac Catchment).¹⁶

3.2. 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 4 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 4: Draft water quality objectives (Upper Nogoa River)

<i>Draft environmental values</i>	<i>TSS</i>	<i>EC</i>	<i>SO4</i>	<i>TN</i>	<i>TP</i>	<i>pH</i>	<i>pH</i>
<i>Measure</i>	<i>Mg/L</i>	<i>µS/cm</i>	<i>Mg/L</i>	<i>µg/L</i>	<i>µg/L</i>		
Aquatic ecosystems	<u>155</u>	<u>275</u>	<u>15</u>	<u>1,000</u>	350	<u>6.5</u>	<u>8.5</u>
Irrigation		600-4,200		5,000	<u>50</u>	6	<u>8.5</u>
Farm use						6	<u>8.5</u>
Stock water		<7,500	1,000				
Human consumption							
Primary recreation						<u>6.5</u>	<u>8.5</u>
Secondary recreation							
Visual appreciation							
Drinking water							
Industrial use							
Cultural/spiritual values							

Source: DERM.

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.

¹⁴ Water by Design (2009). A Business Case for Best Practice Urban Stormwater Management. South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.

¹⁵ DERM (2009) Cumulative Impacts on the Water Quality of Mining activities in the Fitzroy Basin. Report to the Queensland Government by the Department of Environment and Resource Management, April 2009.

¹⁶ Hart (2008) Review of the Fitzroy River Water Quality Issues. Report to the Queensland Premier, November 2008. <http://fitzroyriver.qld.gov.au/pdf/fitzroyriverwaterqualityreport.pdf>.

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.

3.3. 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.

3.3.1. 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 2005–06.¹⁷ 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.¹⁸ 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).
- 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.

¹⁷ Fitzroy Basin Association (2004) The Central Queensland Strategy for Sustainability – 2004 and Beyond (CQSS2).

¹⁸ Johnstone, N., (2007) FBA Interim Water Quality Target.

3.3.2. 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.¹⁹ 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.
- Harmonise water cycle practices across and within the institutions responsible for waterway health, flood management, pollution prevention and protection of social amenity.²⁰

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.).

3.3.3. 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

¹⁹ Water by Design (2009). A Business Case for Best Practice Urban Stormwater Management. South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.

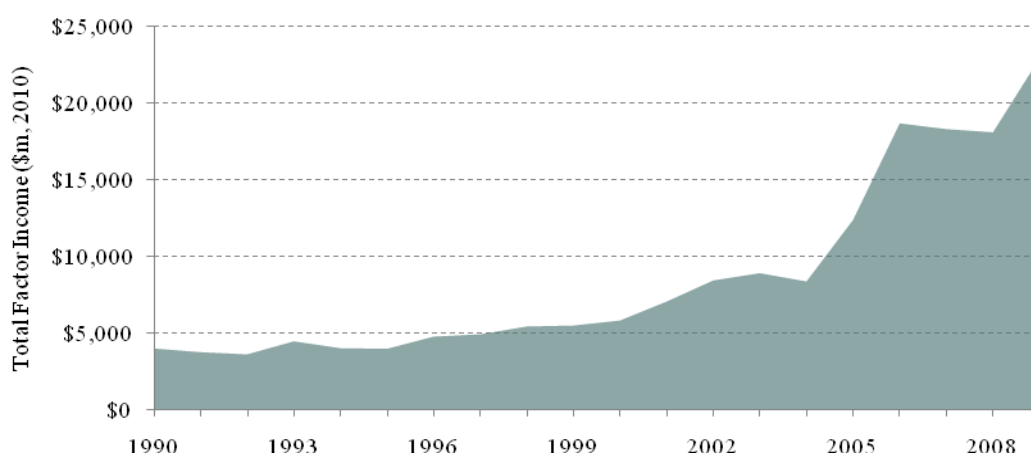
²⁰ National Water Commission (2010). Water Sensitive Urban Design. www.nwc.gov.au/www/html/216-water-sensitive-urban-design.asp?intSiteID=1.

investment in wastewater treatment plant upgrades to reduce concentrations of discharges of key pollutants into receiving waters.

3.4. Future load increases and risks to EVs

Our analysis outlined in Section 2.4 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. Growth in these sectors will also create additional water use and increase discharges into the Fitzroy Basin. Recent growth in the mining sector is shown in Figure 4, expressed in terms of total factor income.

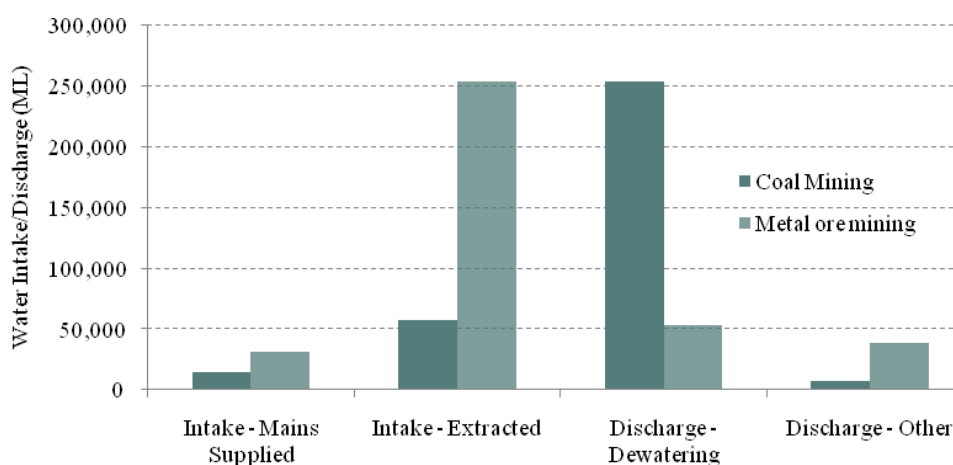
Figure 4: Growth in the mining sector



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

It is clear that mining activities will continue to present an increasing risk to EVs as discharge loads continue to grow. Discharges relate very closely to water use in the mining sector (see Figure 5).

Figure 5: Water intake and discharge by the mining sector in Australia (2000)



Source: ABS 4603.0 Table 2.11

3.4.1. 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.
- **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.

4. 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.
- Where possible, economic estimates of the value of some key benefits of achieving the WQOs.

4.1. 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).²¹ 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.
- 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 5 outlines 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.

²¹ Freeman, A. M. (1993). *The Measurement of Environmental and Resource Values. Theory and Methods.*

Table 5: 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*.

4.2. 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.
- 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 6 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 6: Water quality risks from point and diffuse source loads and the associated economic and social impacts

<i>Risk class</i>	<i>Risks attributable to poor water quality</i>	<i>Example economic & social impacts</i>	<i>Frequency and magnitude of economic & social impacts</i>
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).	<i>Frequency:</i> Infrequent, but frequency may increase as cumulative loads increase and treatment thresholds are exceeded more often. <i>Magnitude:</i> 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.	<i>Frequency:</i> Infrequent. <i>Magnitude:</i> 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.	<i>Frequency:</i> Infrequent. <i>Magnitude:</i> 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.	<i>Frequency:</i> Constant impact attributable to rural diffuse loads, but with significant variation. <i>Magnitude:</i> 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.

<i>Risk class</i>	<i>Risks attributable to poor water quality</i>	<i>Example economic & social impacts</i>	<i>Frequency and magnitude of economic & social impacts</i>
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.	<i>Frequency:</i> Generally infrequent. <i>Magnitude:</i> 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.	<i>Frequency:</i> Infrequent. <i>Magnitude:</i> 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.	<i>Frequency:</i> Impacts likely to be infrequent. <i>Magnitude:</i> 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.

4.3. 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.

4.3.1. 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).
- 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.

4.3.2. 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.²²

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 7 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 7: Indicative benefits of maintaining inland waterway health (\$ millions)

<i>Avoided decline in environmental function / condition</i>	<i>1%</i>	<i>2%</i>	<i>5%</i>	<i>10%</i>
Annual value to current population in Fitzroy Basin	0.5	1.1	2.7	5.5
Capitalised value ²³	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.
- Significant recreational activity and nature-based tourism activity in the Fitzroy Basin is directly or indirectly reliant on the maintenance of waterway health.

²² Rolfe J., and Windle J. (2006) Non market values for improved NRM outcomes in Queensland.

²³ 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%.

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.

4.3.3. 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 8 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 8: Area of crops, irrigation and water use for irrigation

<i>Pastures and crops</i>	<i>Area of agricultural holding '000 ha</i>	<i>Area irrigated '000 ha</i>	<i>Application rate ML/ha</i>
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

ABS (2008) Water Use on Australian Farms 2005-06.

Elevated salinity levels can have a detrimental impact on productivity by essentially mimicking the effects of drought on the crops. Table 9 provides indicative electrical conductivity (EC) tolerances for crops typically grown in the Fitzroy Basin.

Table 9: Irrigated crops and tolerance of plants to salinity in irrigation

<i>Pastures and crops</i>	<i>Electrical conductivity (EC) (dS/m) threshold for yield reduction for crops growing in</i>		
	<i>sand</i>	<i>Loam</i>	<i>clay</i>
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)

Note: 1 dS/m= 1,000 µS/cm.

Source: ABS (2008) Water Use on Australian Farms 2005-06, and Queensland Government: DERM (2009) Irrigation water quality—salinity and soil structure stability

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.²⁴

The dominant primary industry in the Fitzroy Basin is beef cattle, with an estimated 2.8 million head in the Fitzroy NRM region.²⁵ Some of this production is intensive, with the estimated number of cattle in feedlots at approximately 160,000.²⁶ 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.

4.3.4. 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 10 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.

²⁴ MJA (2007) Economic and social report on the proposed amendment to the Pioneer Valley Water Resource Plan to include groundwater.

²⁵ ABS (2008) Agricultural Commodities: Small Area Data, Australia, 2006-07, Cat. No. 7125.0.

²⁶ DEEDI (2010) Unpublished feedlot registration statistics.

Table 10: Indicative water treatment costs

<i>Pollutant</i>	<i>Treatment</i>	<i>Potential costs</i>
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.

4.4. 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.
- **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.

5. 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.

5.1. 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.
- 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.

5.2. 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^{27,28} 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.

²⁷ ABARE (2006) Australian farms: natural resource management in 2004-05.

²⁸ ABARE (2005) Australian Beef 05.01

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 process²⁹ indicates significant decreases in sediment loads can be achieved from increasing average ground cover. It was estimated 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 overlaid the data from the loads modelling used for the planning exercise with economic estimates of changing ground cover estimated by Donaghy et al. (2007)³⁰ 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...

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.
- 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.

²⁹ Johnstone, N., (2007) FBA Interim Water Quality Target.

³⁰ 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.

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.

5.2.1. 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.
- 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.

5.3. 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.³¹ Based on the load reductions and cost estimates for an efficient set of WSUD infrastructure to meet the policy objectives developed³² 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.

³¹ Water by Design (2009). A Business Case for Best Practice Urban Stormwater Management. South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.

³² This included capital, refurbishment and operating costs for infrastructure such as rainwater tanks, bioretention basins etc.

5.4. 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,³³ MJA has estimated the range of costs involved in augmenting treatment standards. Costs are outlined in Table 11 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 11: Indicative wastewater treatment costs (\$ per tonne of pollutant removed)

<i>Annual wastewater treatment costs</i>	<i>Low</i>	<i>Mid</i>	<i>High</i>
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.

5.5. 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.

5.6. 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 and discharges on mines 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,³⁴ and is becoming a major environmental management issue for the emerging coal seam gas industry.

³³ 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.

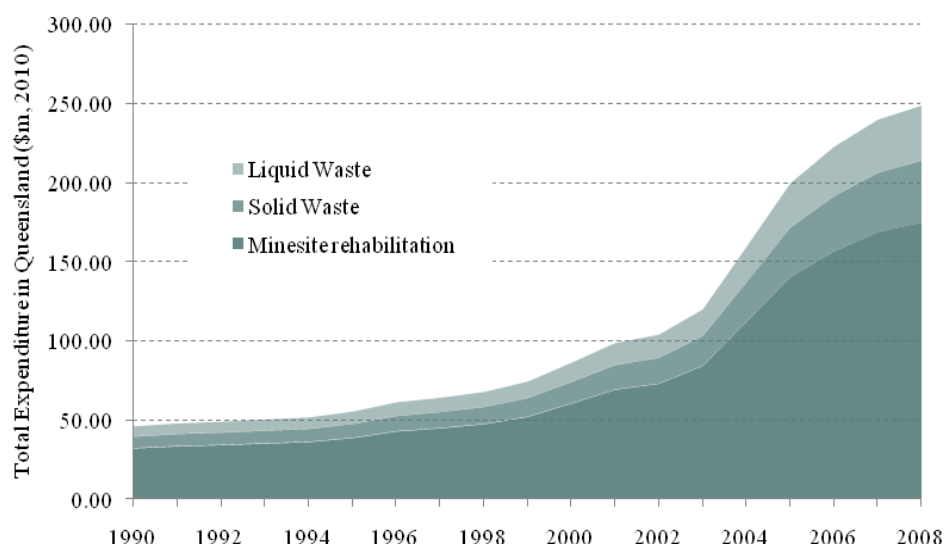
³⁴ Firth., B etc al (2002) Remediation of Saline Water from Coal Mining, CSIRO publishing.

- Waste stream disposal costs.
- Mitigation and remediation costs in the event of spillage or illegal discharge.
- Rehabilitation costs.
- Monitoring, reporting and stakeholder liaison.

Publicly available information on water treatment costs is 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 Figures 6 and 7 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.

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. MJA estimates that approximately 70% of environmental expenditure in any given year is for mine site rehabilitation, 16% for solid waste management, and 14% for liquid waste management.

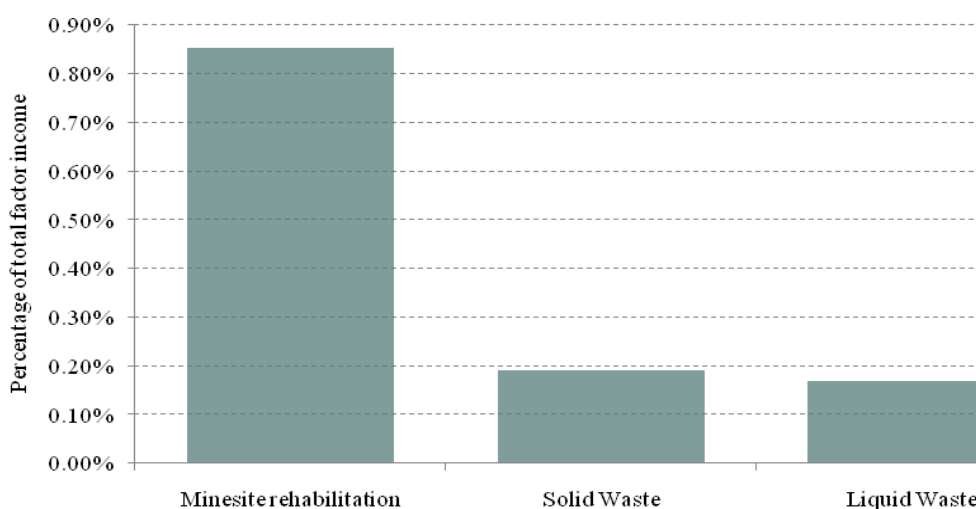
Figure 6: Estimated expenditure on environmental management by the Queensland mining industry, 1990-2008



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

While environmental costs vary considerably (depending on site conditions, commodity, loads, regulatory requirements etc), they rarely exceed more than 2% of total factor income for the mining sector.

Figure 7: Environmental expenditure as a percentage of total factor income in the Queensland mining industry



Source: ABS 4603.0 Table 2.4, ABS 5220.0 Table 4 and MJA estimates

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.³⁵
- 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.³⁶

³⁵ Cote., C et al (2007). Evaluating the costs and benefits of mine salt management using a systems model, Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland.

³⁶ Franks, D.M, Cohen, T, McLellan, B and D, Brereton (2010). Technology Futures Discussion Paper: Technology Assessment and the CSIRO Minerals Down Under National Research Flagship.

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.

6. Implementation issues

This section outlines some of the key issues for implementing policies, programs and projects to meet the WQOs and protect the EVs.

6.1. 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.

6.1.1. 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.
- 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.
- 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.

6.1.2. 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.

6.1.3. 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.
- 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.
- The use of commercial contracts can sometimes result in greater certainty than regulatory or persuasive 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.
- 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.

6.2. Enhancing intervention efficiency

There are a number of issues that need to be considered when looking at options to enhance intervention efficiency.

6.2.1. 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.
- 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.

6.2.2. 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.
- **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.
- **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.

6.2.3. 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).
- 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.

6.2.4. 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.** DERM's analysis of the cumulative impacts of mine discharges³⁷ indicates that discharges from several mines are often undertaken concurrently, increasing the likely of material risks to EVs. A 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.^{38,39}

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. This has proved to be a successful intervention option in some circumstances, such as the Hunter Salinity Trading Scheme in NSW.⁴⁰
- **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.⁴¹ 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.

³⁷ DERM (2009) Cumulative Impacts on the Water Quality of Mining activities in the Fitzroy Basin. Report to the Queensland Government by the Department of Environment and Resource Management, April 2009.

³⁸ For example, meat processing with a volume of 1,000-5,000 tonnes per annum accrues an AES score of 16 and an annual fee of \$3,200.

³⁹ DERM (2010) Summary of annual fees for environmentally relevant activities (ERAs) <http://www.derm.qld.gov.au/register/p00680aa.pdf>, accessed 10 May 2010.

⁴⁰ Department of Environment and Conservation (2003) Hunter River Salinity Trading Scheme: Working together to protect river quality and sustain economic development.

⁴¹ MJA (2010) Economic and Social Impacts of Water Quality Improvements Plans in the Great Barrier Reef Catchments.

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.

6.3. 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.
- **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.

7. 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 can be made, including:

- 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 would appear to be high concentrations of salt from primarily mining operations that may impact on yields for irrigated agriculture and potentially trigger significant cost increases in water treatment for downstream urban centres (e.g., Rockhampton).

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.