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The economic and social impacts of protecting the environmental values of the waters of the Capricorn and Curtis Coasts

Report prepared for the Department of Environment and Heritage Protection

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Glossary

ABS	Australian Bureau of Statistics
ATSI	Aboriginal and Torres Strait Islander
BMP	Best Management Practice
BPEM	Best practice environmental management
DAFF	Department of Agriculture, Fisheries and Forestry (Queensland)
DSITIA	Department of Science, Information Technology, Innovation and the Arts (Queensland)
EHP	Department of Environment and Heritage Protection (Queensland)
EV	Environmental value
FBA	Fitzroy Basin Association
FTE	Full-time equivalent
GAWB	Gladstone Area Water Board
GBR	Great Barrier Reef
GBRMPA	Great Barrier Reef Marine Park Authority
GRP	Gross regional product
LNG	Liquefied natural gas
NRM	Natural resource management
SEIFA	Socio-Economic Indexes For Areas
TEV	Total economic value
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended sediment
WQIP	Water Quality Improvement Plan
WQO	Water Quality Objective
WSUD	Water sensitive urban design
WWTP	Wastewater treatment plant

Key messages

Protecting the environmental values (EVs) of the waters of the Capricorn and Curtis Coasts is vital to the long-term prosperity of each region. Through a process of robust science and meaningful consultation, EVs and water quality objectives (WQOs) are being established for each region.

Consultation undertaken by the Fitzroy Basin Association and previous research has consistently recognised the importance of maintaining the condition of freshwater and marine aquatic ecosystems in the Capricorn and Curtis Coast regions. Where the condition of the aquatic ecosystem declines, key ecosystem functions and services also decline, affecting key sectors such as tourism, agriculture, fishing and recreation.

There is a strong case for maintaining and enhancing waterway health in the region in conjunction with facilitating sustainable regional development. The challenge for policy makers is recognising the trade-offs between regional development and waterway health and establishing development pathways that genuinely meet both objectives.

Capricorn Coast

For the Capricorn Coast there have been a number of benefits identified from maintaining EVs including:

- aquatic ecosystems, ecosystem function and services—<u>provision of direct use values</u>, providing jobs and income to the local, regional and national economy, including through the following channels, for example:
  - maintaining a regionally significant tourism sector, largely reliant on the condition of waterway and coastal waters ecosystem health to continue to attract visitors;
  - providing recreation, boating and other aesthetic benefits to the community;
  - providing reliable and lower cost inputs to other sectors including agriculture, mining, construction and water utilities; and
- ensuring a sustainable and prosperous fishing sector (recreational and commercial), aquatic ecosystems, ecosystem function and services—<u>provision of in-direct use values</u>, including through the following channels, for example:
  - biological support for marine biodiversity, fisheries, etc., and support for other ecosystems;
  - physical protection of coastal ecosystems, shoreline, etc.;
- <u>providing non-market or non-use values</u>; for example existence, bequest, option (future direct and indirect use) and cultural and spiritual values.

Risks to EVs in the Capricorn Coast are relatively lower than in many other parts of the Great Barrier Reef (GBR) catchments. The economic drivers of risks to EVs in the Capricorn Coast region include further agricultural development (cattle and irrigated agriculture – low risk), further urban development (particularly in the narrow coastal zone) and tourism development in specific areas.

Given the nature of the risks and current regulatory and policy measures to mitigate risks to EVs, the costs of maintaining EVs in the Capricorn Coast are likely to be manageable, particularly given the costs will be primarily borne by the entities creating the risks.

Curtis Coast

The Curtis Coast region has a similar scope of benefits – attributable to the maintenance of the condition of freshwater and marine aquatic ecosystems and the range of human use EVs for the tidal and non-tidal waters – to the Capricorn Coast region.

The Curtis Coast is arguably the fastest developing region along the GBR coastline, with a number of world-scale industrial developments triggering significant changes to land use and potential risks to EVs in the region.

In response to these industrial developments, a number of comprehensive strategies have been put in place to ensure development is able to proceed while still being broadly consistent with protecting the EVs through the maintenance of water quality objectives. These initiatives range from comprehensive whole-of-Reef strategies, to baseline water quality monitoring, through to project-specific regulatory requirements for major projects. Within the Curtis Coast region, the costs of these initiatives are primarily borne by the development projects, as part of the conditions attached to the approval of the developments.

Measures in place appear reasonable given the EVs in the region and the outstanding universal values of the GBR. Regulatory requirements under development approvals have been designed to mitigate costs from externalities. While meeting the environmental conditions of development approvals has imposed costs on developments, there is no evidence to suggest that the requirements have made any of the projects non-commercial.

1. Introduction

The Queensland Department of Environment and Heritage Protection (EHP) commissioned Marsden Jacob Associates to assess *"The economic and social impacts of protecting the environmental values of the waters of the Capricorn and Curtis Coasts."* A draft of this report was released for public comment in April 2014 on the EHP website. This is the final report.

A useful definition of environmental values (EVs) is:

> *...those qualities of the waterway that make it suitable to support particular aquatic ecosystems and human uses. This can range from aquatic ecosystems and primary recreation values through to industry and irrigation uses...Environmental values are essentially community aspirations on what human uses and aquatic ecosystem functions people expect from their local waters.*[1]

1.1 Terms of reference

The terms of reference for the study are to:

Assess and report the economic and social impacts of protecting the environmental values of the waters of the Styx, Shoalwater, Waterpark, Curtis Island, Calliope and Boyne drainage basins[2] *and associated Great Barrier Reef waters in accordance with:*

- *the requirements of section 11 (3) (b) of the Environmental Protection (Water) Policy 2009 (EPP Water 2009), and*
- *the general technical and policy framework of the report The Economic and social impacts of protecting environmental values in the Great Barrier Reef catchment waters and reef lagoon, Marsden Jacob Associates, March 2010 (MJA Report).*

1.2 Purpose of this study

The purpose of this study was to identify, scope, and, where possible, value the benefits of achieving water quality objectives (WQOs) in the Capricorn and Curtis Coast regions, which are comprised of the drainage basins identified in the terms of reference (see Figure 1). These regions are essentially the coastal basins and associated Great Barrier Reef (GBR) waters that are east of the much larger Fitzroy Basin. The Capricorn Coast region includes the Styx, Shoalwater and Waterpark drainage basins and adjacent Queensland coastal waters, while the Curtis Coast region includes the Calliope, Curtis Island and Boyne drainage basins and adjacent Queensland coastal waters.

This study was undertaken based on publicly available information and data, and as a desktop exercise. The consequence of this is that, given quantitative values established regarding EVs have sometimes used different approaches, they cannot be imported into a formal cost-benefit

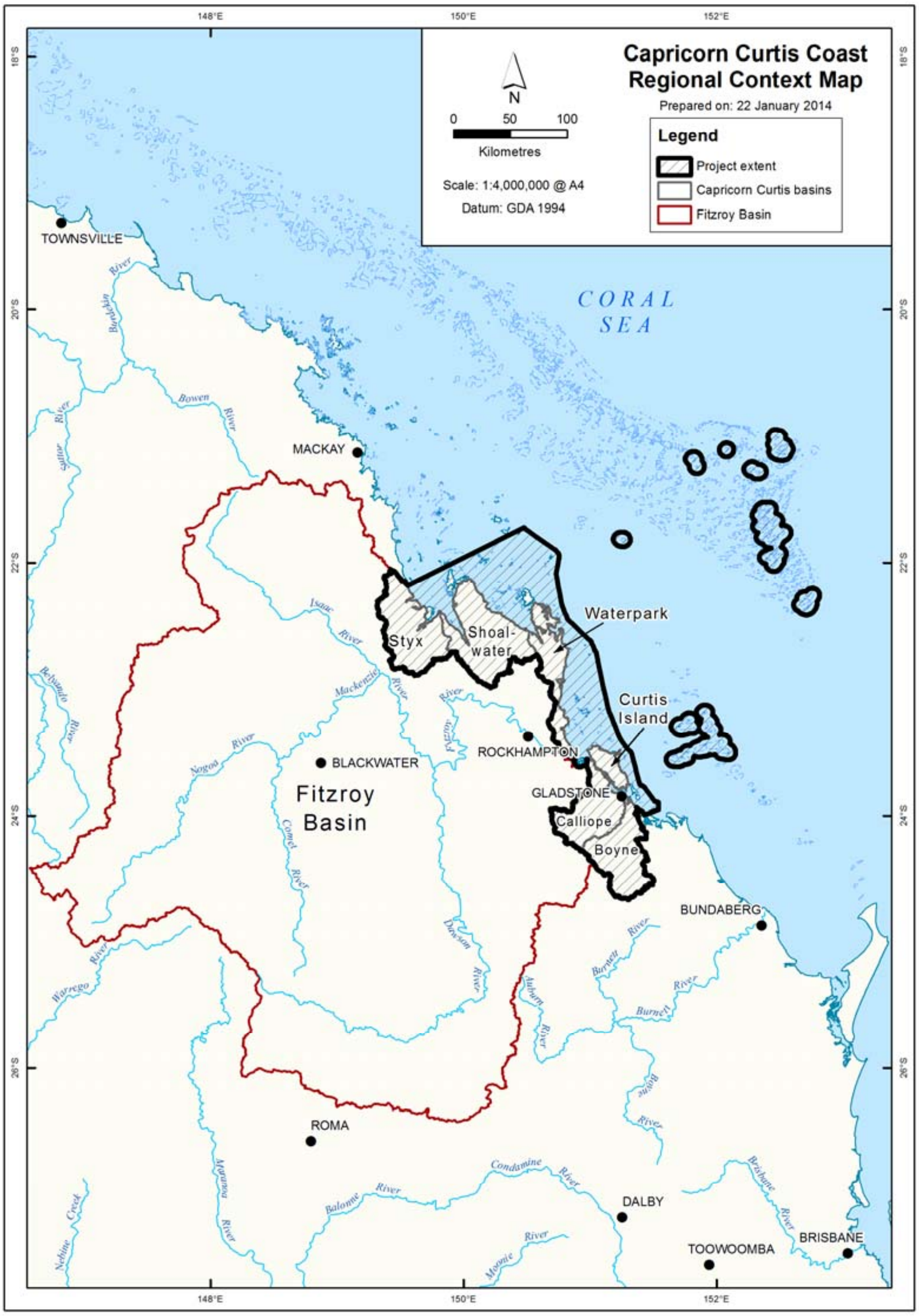
1 Fitzroy Basin Association (2014) *Draft Community Consultation Report Establishing Environmental Values and Water Quality Objectives for Capricorn and Curtis Coastal Basins and Coastal Waters*, February 2014, p. 6 and p. 8.

2 Includes the following Australian Drainage Division and River Basins: Styx (127), Shoalwater (128), Waterpark (129), Curtis Island (131), Calliope (132) and Boyne (133).

analysis. In addition, there are not yet any formal future estimates of loads and the impacts on key environmental assets and functions attributable to those loads.

Therefore, a formal cost-benefit analysis has not been undertaken using the information and data in this report. Rather, this report summarises a number of lines of evidence to assist in understanding the economic and social context of waterway health in the region, and the *potential* benefits and costs associated with managing waterway health.

Figure 1: Regional context map



Source: EHP, 2014.

1.3 Context

1.3.1 Declining water quality in the waters of the Great Barrier Reef

The GBR is an extraordinary part of Queensland's natural heritage and a major economic resource. It supports over 60,000 tourism jobs and is worth around $6 billion to the Queensland economy annually.[3]

The scientific evidence of declining water quality within the GBR is well documented and widely accepted. The following reports have been instrumental in the formation of the Queensland and Australian Governments' water quality policy:

- the Reef Water Quality Protection Plan, First Report;
- the Great Barrier Reef First Report Card, 2009 Baseline;
- Reef Water Quality Protection Plan, August 2011, Australian and Queensland Governments' publication (at www.reefplan.qld.gov.au); and
- the scientific consensus statement prepared for the Queensland Government.

The GBR second report card (April 2013) provides an update on the status of land management actions throughout GBR catchments and information on the condition of marine water quality, sea grass and corals.

The key contaminants contributing to declining water quality in reef catchments and coastal waters are nutrients, toxicants (including pesticides and herbicides) and sediments. These contaminants are sourced from land-based activities, including from:

- **rural diffuse source emissions**: stormwater run-off containing sediments, nutrients and toxicants (including pesticides and herbicides) from rural land use activities;
- **urban diffuse source emissions**: contaminated stormwater run-off from regulated urban land development and its construction and from established urban areas, including contaminants from roads and nutrients and pesticides from household lawns and urban parks and gardens; and
- **point source emissions**: primarily wastewater discharges from regulated activities.

1.3.2 Initiatives and programs to address land-based contaminant emissions

The Queensland Government is committed to the ongoing protection of the GBR through a range of initiatives and programs to address land-based contaminant emissions, including:

- **Reef Water Quality Protection Plan 2013**. Through the Reef Water Quality Protection Plan (and supporting water quality improvement plans where prepared), major on-ground investments have been made to improve the water quality of the reef catchments.
- **Cane and Grazing Best Management Practices Program**. The Queensland Government is working in partnership with industry to set in place a Best Management Practice (BMP) program for the cane and grazing industries.
- **Strategic Assessment**. The Queensland Government and the Australian Government's Great Barrier Reef Marine Park Authority (GBRMPA) are undertaking a comprehensive

3 Deloitte Access Economics (2013) *Economic contribution of the Great Barrier Reef*, report prepared for the Great Barrier Reef Marine Park Authority.

strategic assessment of the GBR World Heritage Area and the adjacent coastal zone. The strategic assessment includes:

- a coastal zone component, led by the Queensland Government, examining the State's coastal management, planning and development framework and how it provides environmental protection along the coastal zone, adjacent to the GBR; and
- a marine component, led by GBRMPA, examining the arrangements in place to manage and protect the GBR Marine Park and World Heritage Area.

The GBR Strategic Assessment was released for public consultation, with submissions having closed on 31 January 2014. Further information on the strategic assessment is available from http://www.dsdip.qld.gov.au/gbr-strategic-assessment/.

- **Gladstone Healthy Harbour Partnership.** A forum to bring together parties (including community, industry, science, government, statutory bodies and management) to maintain and, where necessary, improve the health of Gladstone Harbour. The guiding principles of the Partnership are open, honest and accountable management, annual reporting of the health of the Gladstone Harbour and management recommendations and action based on rigorous science and strong stakeholder engagement to ensure the ongoing and continuous improvement in the health of Gladstone Harbour.

Further details on Queensland Government actions pertaining to reef protection are provided on the Reef Facts website at http://www.reeffacts.qld.gov.au/ .

Additionally, the **Single State Planning Policy** (finalised in December 2013) provides a range of state interests under the Sustainable Planning Act 2009. State interests include water quality, wherein urban land development and its construction are planned, designed, constructed and operated to protect environmental values and support the achievement of water quality objectives under the *Environmental Protection (Water) Policy 2009.*[4]

At the Commonwealth level, another relevant policy is $400 million voluntary **Reef Rescue** program. Under this program, the Commonwealth has provided grants to fund on-farm activities by landholders that improve the quality of water entering the GBR lagoon.[5]

1.3.3 Regional context: Establishing local environmental values and water quality objectives in the Fitzroy and Capricorn-Curtis Coast areas

With a view to improving the resilience of the GBR by advancing local (and reef) water quality protection, EHP has developed local-scale EVs, WQOs and aquatic ecosystems mapping for key reef catchments and associated coastal waters.

EVs and WQOs for the Fitzroy Basin (adjacent to the current project area) were the subject of a separate EVs process and were finalised in September 2011. Documents and plans are available on the EHP website. Reference to Figure 1 shows that the Fitzroy Basin is substantially larger than the Capricorn and Curtis Coast project area. (The Fitzroy Basin is approximately 143,000km^2 in area whereas the current project area, comprising six river basins, is about

4 Environmental values for tidal and non-tidal waters include aquatic ecosystems and human uses (e.g. agriculture, human consumption of aquatic foods, industry, recreation and aesthetics, drinking water and cultural and spiritual values). Water quality objectives are long-term objectives for receiving waters (e.g. pH, suspended solids) that protect the environmental values. They are not end-of-pipe emission standards.

5 See http://www.nrm.gov.au/funding/reef-rescue/

13,800 km^2 in area.) Information on land-sourced sediment and nutrient loads in this report also identifies that the bulk of the loads is from the Fitzroy Basin.

Draft EVs and WQOs for the Capricorn and Curtis Coasts Regions were published at EHP's website for public comment from April to June 2014. A draft of this report and a report on consultation activities were also released for public comment[6]. Final EVs and WQOs are listed on the EHP website (www.ehp.qld.gov.au), and inform local-scale natural resource management and land development planning and decision-making.

Locally derived EVs, WQOs and associated spatial mapping for reef catchments and coastal waters inform:

- planning and decision making for new developments involving wastewater discharges to receiving waters (e.g. for point source environmentally relevant activities) under the Environmental Protection Act 1994;
- Local Government planning and decision making for urban land development under the Single State Planning Policy (Water Quality State Interest) (Sustainable Planning Act 2009)—at the scale of local land development;
- BMP approaches for cane and grazing activities to address diffuse emissions from rural lands—at property / paddock scale;
- the local scale natural resource management planning and decision-making by community-based regional natural resource management (NRM) bodies – the Fitzroy Basin Association (FBA) for the Capricorn and Curtis Coast regions; and
- the development of water resource plans under the Water Act 2000.

These actions address sources of contaminant emissions, advancing reef catchments and GBR coastal water quality and improving resilience.

1.3.4 Water quality objectives and the Four Pillars underpinning Queensland's economic development

The WQOs for Queensland waters are set within the context of the Queensland Government's State development priorities, the Four Pillars. In 2012, the State Government established an economic development strategy for Queensland based around the following Four Pillars for economic growth.

Agriculture

Queensland's agricultural exports were valued at $8.9 billion, 16% of the state's commodity exports by value, in 2012-13.[7] Queensland's agriculture strategy sets the goal to double the value of Queensland's agricultural production by 2040. The four key pathways to achieving this goal include:

- increasing resource availability (e.g. water for irrigation);
- driving productivity growth through innovation and bio-security;

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6 Fitzroy Basin Association (2014) *Draft Community Consultation Report Establishing Environmental Values and Water Quality Objectives for Capricorn and Curtis Coastal Basins and Coastal Waters*, February 2014, and Queensland Government (2014) *Aquatic ecosystem water quality guidelines: Capricorn-Curtis Coast region*.

7 Queensland Government Department of Agriculture, Fisheries and Forestry (2013) *Queensland's Agriculture Strategy: A 2040 vision to double agriculture production*, June 2013.

- focusing on access to key growth markets; and
- enhancing production and supply chain inputs to lower the costs of production.[8]

The quality of the State's land and water resources is critical to sustainable cropping, aquaculture and fishing.

Resources

Coal, petroleum and minerals currently comprise in excess of 60% of Queensland's exports by value.[9] The resources sector underpins a significant share of the Queensland economy, with direct spending of around $36 billion in 2011-12, 64,300 residing full-time equivalent (FTE) employees and with $8 billion of associated salaries.[10] Further there is a large expected benefit from the anticipated commencement of LNG production and export from terminals at Curtis Island off Gladstone in the next few years. LNG exports are expected to boost exports in 2015-16 to a growth rate of 23¼% and are forecast to boost gross state product (GSP) growth in the same year to 6%.[11]

The Government's objective is to grow the resources industry through higher levels of productivity and innovation. The continuing sustainable management and development of current and future activities is necessary to protect Queensland's water environment.

Construction

Construction is also a key activity underpinning economic growth, with the construction industry directly accounting for around 10% of the State workforce. Within the study region, construction is particularly important in the Gladstone region, with a large construction workforce on Curtis Island building the LNG production and export facilities, which are all being constructed by Bechtel. Bechtel's workforce for the Curtis Island projects is, as at November 2013, around 10,550 and is expected to peak in 2014 at around 11,000.[12] The estimated construction value of the three LNG plants is around $62 billion.[13]

The State is focussing on growth in the broader construction sector through a number of planning initiatives (e.g. changes in planning regulation to expedite planning processes) through to targeting grants for first time home owners who build a new home. The State interest in water quality is achieved by land development and construction that is planned, designed, constructed and operated to protect EVs of Queensland waters and support the achievement of water quality objectives.

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8 Queensland Government (2012) Queensland Agricultural Strategy: a 2040 vision to double the value of production – discussion paper.

9 Government Statistician, Queensland Treasury and Trade (2012) *Exports from Queensland and Australia to all countries, by commodity, value, 2011-12* and Department of Transport and Main Roads (2013) *Trade Statistics for Queensland Ports for the five years ending 30 June 2012*.

10 Lawrence Consulting (2012) *Economic Impact of the Resources Sector on the Queensland Economy 2011/12*, prepared for Queensland Resources Council, p. iv.

11 Queensland Government (2013) *Budget Strategy and Outlook 2013-14*, p. 31.

12 Kevin Berg, GM Gladstone, Bechtel, presentation to Energy Skills Queensland conference, 4 November 2013.

13 Bureau of Resources and Energy Economics (2013) *Resources and Energy Major Projects*, p. 16.

Tourism

The Queensland Government recognises tourism as one of the four pillars of our economy and has a growth target for the tourism sector to reach $30 billion in overnight visitor expenditure by 2020.[14, 15]. *Destination success: the 20 year plan for Queensland tourism* outlines the direction for tourism in Queensland (refer http://www.destq.com.au/20-year-plan). The main goal of *Destination success* is to make Queensland the number one tourist destination in Australia, with a medium-term goal of achieving the national Tourism 2020 target (i.e. doubling 2010 visitor expenditure to $30 billion by 2020).

Destination success contains six themes to direct efforts. The 2nd theme - Preserve our nature and culture - recognises the strong links between natural assets (including rivers, the Great Barrier reef, beaches, etc.) and tourism, stating '*To be competitive and successful over the next 20 years, we will preserve our nature and culture: Natural assets will continue to be the heart of the Queensland experience—able to be enjoyed by visitors and locals alike, and preserved for future generations…*'. Water quality of rivers, streams, wetlands and coastal waters underpins the tourism sector and outdoor recreation opportunities for all residents and visitors.

The *Queensland Ecotourism Plan* (2013–2020) has been prepared by the Queensland Government in recognition of the key role played by the environment in ecotourism experiences. (State of Queensland, 2013, Queensland Parks and Wildlife Service, available at http://www.nprsr.qld.gov.au/tourism/pdf/final-ecotourism-plan-2013.pdf).

The process to identify EVs and WQOs is consistent with the drivers and directions established in the plan, including:

- Recent international visitor research reveals Australia's biggest strength is its 'world class beauty' and natural environments, rated number one by visitor markets.
- Interest in nature is high amongst actual visitors to Australia, with 62% of international visitors engaging in nature-based activities.
- The strong interest of visitors in nature-based activities highlights the value of ecotourism to the Queensland economy. With nature-based activities across Queensland, ecotourism is an important driver of regional dispersal and contributor to regional economies.
- Successful ecotourism relies on the maintaining the natural values that are the basis for ecotourism: '*It is the quality of Queensland's unique natural environment with its rich biodiversity and wildlife that is the foundation of the state's tourism competitive advantage. Visitors' experiences are enriched by the outstanding natural and cultural values they encounter. Recognition of this advantage is the first step in making Queensland a world leader in ecotourism by 2020. Through best practice ecotourism, Queensland can deliver world-class experiences that retain the inherent natural values upon which the tourism industry depends and contribute to the sustainability of the natural areas as well as socially and economically to local communities.'*

[14] See http://www.business.qld.gov.au/industry/tourism/tourism-in-queensland/queenslands-tourism-industry/tourism-2020-strategy

[15] Tourism and Events Queensland (2013) *Tourism and Events Queensland Strategic Plan 2013-17*.

The need to conserve the natural values on which ecotourism is based is also reflected in the vision of the *Queensland Ecotourism Plan*, to be achieved by 2020:

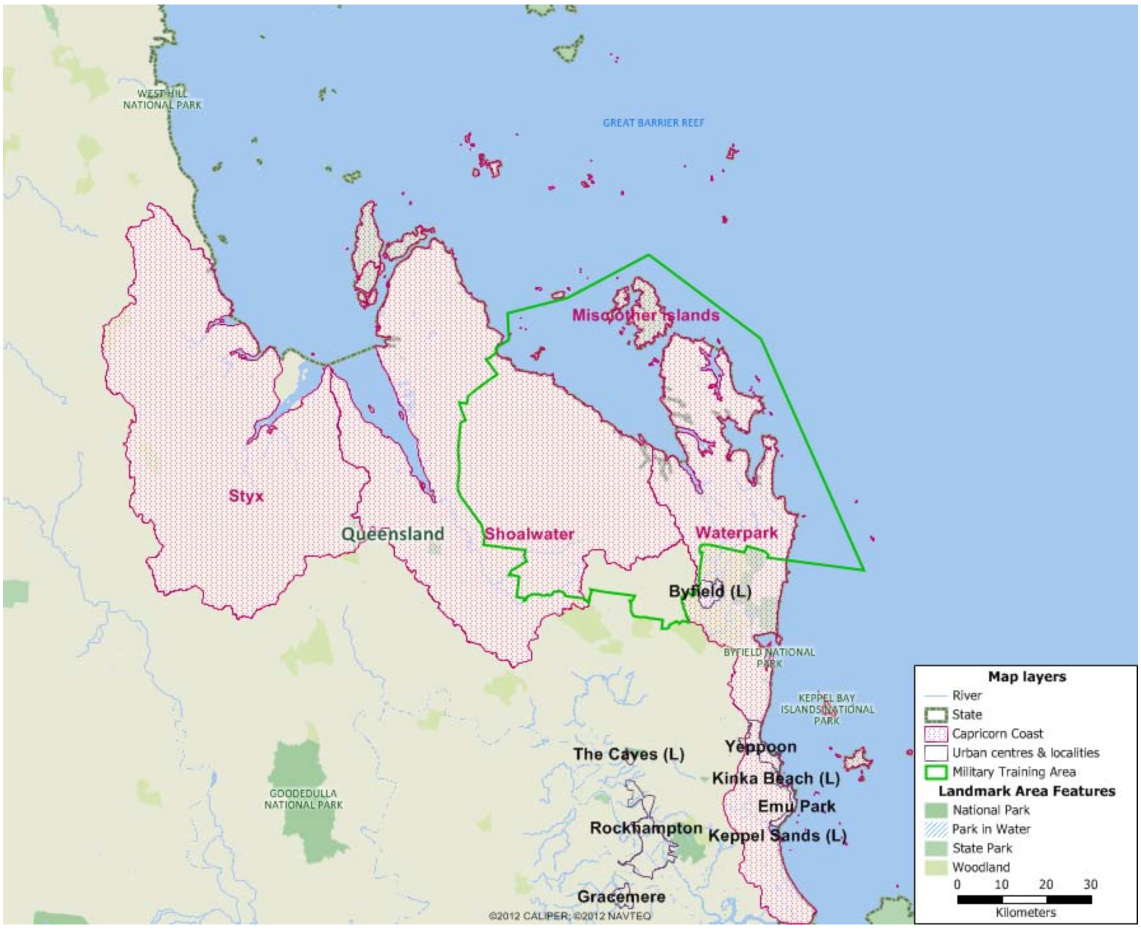
'*Queensland is Australia's number one ecotourism destination and recognised as a world leader in ecotourism, delivering best practice nature-based experiences that contribute to the conservation of our natural resources and cultural heritage....Underpinning the plan is acknowledgement that world-leading ecotourism is wholly dependent upon the conservation of Queensland's rich biodiversity and environmental and cultural resources. The plan demonstrates the commitment the Queensland Government, tourism industry and the community is making to balance preservation with presentation by providing best practice ecotourism.'*

2. Capricorn Coast

2.1 Introduction

This chapter considers the economic and social impacts of protecting the EVs of the tidal and non-tidal waters of the Capricorn Coast (see Figure 2). The Capricorn Coast comprises the Styx (area: 3020km^2), Shoalwater (3607 km^2), and Waterpark (1838 km^2) basins (combined area: 8464km^2), and GBR waters. The Capricorn Coast is to the east and north of Rockhampton, and includes only a small number of urban centres and localities, such as Yeppoon, Kinka Beach and Emu Park.

Figure 2: Map of the Capricorn Coast



Source: MJA, 2013.

In accordance with the *Environmental Protection (Water) Policy 2009* EVs are protected by achieving or maintaining the water quality objectives, through the management measures and control actions applicable to the rural and urban diffuse and point source emissions of nutrients, sediment and toxicants from activities and land uses in the basins.

2.2 Socio-economic profile – Capricorn Coast

Demographic, social and economic data and information have been used to develop the Capricorn Coast regional socio-economic profile.

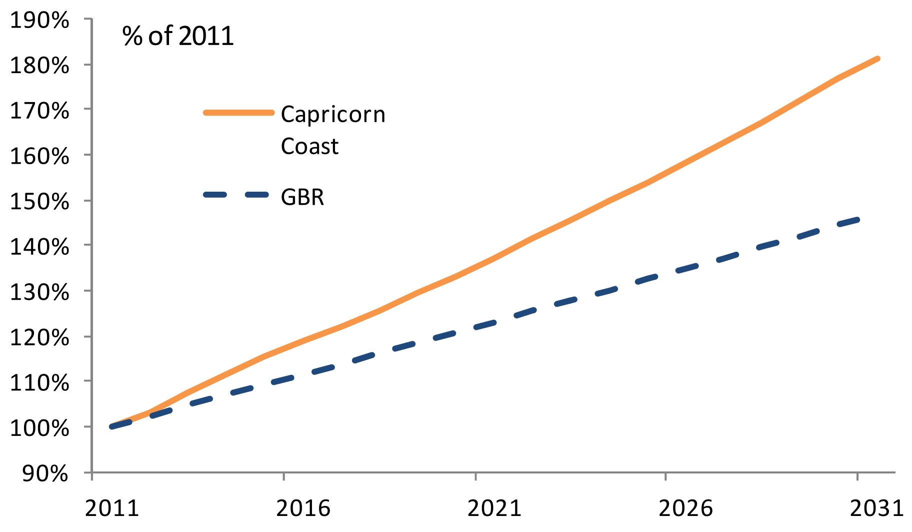
2.2.1 Demographic profile

Population and population growth

From the 2011 Census, it is estimated that the population of the Capricorn Coast region is around 24,331 people. Figure 1 shows the recent historical and forecast population growth for the Capricorn Coast region compared with all GBR regions assessed in the 2010 Marsden Jacob report. It indicates that:

- significant population growth is expected in the Capricorn Coast region and across the GBR regions over the next 20 years; and
- the Capricorn Coast rate of population growth is likely to be higher than for the GBR as a whole.

Figure 3: Population projections – Capricorn Coast



Source: OESR and Marsden Jacob, 2014.

Other population and demographic statistics (Table 1) are noted below:

- unlike much of the GBR, the population of the Capricorn Coast region is slightly skewed to females (50.8% of the population), which may be related to men pursuing opportunities in the resources sector outside of the region;
- in the 2011 census, 3% of respondents identified themselves as being Aboriginal and Torres Strait Islander (ATSI) in the Capricorn Coast region compared with around 3.6% for the whole of Queensland; and
- approximately 12.2% of people in the Capricorn Coast region were not born in Australia and around 2.7% of the population speak a language other than English at home.

Table 1: Demographic summary 2001, 2006, 2011 – Capricorn Coast

	2001	2006	2011
Total population	20,049	21,901	24,331
Percentage of males	50.1	49.7	49.2
Percentage of females	49.9	50.3	50.8
Percentage of ATSI descent	2.8	3.0	3.0
Percentage of people not born in Australia	10.7	11.1	12.2
Percentage of people who speak a language other than English at home	2.5	2.5	2.7

Source: OESR and Marsden Jacob, 2013.

Note: data are based on place of enumeration.

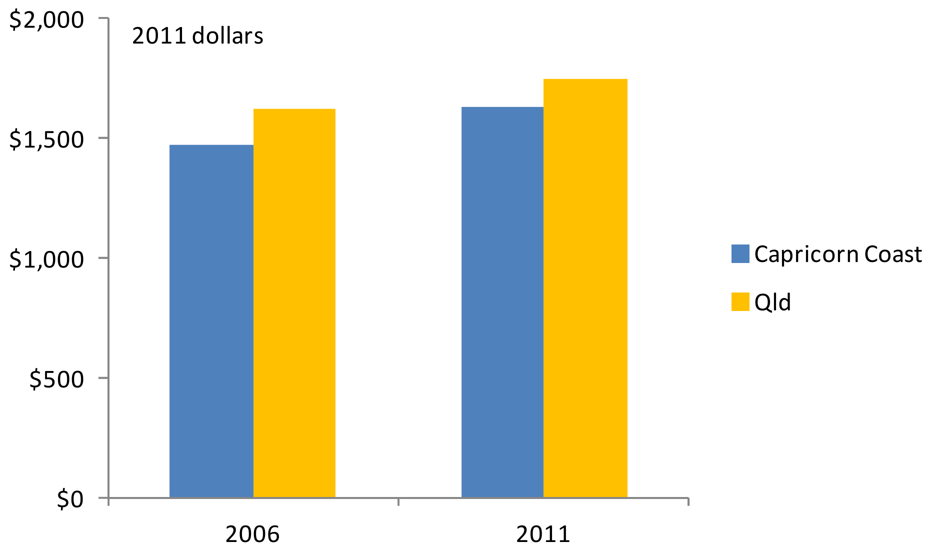
Community capacity

A community's capacity to participate in NRM is often indicated by a number of issues, briefly outlined below.

Approximately 20% of adults (>15 years old) participate in **voluntary work** compared with a State average of 18%, potentially indicating reasonable levels of social capital. Females had higher levels of participation in volunteer work at 22%, compared to males (at 17%). However, the ABS census data do not indicate what type of volunteer work (e.g. environmental management) was undertaken.

The relative financial impact of any projects or policies that broadly impact on costs must be considered as the burden may be relatively greater for lower-income families. The Capricorn has a slightly higher incidence of **low-income families** than the State as a whole. Approximately 16% of families in the Capricorn Coast area were on low incomes in 2011 (i.e. <$600/week) compared with 13% for the State. The Capricorn Coast has a lower average weekly family income than the State average (Figure 4).

Figure 4: Average weekly gross family income – Capricorn Coast



Source: Marsden Jacob based on ABS 2006 and 2011 Census data and CPI data.

Household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In the Capricorn, approximately 63% of homes are owned or are being purchased. This is similar to a State average of 61%.

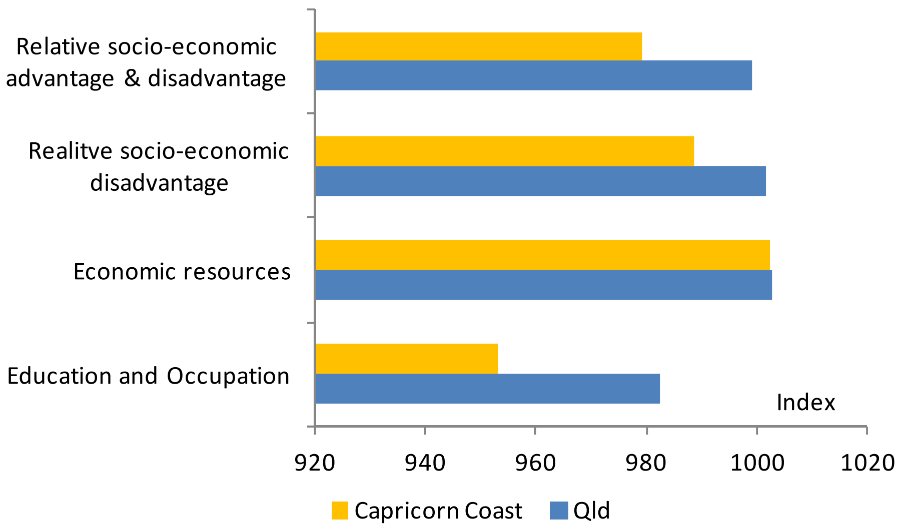
The ABS Socio-Economic Indexes for Areas (**SEIFA**) is a suite of composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad means to make relative comparisons of social and economic resources between regions. The three indices of most relevance are: [16]

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

These indices were estimated for the Capricorn Coast based on a weighted average of SEIFA indices for SA1 areas within the region. Results including a comparison with Queensland as a whole are shown in Figure 5.

[16] ABS (2001) *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas*, cat. no. 2039.0,

Figure 5: SEIFA indices – Capricorn Coast, 2011



Source: Marsden Jacob based on ABS 2011 census SEIFA indices.

Analysis of the data indicates:

- compared with the State average, the Capricorn is at a relative disadvantage;
- economic resources in the Capricorn are around the average of the State as a whole; and
- the Index of Education and Occupation shows that the Capricorn is lower than the State as a whole, which may indicate lower resilience to change.

Education levels in the Capricorn are lower than the State as a whole (Table 2), with lower proportions of people having completed year 12 and having diploma, undergraduate or postgraduate qualifications than the State average.

Table 2: Educational attainment – Capricorn Coast

Highest education level completed	Capricorn Coast (% of 15+ population)	QLD (% of 15+ population)
Schooling		
Year 10	38.4%	31.9%
Year 12	36.8%	47.8%
Post-school		
Certificate	22.1%	20.6%
Diploma	6.5%	7.9%
Undergraduate degree	9.0%	12.2%
Postgraduate degree	3.2%	4.3%

Source: ABS 2011 Census of Population and Housing.

Employment and labour force

Labour force statistics in Table 3 show a reasonable degree of diversity in the Capricorn Coast economy.

- Employment in primary industries is slightly lower than the GBR average (10.6% compared with 11.6%), but is twice the state average (10.6% with 5.3%).
- Manufacturing employment is slightly lower in the region than for the rest of the GBR (6.0% versus 8.9% of employment).
- Employment in the construction and accommodation and food service industries are significantly higher than the GBR and State averages.
- Collectively mining, manufacturing and construction employ around 23% of the workforce. Mining has become a key industry in the region, employing around 7% of the workforce.
- Health care and social assistance are around the same proportion of employed persons as the GBR average, but the share in education and training is substantially higher (9.9% versus 7.5% for the GBR and 8.1% for Queensland).

There were a number of important trends occurring between the 2006 and 2011 Censuses:

- Employment in the mining sector has more than doubled over the five years, from 307 people (3.6% of employed persons) to 704 (7.1% of employed persons). Given the data on are on a place of enumeration basis, a number of these workers are likely to be fly-in, fly-out (FIFO) or drive-in, drive-out (DIDO) workers.
- Agriculture continued its downward trend in employment from 399 people (4.7% of employed persons) to 344 people (3.5% of employed persons).
- While health care and social assistance experience slight growth in employment from 824 to 1,057 employed persons (from 9.7 to 10.7% of employed persons), numbers employed in education and training were more-or-less stable, only slightly declining in absolute terms from 998 to 984. This, however, meant a relative decline in education and training from 11.7% to 9.9% of the workforce.

Table 3: Employed persons by industry – Capricorn Coast

Industry	Employed persons 2006	Employed persons 2011	Employed persons Change	Percentage 2006	Percentage 2011	Percentage Change
Agriculture, forestry and fishing	399	344	-55	4.7	3.5	-1.2
Mining	307	704	397	3.6	7.1	3.5
Manufacturing	567	593	26	6.7	6.0	-0.7
Electricity, gas, water and waste services	130	153	23	1.5	1.5	0.0
Construction	910	1,019	109	10.7	10.3	-0.4
Wholesale trade	193	270	77	2.3	2.7	0.4
Retail trade	908	1,087	179	10.7	11.0	0.3
Accommodation and food services	823	900	77	9.7	9.1	-0.6
Transport, postal and warehousing	276	382	106	3.2	3.9	0.7
Information media and telecommunications	68	93	25	0.8	0.9	0.1
Financial and insurance services	159	191	32	1.9	1.9	0.0
Rental, hiring and real estate services	227	205	-22	2.7	2.1	-0.6
Professional, scientific and technical services	329	359	30	3.9	3.6	-0.3
Administrative and support services	165	217	52	1.9	2.2	0.3
Public administration and safety	603	729	126	7.1	7.4	0.3
Education and training	998	984	-14	11.7	9.9	-1.8
Health care and social assistance	824	1,057	233	9.7	10.7	1.0
Arts and recreation services	81	90	9	1.0	0.9	-0.1
Other services	318	342	24	3.7	3.5	-0.2
Not stated	223	192	-31	2.6	1.9	-0.7
Total	**8,508**	**9,911**	**1,403**	**100.0**	**100.0**	**0.0**

Source: ABS 2011 Census of Population and Housing.

Note: Based on place of enumeration.

2.2.2 Summary of socio-economic profile

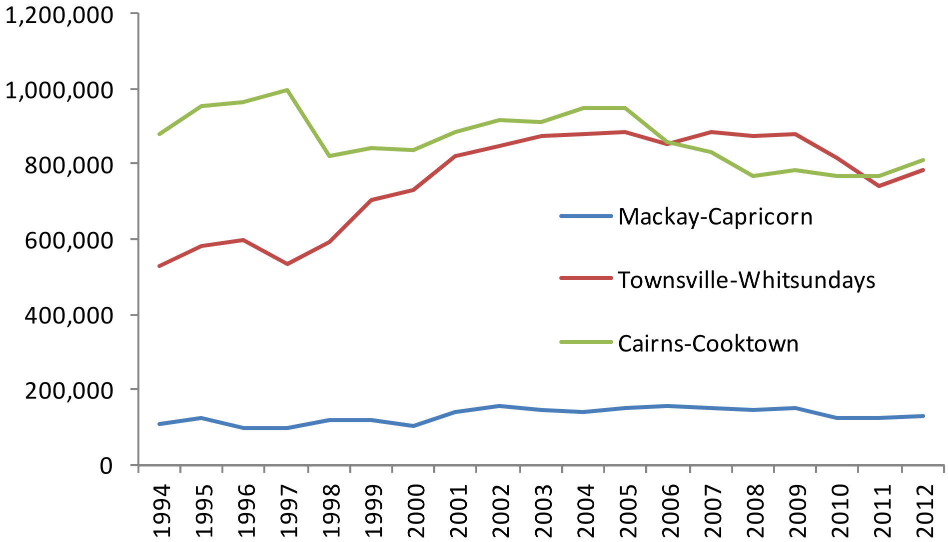
The socio-economic profile presented above shows the Capricorn Coast region's slightly lower social and economic wellbeing than the State average. However, the economy of the Capricorn Coast appears more diverse than some other GBR regions, which would tend to mitigate any economic impacts that may occur as a result of measures to protect EVs.

2.2.3 Industry profile

Tourism

Tourism in the region is much lower than in other regions along the GBR, based on visitations data collected as an administrative by-product of Environmental Management Charge (EMC) data collected by the GBRMPA (see Figure 6).[17] EMC data are collected where people are customers of a commercial operator using the GBR. However, tourism is very significant to the Capricornia Coast region from Yeppoon to Emu Park at the southern end of the region and also to Great Keppel Island. The Capricorn Coast region is part of the broader Fitzroy NRM region in which tourism made an estimated contribution of $478 million in 2011-12.[18]

Figure 6: EMC-related visitations



Source: GBRMPA website, 2013.

Substantial new tourism opportunities have been approved for Great Keppel Island as part of an integrated report development. It includes a hotel, apartments, marina and golf course. Estimated economic benefits identified in the Queensland Coordinator General's review of the proposal included:

- post-construction, an average of 1055 full-time, part-time and casual jobs on the island and in the Capricorn Region—comprising 685 persons on the island and 370 on the mainland in the surrounding regions (predominantly in Rockhampton and Yeppoon.
- increased economic activity due to an increase in the estimated average daily population on the island to 2274 visitors, residents and employees, which is approximately three times that of the previous peak in the early 1990s.
- once fully operational, total consumption expenditure on the island is expected to be around $83 million each year, having significant flow-on effects to the local and regional economy.

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17 Note these data are only where there is a trip to the GBR which is subject to the EMC. There are a large number of other visits to the region which are not recorded in the EMC data set because they do not involve a trip to the GBR.

18 Deloitte Access Economics (2013) *Economic Contribution of the Great Barrier Reef*, p. 15.

- once fully operational, a projected annual increase in gross regional product (GRP) of the Fitzroy Region of $75.2 million arising from estimated annual expenditure of $83 million on the island. This is comprised of a direct increase of $41.7 million, an indirect increase of $16.6 million and an induced increase of $16.9 million.

(State of Queensland (2013) http://www.dsdip.qld.gov.au/resources/project/great-keppel-island-resort/gki-cg-report-eis.pdf)

A current proposal exists to expand the Iwasaki Capricorn Integrated Resort (north of Yeppoon) in a 20 year staged, master-planned development comprising conservation, rural and urban precincts. The initial advice statement for the report development estimates that it would

- comprise approximately 8,000 dwellings in the residential community at capacity, equating to a residential population of approximately 21,000 people.
- Create between 18,500 and 19,000 construction jobs over the lifetime of the Project (comprising between 8,000 and 8,500 on site jobs and between 10,000 and 10,500 off site jobs).
- Provide approximately 2,160 on-going permanent tourism/education jobs.

(Iwasaki Capricorn Integrated Resort Project Initial Advice Statement, 2013; available from http://www.dsdip.qld.gov.au/resources/project/capricorn-integrated-resort/cir-ias-overview.pdf

Both these proposals occur within the broader context of the Queensland Ecotourism Plan (2013–2020) prepared by the Queensland Government in recognition of the key role played by the environment in ecotourism experiences. (State of Queensland, 2013, Queensland Parks and Wildlife Service, available at http://www.nprsr.qld.gov.au/tourism/pdf/final-ecotourism-plan-2013.pdf).

The vision of the plan is that by 2020 '*Queensland is Australia's number one ecotourism destination and recognised as a world leader in ecotourism, delivering best practice nature-based experiences that contribute to the conservation of our natural resources and cultural heritage….Underpinning the plan is acknowledgement that world-leading ecotourism is wholly dependent upon the conservation of Queensland's rich biodiversity and environmental and cultural resources'*.

Agriculture

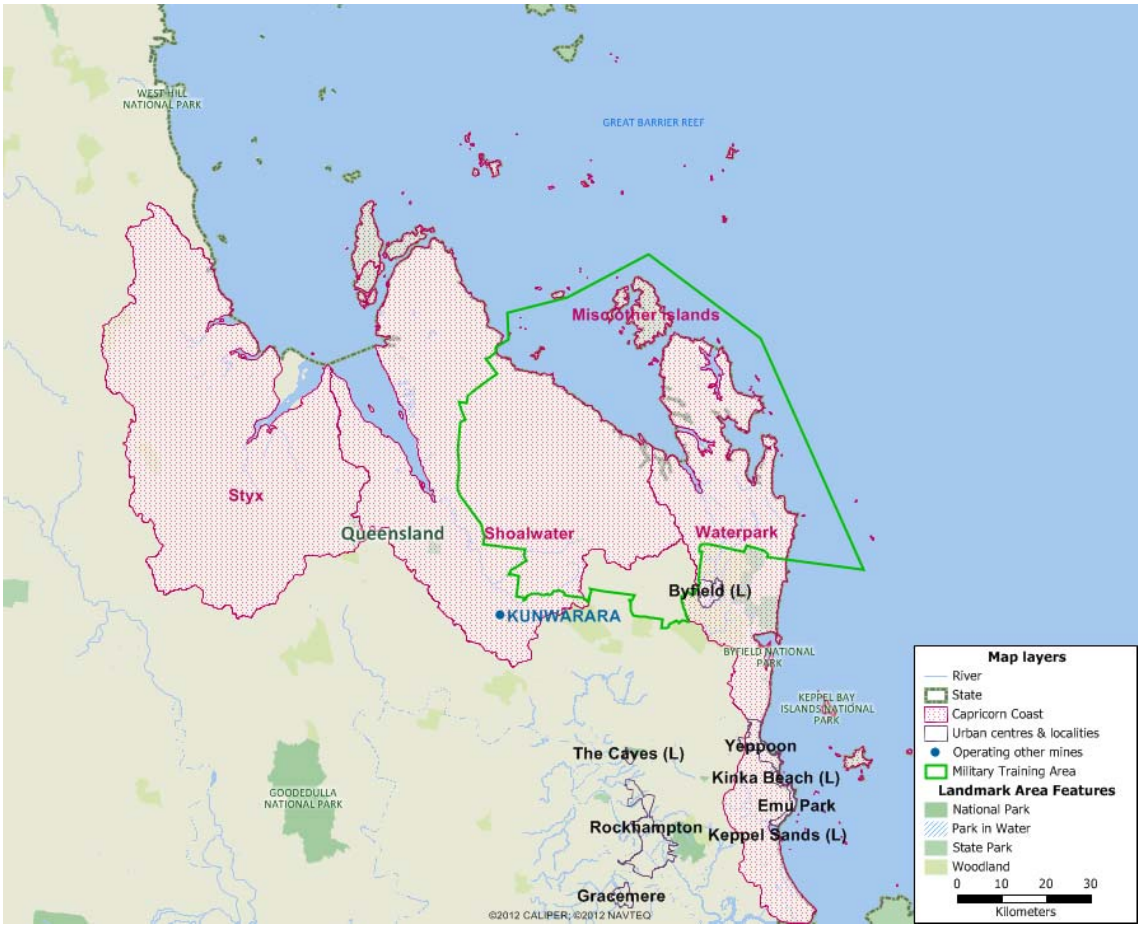
Employing around 3.5% of the workforce, agriculture is slightly more significant in the region than in the State as the whole (at 2.7%) and the broader Rockhampton region (at 2.3%). Within the region, beef grazing is the major agricultural activity, and the predominant one in Styx River and Shoalwater Creek catchments. In the Waterpark Creek catchment, cattle grazing was undertaken on around 51% of holdings, and horticulture was much more significant than in the other parts of the Capricorn Coast region.[19]

[19] ABS (2010) *Land Management Practices in the Great Barrier Reef Catchments, Preliminary, 2008-09*, cat. no. 4619.0.

Mining

The Capricorn Coast basin does not contain a large mining industry, with only one operating mine, the Kunwarara magnesia mine in the southern part of the Shoalwater region (Figure 7).

Figure 7: Operational mines – Capricorn Coast



Source: MJA, 2013.

Defence

The area is home to the Shoalwater Bay Military Training Area, which covers 454,500 hectares, and is managed by the Commonwealth Department of Defence. The region has significant environmental value, particularly due to its wetlands of international importance (Ramsar wetlands) and its biodiversity, including vulnerable or rare plant or animal species.[20]

The Training Area poses environmental risks, particularly through the use of live ammunition, including in major national and multi-lateral simulated combat exercises such as Talisman Sabre. Because of the risks involved and the environmental and heritage values of the area, the Department of Defence maintains strict environmental management of the area, including appropriate rehabilitation and comprehensive water quality monitoring.[21] The Department has advised that water quality generally meets the water quality objectives and there are major parts of the basin with intact high aquatic ecosystem values.

20 Department of Environment and Heritage (2006) *Shoalwater Bay Military Training Area, Statement of Significance*.

21 Department of Defence (2009) *State of the Environment Report for Shoalwater Bay Training*.

2.3 Water quality in the Capricorn Coast

EVs are the attributes of the water asset that support aquatic ecosystems and the multitude of direct and indirect human uses. Final EVs for tidal and non-tidal waters of the Capricorn Coast are on the EHP website (www.whp.qld.gov.au). These are derived from the draft EVs established by FBA in conjunction with key local stakeholder organisations and the community, released for public comment in April 2014 [22]. While there is some sub-regional variation, the identified EVs are:

- **Aquatic ecosystems.** Apparent across all freshwater (surface and groundwater), estuaries/bays and marine coastal waters where relevant. These values are negatively impacted by a number of land use activities across all sectors.
- **Agricultural use.** Water used for irrigation and stock and domestic use where relevant. The quality of water used by agriculture can have a marked impact on productivity. Grazing BMP modules are being developed by the Queensland Government Department of Agriculture, Fisheries and Forestry (DAFF), with the FBA and grazing industry leading the process. BMP is informed by the EVs and water quality objectives for the waters of the Capricorn Coast.
- **Fishing.** Commercial fishing is undertaken in the region, particularly in the marine and coastal zone. Water quality and waterway health have a significant impact on fish population dynamics, fish health, catch rates, and the quality of fish caught.
- **Recreation.** Both primary recreation (e.g. swimming, snorkeling) and secondary recreation (e.g. waterskiing, fishing) are relevant across all sub-regions. This is also a vital attribute underpinning tourism activity and can be impacted by changes in water quality.[23]
- **Visual appreciation and aesthetics.** Visual appreciation and aesthetics are key values in the region. These values can enhance values of adjacent land uses (e.g. residential, tourism) and any decline in aesthetics is often reflected in land values. This use is non-consumptive.
- **Drinking water.** Declines in water quality increase the cost of supplying potable water through higher treatment costs, and potentially the need to augment treatment standards where water pollutant thresholds are regularly exceeded. The majority of the drinking water consumed in the region is provided by Fitzroy River Water (FRW) – a commercial business unit of Rockhampton Regional Council responsible for delivering water supply and sewerage services.[24]
- **Industry.** Mining and construction are important industries underpinning the regional economy. The State interest in water quality is achieved by land development and construction that is planned, designed, constructed and operated to protect the EVs through the achievement of water quality objectives.
- **Cultural and spiritual use.** There is also significant evidence of cultural and spiritual values attached to waterways by Traditional Owners, while some waterways also have a

[22] Fitzroy Basin Association (2014) *Draft Community Consultation Report Establishing Environmental Values and Water Quality Objectives for Capricorn and Curtis Coastal Basins and Coastal Waters,* February 2014.

[23] Prayaga, P (2011) *Estimating changes in values for recreation in the Capricorn Coast region of the Great Barrier Reef,* Doctor of Philosophy thesis, Central Queensland University, Rockhampton.

[24] Rockhampton Regional Council (2013) *Corporate Plan 2012-17.*

historical and cultural value to non-indigenous residents. These uses tend to be non-consumptive.

A broad range of aquatic ecosystem and human use EVs relate to water quality and waterway health for the tidal and non-tidal waters of the Capricorn Coast. However there are fewer studies covering the ecological and economic values than for other parts of the GBR. This reflects the relatively small geographic area, small population centres, relatively low industrial activity and large protected areas (e.g. Shoalwater Bay Military Training area, outlined in Figure 7)—resulting in a generally low risk to water quality and the protection of the environmental values. As noted in section 2.5.2 below, cattle grazing accounts for 48% of regional land use, while cropping is under 1%.

2.3.1 Current risks from loads

Pollution loads in the Capricorn Coast region are a function of natural variation, historical land use change and development. Much of the coastal waters pollution loads will be driven by rural lands diffuse emissions from activities within the Capricorn Coast Region. The Fitzroy Basin loads to coastal waters (primarily sediments and associated nutrients) are totally dominant by comparison.

Sampling of water pollution loads is undertaken across the GBR catchments and reported under the Reef Water Quality Protection Plan.[25] However, in the short-term, annual loads vary significantly depending on physical parameters such as rainfall as well as anthropogenic actions such as land use and changes in practice.

It is more instructive to consider an estimate of the natural loads and estimates of the anthropogenic loads as this provides more insight into the degree to which loads have changed due to anthropogenic activity (e.g. changes in land use). The table below summarises key estimates for the region developed by CSIRO.[26]

[25] Turner. R, Huggins. R, Wallace. R, Smith. R, Warne. M St. J. (2013) *Total suspended solids, nutrient and pesticide loads (2010-2011) for rivers that discharge to the Great Barrier Reef: Great Barrier Reef Catchment Loads Monitoring 2010-2011,* Department of Science, Information Technology, Innovation and the Arts, Brisbane.

[26] Kroon F, Kuhnert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J, and Joo M. (2010) *Baseline pollutant loads to the Great Barrier Reef. CSIRO: Water for a Healthy Country Flagship Report,* series ISSN: 1835-095X.

Table 4: Estimated anthropogenic loads data for key pollutants – Capricorn Coast

	Sediment - TSS (ktonnes/year)			Nutrients – TN (tonnes/year)		
Area	**Natural**	**Total**	**Anthrop-ogenic**	**Natural**	**Total**	**Anthrop-ogenic**
Styx River	25	262	237	52	597	545
Shoalwater Creek	22	95	73	87	263	176
Water Park Creek	10	89	79	86	505	419
Capricorn basins Total	57	446	389	225	1365	1140
Fitzroy Basin	1141	3409	2268	1311	12974	11663
Fitzroy NRM region*	1259	4109	2850	1672	15126	13454
Capricorn basins total as % of Fitzroy NRM region	4.5%	10.9%	13.6%	13.5%	9.0%	8.5%
GBR total	3112	16075	12963	13891	89112	75221
Capricorn basins total as % of GBR	1.8%	2.8%	3.0%	1.6%	1.7%	1.5%

Source: Kroon F, Kuhnert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J, and Joo M. 2010. Baseline pollutant loads to the Great Barrier Reef. CSIRO: Water for a Healthy Country Flagship Report series ISSN: 1835-095X.

Notes:

Anthropogenic loads were referred to as "baseline" loads in Kroon et al. (2010).

Loads for other pollutants are also reported in Kroon et al. (2010).

TSS=total suspended sediment; TN =total nitrogen.

** Fitzroy NRM region comprises Styx, Shoalwater Creek, Water Park Creek, Fitzroy, Calliope and Boyne river basins*

The key points to note from the above CSIRO estimates are:

- The overall contribution of the Capricorn basins to sediment loads is small (10.9% of the total Fitzroy NRM region loads and 2.8% of the total GBR loads). In comparison, the neighbouring Fitzroy Basin contributes over 80% of the region's total sediment load and 80% of its anthropogenic load;
- estimated total sediment loads for the Capricorn basins are around 7.8 times estimated natural loads in these basins, significantly higher than the ratio for the Fitzroy NRM region as a whole (3.3 times), and the GBR as a whole (over 5 times);
- The overall contribution of the Capricorn basins to total nitrogen loads is relatively small (9% of the total Fitzroy NRM region loads and 1.7% of the total GBR loads). In comparison, the neighbouring Fitzroy Basin contributes over 85% of the region's total nitrogen load and 80% of its anthropogenic load;

- Estimated total nitrogen loads for the Capricorn basins are around 6.1 times estimated natural loads, lower than the ratio for the Fitzroy NRM region (9.0 times), and the GBR as a whole (6.4 times); and
- Data available on other pollutants (e.g. phosphorus, herbicides) all indicate loads that are often several times natural loads across the region.[27]

Drivers and risks to EVs

Without continued focus on best management environmental practice, future development is expected to increase pollution loads. The greater these loads deviate from natural levels, the greater the risks they place on key waterway assets and the benefits they provide to society. Major developments in the region hence require significant and formal environmental assessments before approval. This includes specific conditions on new developments to mitigate their impacts on waterway health. However, the current and likely future development in the broader region will require continued sustainable management of risks to water quality and EVs. These pressures are a consequence of development within the Capricorn Coast urban centres and development in inland sub-catchments that drain into the Capricorn Coast.

Diffuse run-off of sediments and nutrients from rural lands is being managed through the development of industry-led BMP modules for grazing land management and soil health. As noted above, DAFF has commissioned the FBA to develop industry-led BMP modules to assist graziers to maintain and improve land resources, maintain quality pasture cover throughout the year and keep soil on their properties—informed by local EVs and WQOs.

Final EVs and WQOs are published on EHP's website at www.ehp.qld.gov.au.

Future risks to EVs are essentially a consequence of development patterns in the region and relevant inland sub-catchments. Table 5 below summarises likely key economic and demographic drivers and their potential relative contribution to future risks to EVs.

27 For a comprehensive overview of estimates of loads, see: Kroon F, Kuhnert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J, and Joo M. (2010) *Baseline pollutant loads to the Great Barrier Reef. CSIRO: Water for a Healthy Country Flagship Report,* series ISSN: 1835-095X.

Table 5: Economic and demographic drivers and future risks to EVs

Sector	Future potential risk to EVs	Comments
Cattle	Negligible/ moderate	The broader Fitzroy region has a significant competitive advantage in beef production. As incomes rise in developing economies, demand for meat also increases sharply. The FAO estimate that worldwide beef consumption will grow by 1.2% per annum to 2050. However, growth in demand in developing economies (particularly in Asia) is likely to increase 1.9% per annum (up 40,000,000 tonnes per annum) by 2050.[28] Fitzroy producers are likely to meet part of this international demand growth, resulting in increased intensification and potential runoff. However, this is less likely to be in the sub-regions of the Fitzroy relevant to this study. The management of rural diffuse sediment and nutrient emissions is being promoted through industry-led BMP module development.
Irrigated agriculture	Negligible	Limited activity currently in region. Region does not have any apparent competitive advantage in the domestic market. International competitiveness is limited.[29]
Urban development	Insignificant	Although very significant in relative terms, population growth is not large in absolute terms, as it comes off a relatively low base of around 24,000 people.[30] Development is expected to lead to increased runoff from housing development, associated infrastructure development (e.g. roads) and associated commercial and social development (e.g. commercial land, schools, etc.).
Tourism	Location specific	Much of the tourism activity in the Capricorn Coast region is focussed offshore and is site-specific (e.g. Great Keppel Island and associated waste water discharge). • The proposal for Great Keppel Island was approved by the Queensland Government in 2013 and includes: accommodation including a new hotel, 750 villas and 300 apartments; a new 18 hole golf course; an upgrade and extension of the existing airstrip; a marina at Putney Beach (up to 250 berths and various commercial premises); installation of submarine utility lines between Great Keppel Island and the mainland; and service facilities and utilities (waste collection, waste water treatment plant and constructed wetland).[31] • An initial advice statement has been released for the expansion of the Iwasaki Capricorn Integrated Resort (north of Yeppoon). Further information is available at http://eisdocs.dsdip.qld.gov.au/Capricorn-Integrated-Resort/cir-ias.pdf

28 Alexandratos, N. and J. Bruinsma (2012) *World agriculture towards 2030/2050: the 2012 revision*, ESA Working paper No. 12-03. FAO, Rome.

29 Apted, S., Berry, P., Short, C., Topp, V., Mazur, K., and Mellor, T. (2006) *International Competitiveness of the Australian Vegetable Production Sector*, ABARE eReport 06.5, Canberra.

30 OESR estimates.

31 http://www.dsdip.qld.gov.au/assessments-and-approvals/great-keppel-island-resort.html

Sector	Future potential risk to EVs	Comments
Mining and energy	Location specific	Coal and gas reserves exist in the Styx River catchment. To the degree the development of these reserves becomes commercially viable, any development will result in land use change and runoff from multiple sources during the development and operations phases of projects. However, such developments would be subject to regulation including detailed environmental assessments and subsequent conditions of approval to mitigate risks to waterway health.
Transport infrastructure	Potentially	Depending of the pattern of regional development (particularly coal and gas reserves), expansions to transport infrastructure and services may be necessary. Such developments would be subject to regulatory approvals and conditions to mitigate environmental risks.

Source: MJA and MainStream analysis.

The bottom line from the analysis is that the future risks to EVs from developments within the region are manageable within the existing policy and regulatory regime.

2.4 Benefits of maintaining Environmental Values

There are multiple benefits from undertaking actions that may be required to maintain or improve water quality to protect EVs. This section briefly outlines some of the key benefits.

2.4.1 Aquatic ecosystem function and services

Consultation undertaken by FBA and previous research has consistently recognised the importance of maintaining the condition of freshwater and marine aquatic ecosystems in the planning region. Where the condition of the aquatic ecosystem declines, key ecosystem functions and services also decline (including issues such as fish breeding, losses of recreation, tourism etc.)

Healthy GBR aquatic ecosystems are among the most important biologically diverse and economically valuable ecosystems. They provide valuable and vital ecosystem services, the protection of coastlines from storms and erosion, habitat for living organisms, and jobs and incomes to local, regional and national economies from fishing, recreation, and tourism.

While much of the population may argue that the value of aquatic ecosystems in the region (particularly the GBR) is essentially priceless, economists are able to estimate values for the GBR based on what people are prepared to pay to protect and manage the Reef.

Rolfe, J et al[32] (2010) have framed the analysis in terms of marginal improvements to protection; that is the total economic value (TEV[33]) of a 10% improvement in GBR health (or avoiding a 10% decline in health). The TEV approach shows a 10% improvement in protection

32 Rolfe, J., Windle, J. and Prayaga, P. (2010) *Assessing total economic value for protecting the Great Barrier Reef.*

33 Total Economic Value includes: direct use values of industries (producer surplus) e.g. from commercial fishing, recreational fishing and tourism; direct use values of tourists and recreational fishers (consumer surplus); indirect values of coastal protection; non-use values of Australians (who may not all visit); and non-use values for international residents.

(or avoiding a 10% decline) for 25 years to be $6.3 billion.

The analysis assumes that direct use and in-direct use values can be scaled to GBR health, i.e. a 10% decline in health would lead to a 10% drop in use and non-use values.

According to a United Nations estimate, the total economic value (TEV) of coral reefs range from US$ 100,000 to 600,000 per square kilometre per year.[34]

Other studies suggest that even a 1% improvement in the condition of the GBR would have a significant benefit to residents. Based on estimates of the number of households in the Capricorn Coast region[35] and studies of households' willingness to pay[36], the mean annual value of a 1% improvement in GBR condition to Capricorn Coast residents only is around $310,000. However, given the uncertainties in the surveying and economic modelling, values could be as high as $640,000 per annum. Other studies also indicate that aquatic ecosystems have significant economic values.[37] The key point to note is that all studies indicate the community's willingness to pay for waterway protection is significant.

In addition, there is a significant preference for protection of the GBR across Australia and internationally. Across Australian households, the average willingness to pay to protect the health of the GBR has been estimated at around $22 per household per annum for five years.[38] The Great Barrier Reef National Survey carried out under the Social and Economic Long Term Monitoring Program (SELTMP) provides additional information on attitudes towards the Great Barrier Reef, and is available from the NERP Tropical Ecosystems Hub website: http://www.nerptropical.edu.au/sites/default/files/publications/files/NERP-TE-PROJ-10.1-SELTMP-2013-NATIONAL-SURVEY-Complete.pdf .

Specific direct-use values are considered in the following sections.

2.4.2 Benefits to industry

There are a number of benefits to industry from maintaining waterway health.

Agriculture

As noted above, agriculture is reasonably significant within the study area, with a gross value of $904 million in 2011-12 in the broader Fitzroy region, and it is expected that current agricultural production in the area will be impacted by any adverse changes in water quality (impacting on stock watering, irrigation efficiency etc.).[39] However, although the potential impact could not be determined based on information available, the risk is low and will need to

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34 UNEP-WCMC (2006) *In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs*, Cambridge UK. Available online at http://www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series/24.cfm)

35 Based on OESR concorded estimates of 2011 Census data.

36 Rolfe. J and Windle. J (2010) *Assessing national values to protect the health of the Great Barrier Reef.*

37 For example: Rolfe, J. and Windle, J. 2011 Assessing community values for reducing agricultural emissions to improve water quality and protect coral health in the Great Barrier Reef, *Water Resources Research*, 47(12): W12506, doi:10.1029/2010WR010355.

38 Rolfe, J. And Windle, J. (2012) "Distance decay functions for iconic assets: Assessing national values to protect the health of the Great Barrier Reef in Australia", *Environmental and Resource Economics*, vol. 54, no. 3, pp. 347-365.

39 ABS, 2013, *Value of Agricultural Commodities Produced, Australia*, 2011-12, cat. no. 7503.0.

be continued to be managed. Adoption of grazing BMP will minimise the risk of emissions from rural lands.

Commercial fisheries

Based on 2005 data, there are around 171 commercial fishing operators in the region[40] with a commercial catch of around $3.2 million per annum (Table 6).

Table 6: Gross value of commercial fishing catch (2005)

Fishing type	Tonnes	Effort days	Value of catch ($)
Line	6.3	117	$35,400
Net	216.4	1,657	$1,118,800
Pot – Crab	139.0	4,356	$1,452,300
Trawl – Beam	21.9	569	$197,100
Trawl – Otter	35.9	248	$364,600
Total	419.5	6,947	$3,168,200

Source: http://chrisweb.dpi.qld.gov.au/chris/

While the gross value of the catch is not significant in a broader economic sense, it is important to the local economy. Commercial fishing is a long-term regional industry that is susceptible to changes in ecosystem function impacting on catch rates and product quality. Furthermore, profit margins in the industry are generally low, making the industry particularly commercially susceptible to relatively small fluctuations in catch.

To the extent that EVs can be maintained, the long-term prospects of the commercial fishing industry will be improved.

Tourism

As noted above, tourism is important to part of the Capricorn Coast region, particularly around Yeppoon, Kinka Beach and Emu Park, which are on the Coast near Great Keppel Island. The Queensland Ecotourism Plan (2013–2020) has been prepared by the Queensland Government in recognition of the key role played by the environment in ecotourism experiences. (State of Queensland, 2013, Queensland Parks and Wildlife Service, available at http://www.nprsr.qld.gov.au/tourism/pdf/final-ecotourism-plan-2013.pdf). Without best practice management, tourism in the region will be impacted by changes in waterway health in a similar way to recreational fishing and boating. Substantial new resort/tourism developments are proposed in the Capricorn Coast, predicated on its terrestrial and aquatic environmental values. These include:

- approved development on Great Keppel Island, including hotel, apartments, marina and golf course - environmental values of the island including its waters. Estimated economic benefits identified in the Queensland Coordinator General’s review of the proposal included an expected increase to the gross regional product of the Fitzroy Region by $75 million per annum.

40 Here we have used commercial fisheries grids P27, Q27, R27, R28 and R29 as a proxy for the study area.

- Expansion of the Iwasaki resort (north of Yeppoon), in a staged, master-planned process with 8,000 dwellings in the residential community at capacity, equating to a residential population of approximately 21,000 people.

2.4.3 Recreational fishing and boating

Fishing

Recreational fishing in the region provides a benefit to a significant number of people, both local residents and visitors. In 2010, there were around 20,400 people who participated in recreational fishing in the study area, with the bulk from the broader Fitzroy region and a fraction coming from further north in the Mackay region.[41]

This level of recreational fishing generates a value to fishers (consumer surplus) in the order of $6 million per annum, or around $300 per fisher. This is based on assumed consumer surplus of $80 per fisher per trip, consistent with empirical literature for Queensland and Australia.[42] These estimates should be taken as indicative only because the majority of empirical studies relate to freshwater fishing.

Table 7: Consumer surplus from recreational fishing in the Capricorn Coast region

	Effort days	Consumer surplus $M
Private boat	32,369	2.59
Shore	38,008	3.04
Total	70,377	5.63

Source: Marsden Jacob estimates based on DAFF 2010 data.

Boating

Boat registrations recorded by Queensland Transport and Main Roads (TMR) have grown strongly in the Rockhampton Regional Council area over the last decade, and much faster than population growth. With boat registrations growing much faster than population growth, the number of boats per 100 people has risen from 6.0 to 7.5 per 100 people since 2001.[43]

2.4.4 Other benefits

There are a number of other benefits that also need to be considered. These include:

- **Visual and aesthetic amenity.** Visual and aesthetic amenity is related to maintaining waterway health, which can have an impact on property prices.

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41 DAFF (2012) *Queensland Statewide Recreational Fishing Survey, 2010*.

42 This value is based on a review of recent studies including: Deloitte Access Economics (2012) *Benefit of Basin Plan for the MDB fishing industries*; Rolfe, J. and Prayaga, P. (2007) "Estimating values for recreational fishing at freshwater dams in Queensland", *Australian Agricultural and Resource Economics*, vol 51; and Mazur, K., (2012) *Valuing gamefishing activity in Eastern Australia*, ABARES. It is a relatively conservative estimate because one relevant study estimates very high values for recreation: Rolfe, J., Gregg, D. And Tucker, G. (2011) *Valuing local recreation in the Great Barrier Reef, Australia*.

43 Based on Marine Queensland data and ABS population estimates.

- **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.
- **Human health.** Ensuring human health is maintained through reducing risks to water supplies and waters where human contact is likely.

2.5 Costs of improving or maintaining water quality objectives

2.5.1 Types of costs

Final water quality objectives are published on EHP's website at www.ehp.qld.gov.au. These are based on the guidelines stated in the draft report *Aquatic ecosystem water quality guidelines: Capricorn-Curtis Coast region* (DSITIA, February 2014), with updates following public release of draft materials. There are a number of costs associated with undertaking any additional actions necessary to maintain/improve water quality to continue to achieve the water quality objectives for the tidal and non-tidal waters of the Capricorn Coast.

These include:

- the direct financial cost of actions (e.g. the Yeppoon Sewage Treatment was renewed in 2006 at a capital cost of $17 million to minimize nutrient emissions to waters, maximize local water reuse, and accommodate population growth in the area);
- the opportunity cost of actions (e.g. reduced production areas); and
- program management costs (e.g. science and administration).

The following sections identify, scope, and wherever possible, quantify some of the key costs associated with reducing pollution loads into waterways.

2.5.2 Costs to primary industries

Primary industries are a relatively important contributor to the regional economy and are the dominant land use in the region. Table 8 shows data from the Queensland Land Use Mapping Program (QLUMP) for the major primary industry land uses in the region. The key point to note is the dominance of cattle, at around 48% of the total region, with around 58% of grazing lands being in the Styx Basin.

The area of dryland crops is around 0.4% of the total region (dominated by modified grazing pastures) and the area of irrigated crops is also only around 0.4% of the total region (dominated by irrigated tree crops in the Styx Basin).

Table 8: Key rural land uses (2009)

Land use	Area (ha –2009)	% of total region
Cattle grazing	408,737	48.2
Dryland crops and plantations	3,387	0.4
Irrigated crops and plantations	3,345	0.4

Source: QLUMP mapping data provided by EHP.

The rest of the region is dominated by other less intensive uses. Comparisons of mapping data between 1999 and 2009 indicate that the area is not undergoing major changes in land use compared with the Curtis Coast.

Grazing is the dominant rural land use and the land use that offers the greatest potential for sediment abatement in the region. However, groundcover data for the region shown in the table below indicates that mean long-term groundcover in the region is relatively high (generally >80%) and that around 6-11% of the grazing area has had average groundcover of less than 50% over the 23 years to 2010, depending on the sub-catchment. Groundcover outcomes in the region are relatively similar to the average for the Fitzroy. However, the fact that the region is essentially adjacent to the GBR suggests that loads have a direct pathway to the GBR.

Table 9: Regional groundcover statistics

Region	23-year mean groundcover (%)	2010 mean groundcover (%)	Percentage of regional area with less than 50% groundcover averaged over last 23 years (%)	Percentage of regional area with less than 50% groundcover in 2010 (%)
Styx	79.8	92.7	11.2	1.1
Shoalwater	84.1	91.5	6.8	4.2
Waterpark	86.8	92.2	6.0	4.8
Whole Fitzroy	80.1	93.5	9.3	1.0

Source: Reef Plan 2010 Report Card.

Reef Plan practice data for management practices for the whole Fitzroy show only around 9.3% of all grazing properties are currently using "D" practices. Over 50% are using "A" or "B" practices, with the remaining 40% using "C" practices. Given the groundcover results for the Capricorn Coast are similar to the average for the Fitzroy, it is also likely that practices in the Capricorn Coast may also be similar to the broader regional averages. Opportunities for achieving major reductions in sediment loads entering waterways from enhancing grazing management practices may be limited as many producers are already likely to be at "A" or "B" practices, and relative levels of groundcover are reasonable.

Marsden Jacob has previously estimated the costs of abatement in the Fitzroy at around $48-68 per tonne (including any opportunity cost, reduced gross margin and program management costs).[44]

However, analysis by Donaghy et al. (2007) indicates that the long-term costs and benefits of managing for target groundcover levels vary significantly depending on the starting pasture condition and the dominant local land type. For example:

> *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…* [45]

44 MJA based on 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 estimate was broadly in line with indicative estimates from Donaghy et al (2006) of around $56 million to reduce sediment exports by 12% in the catchment.

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

Furthermore, initial findings from analysis currently underway under the auspices of the Reef Rescue R&D Program confirm that the costs of moving between practices can be relatively low (<$20/tonne of TSS) for the dominant soil types in this study region, particularly where the pasture condition is already relatively good.[46] Often it is attitudes to risk[47] and other social factors[48] that create the greater impediment to improved management practices.

2.5.3 Urban diffuse costs

The region's population is developing relatively rapidly, albeit from a small population base of around 24,000 people. The increased population drives demand for further expansion of urban areas for residential, commercial and infrastructure land uses. Current best practice to avoid and mitigate urban diffuse water pollution loads is the implementation of water sensitive urban design (WSUD) principles and actions. While there is a broad suite of actions that could be undertaken as WSUD, the need for more effective and costly actions for large multi-lot developments, such as bioretention, is more likely in areas in the coastal zone where population growth is rapid and there is potential for urban diffuse emissions.

MJA have estimated the potential costs of addressing urban loads by assuming greenfield urban development will implement on-ground actions, particularly via the implementation of bio-retention basins as a key stormwater management strategy.

Using an updated version[49] of Marsden Jacob's economic model used for the business case for WSUD,[50] it is possible to develop broad estimates of the cost of managing urban diffuse loads in greenfield development over a reasonable planning time frame (10 years). It is also possible to establish broad estimates of the volume of pollution abatement attributable to the use of bio-retention basins. We have assumed that WSUD will primarily be implemented in Yeppoon as a proxy for the coastal zone. Building approvals data for the Yeppoon Statistical Local Area indicates annual building approvals in recent years have ranged between 100 and 140 per annum.[51] The results of our analysis are shown in Table 10 below.

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46 Star et al (2013 forthcoming) *Management practice trade-offs between, sediment and private benefits in grazing settings – implications of land type, land condition, grazing pressure and land regeneration*.

47 Rolfe at al (2013a forthcoming) *Risk – management tradeoffs in grazing and cane settings*.

48 Rolfe at al (2013b forthcoming) *Barriers and opportunities to adoption at the individual BMP and delivery scales*.

49 The original model does not include case studies for this study region. Therefore, we established proxy regional estimates for this region through interpolating the outputs from the Brisbane and Mackay case studies. Average annual rainfall data from the BOM was used to inform the interpolation exercise. It should be noted that all regions assessed had a dominant summer rainfall pattern, where higher and more intensive rains during dominant season drive the need for larger scale bio-retention basins.

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

51 ABS 8731.0, *Building Approvals, Australia*, various editions.

Table 10: Urban diffuse management – estimated costs and load reductions over the next 10 years

Indicator	Estimate (range)	Comments
Number of properties (over 10 years)	1,000 – 1,400	Actual number will depend on dwelling makeup over time.
Capital cost over 10 years	$9 – 11 million	Actual costs will depend on multiple issues (dwelling type, variability in site constraints, availability/unit cost of inputs, etc.).
Potential load reduction from business as usual		
TSS (tonnes per annum over 10 years)	210 - 250	Will depend on development site considerations and degree of compliance with WSUD best practice.
TP (kg per annum over 10 years)	330 - 400	As above.
TN (kg per annum over 10 years)	1,040 – 1,270	As above.

Source: Marsden Jacob and Mainstream estimates, 2014.

Notes: TSS=total suspended sediment; TP=total phosphorus; TN=total nitrogen.

The key points to note are that:

- Capital investments are likely to be made into WSUD infrastructure, particularly in coastal areas and areas adjacent to other waterways. To ensure the benefits of WSUD investments are maintained, local government will need to continue to maintain these assets once ownership is transferred from developers.
- The analysis assumes the above developments are all a part of large residential developments, involving land area thresholds of greater than 2,500 square metres and requiring post-construction phase stormwater design objectives for sediments and nutrients to be met before site discharge.
- The investments in mitigating urban diffuse loads will make a contribution to overall water quality targets. The impact is small when compared with the overall sediment load profile, but local sediment, nutrient and toxicant emissions may be more significant.

2.5.4 Point sources – wastewater treatment costs

Major wastewater treatment infrastructure in the Capricorn Coast includes:

- The Yeppoon sewerage system (capacity around 1,320ML/day), which services around 5,400 connections across Yeppoon, Pacific Heights, Meikleville Hill, Barlow's Hill, Cooee Bay, Taranganba, Lammermoor Beach, Statue Bay, Mulambin Waters and Rosslyn Bay. Around half of the treated sewage is used to irrigate parks and golf courses.
- A smaller sewage treatment plant and system (capacity around 250ML/day), which services around 1,400 connections across Tanby Point, Emu Park, Zilzie and the Great Barrier Reef Resort. [52]

52 http://www.rockhamptonregion.qld.gov.au/Council_Services/Fitzroy_River_Water/Water_and_Sewerage_Infrastructure/Sewage_treatment_plants

In addition, a major expansion of the resort at Great Keppel Island would see an additional 750 villas and 300 apartments established on the island. This broader development would also require a significant augmentation of the sewage treatment system.[53]

Best practice environmental management (BPEM) wastewater treatment standards are required for upgrades to meet population increases or new developments. In these cases, capital costs are significant.

Based on previous analysis undertaken by BDA consulting,[54] 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 (including incremental improvement in concentrations required). 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 (annual $ per tonne of pollutant removed)

Indicator	Estimated cost - $/tonne/annum (range)
Unit annual $ / tonne phosphorus	82,000 – 602,000
Unit annual $ / tonne nitrogen	188,000 – 857,000

Source: Marsden Jacob based on BDA Group (2006) Scoping Study on a Nutrient Trading Program to Improve Water Quality in Moreton Bay.

Given the sensitive nature of many development areas in the Capricorn Coast (close to the GBR), BPEM wastewater treatment standards will be required. Schemes will be relatively modest in size, and therefore costs per unit of pollution abatement may be relatively high, due to a lack of economies of scale.

53 http://www.gbrmpa.gov.au/about-us/consultation/current-proposals/great-keppel-island-resort-marina-and-utilities-pipeline/great-keppel-island-marina-and-tourism-development

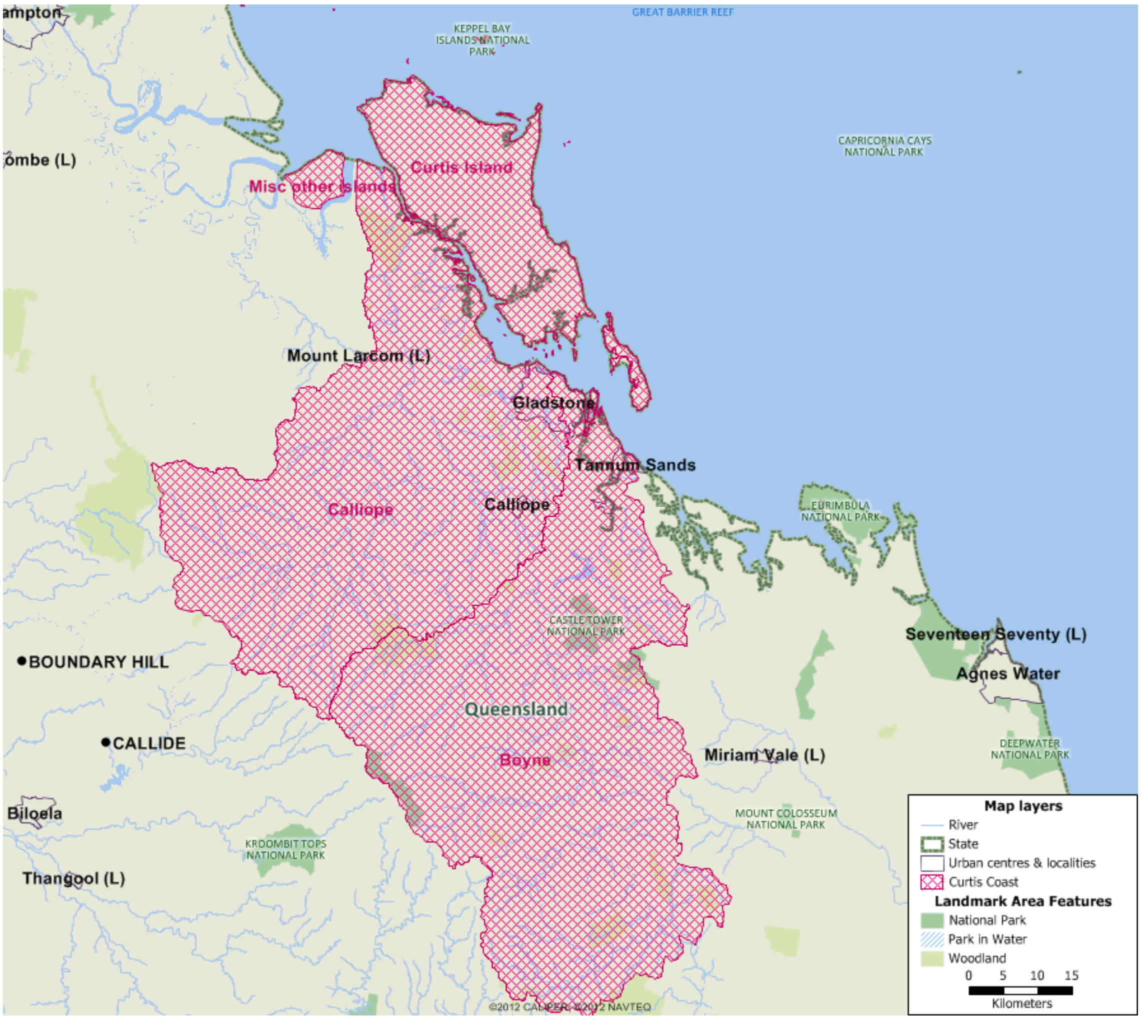
54 BDA Group (2006) *Scoping Study on a Nutrient Trading Program to Improve Water Quality in Moreton Bay*, Report prepared for the Queensland Environmental Protection Agency.

3. Curtis Coast

3.1 Introduction

This chapter considers the economic and social impacts of protecting the EVs of the tidal and non-tidal waters of the Curtis Coast (see Figure 8). The Curtis Coast comprises Curtis Island (area: 575 km^2), Calliope (2241 km^2) and Boyne (2496km^2) basins (total: 5312 km^2) and adjacent estuarine waters including Port Curtis. The Curtis Coast is centred on Gladstone, and includes only a small number of other urban centres and localities, namely Tannum Sands, Calliope, Benaraby and Boyne Island.

Figure 8: Map of the Curtis Coast



Source: Marsden Jacob, 2014.

In accordance with the *Environmental Protection (Water) Policy 2009* EVs are protected by achieving or maintaining the water quality objectives, through the management measures and control actions applicable to the rural and urban diffuse and point source emissions of nutrients, sediment and toxicants from activities and land uses in the basins.

3.2 Socio-economic profile – Curtis Coast

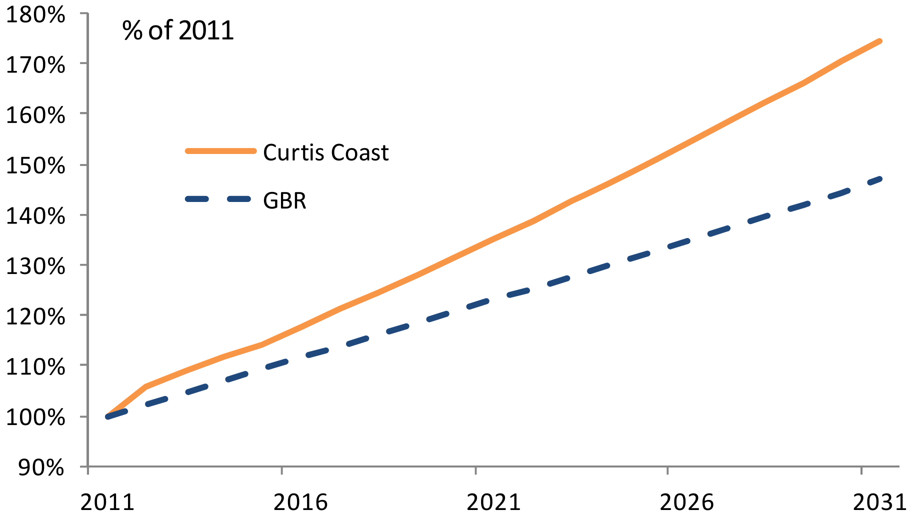
3.2.1 Demographic profile

Population and population growth

From the 2011 census, it is estimated that the population of the Curtis Coast region is around 52,623. Figure 2 shows the recent historical and forecast population growth for the Curtis Coast region compared with all GBR regions assessed in the 2010 Marsden Jacob report. It indicates that:

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

Figure 9: Population projections – Curtis Coast



Source: OESR and Marsden Jacob, 2014.

Like much of the GBR, the population of the Curtis Coast region is slightly skewed to males (52% of the population). In the 2011 census:

- 3.5% of respondents identified themselves as being of ATSI descent in the Curtis coast region compared with around 3.6% for the whole of Queensland; and
- approximately 12.5% of people in the Curtis Coast region were not born in Australia and around 4.3% of the population speak a language other than English at home.

A summary of demographic statistics for the region is presented in Table 12.

Table 12: Demographic summary 2001, 2006, 2011 – Curtis Coast

	2001	2006	2011
Total population	40,647	44,554	52,623
Percentage of males	51.0	51.6	52.6
Percentage of females	49.0	48.4	47.4
Percentage of ATSI descent	1.5	3.2	3.5
Percentage of people not born in Australia	10.7	10.6	12.5
Percentage of people who speak a language other than English at home	2.5	2.8	4.3

Source: OESR and Marsden Jacob, 2014.

Note: data are based on place of enumeration.

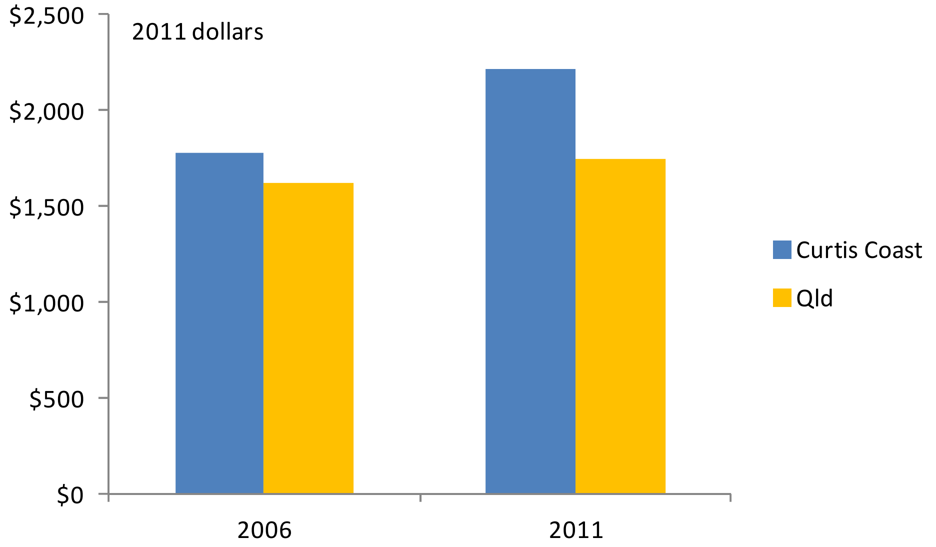
Community capacity

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

Approximately 19% of adults (>15 years old) participate in **voluntary work**, potentially indicating reasonable levels of social capital. Males had lower rates of participation in volunteer work at 16%, compared with females at 22%. However, the ABS census data does not indicate what type of volunteer work (e.g. environmental management) was undertaken.

The relative financial impact of any projects or policies that broadly impact on costs must be considered, as the burden may be relatively greater for lower-income families. The Curtis Coast has a significantly lower incidence of **low-income families** than the State as a whole. Approximately 9% of families in the Curtis Coast area were on low incomes in 2011 (i.e. < $600/week) compared with 13% for the State. The Curtis Coast has a higher average weekly family income than the State average and this gap has increased since 2006, an increase which has likely been associated with resources sector-related economic activity and employment (Figure 10).

Figure 10: Average weekly gross family income – Curtis Coast



Source: Marsden Jacob based on ABS 2006 and 2011 Census data and CPI data.

Household ownership (owned or being purchased) is sometimes used as a proxy for economic capacity. In the Curtis Coast, approximately 60% of homes are owned or are being purchased. This is very similar to the State average of 61%.

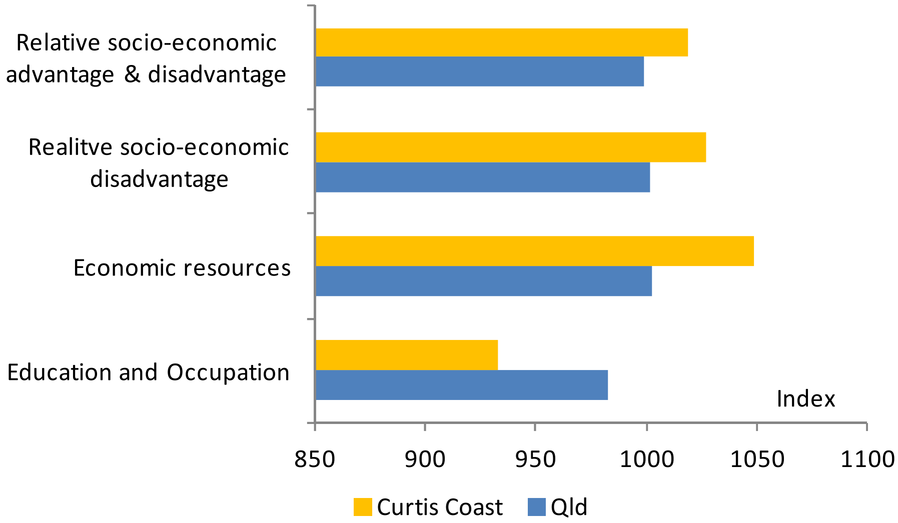
The ABS Socio-Economic Indexes for Areas (**SEIFA**) is a suite of broad composite indices of a community's capacity and socio-economic wellbeing. These indices are prepared using census data and provide a broad means to make relative comparisons of social and economic resources between regions. The three indices of most relevance are: [55]

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

These indices were estimated for the Curtis Coast based on a weighted average of SEIFA indices for SA1 areas within the region. Results including a comparison with Queensland as a whole are shown in Figure 11.

[55] ABS (2001) *Information Paper: Census of Population and Housing — Socio-Economic Indexes for Areas*, cat. no. 2039.0.

Figure 11: SEIFA indices – Curtis Coast, 2011



Source: Marsden Jacob based on ABS 2011 census SEIFA indices.

Analysis of the data indicates:

- relative to the Queensland average, the Curtis Coast is at a relatively significant, pronounced advantage;
- economic resources in the Curtis Coast are significantly higher the State average as a whole; and
- the only SEIFA index where the Curtis Coast is below the state average is the index of education and occupation, but this may simply reflect the importance of industries to Gladstone and Curtis Coast that rely heavily on trades-qualified people rather than university graduates.

Regarding **education levels**, while the Curtis Coast has lower Year 12 attainment and undergraduate and postgraduate attainment than the State average, it has a much higher proportion of people with Certificate level qualifications (Table 13). This may be related to Gladstone being a major industrial centre and port with industries that demand workers with trade qualifications.

Table 13: Educational attainment – Curtis Coast

Highest education level completed	Curtis (% of 15+ population)	QLD (% of 15+ population)
Schooling		
Year 10	38.6%	31.9%
Year 12	39.7%	47.8%
Post-school		
Certificate	26.7%	20.6%
Diploma	5.7%	7.9%
Undergraduate degree	8.3%	12.2%
Postgraduate degree	2.3%	4.3%

Source: ABS 2011 Census of Population and Housing.

Overall, based on a range of indicators, the Curtis Coast region has a high degree of community capacity and hence an ability to adapt to change.

Employment and labour force

Reflecting the nature of its main centre, Gladstone, as a major industrial centre and port in Queensland, the workforce composition of the Curtis Coast basin differs greatly from the rest of the GBR or Queensland. Notably:

- Employment in agriculture, forestry and fishing is much lower than elsewhere, at only 0.7% compared with the GBR average of 5.3% and the State average of 2.7%.
- Manufacturing is over double its share of employment in the broader GBR or Queensland, at 17.6% compared with the GBR average of 7.9% and the State average of 8.5%.
- Construction is also much higher, owing in large part to the construction of three new liquid natural gas (LNG) terminals on Curtis Island, with 14.2% of employed persons working in construction compared with the State and GBR averages at around 9%.
- Reflecting Gladstone's importance as one of Queensland's major bulk export ports (primarily for coal), employment in the transport, postal and warehousing industry is around 8% of employed persons compared with the GBR and State averages at around 5.5%.
- Employment in the public administration and safety, education and training and the health care and social assistance sectors are much lower than the GBR and Stage averages (16.3% in total compared with the GBR average of 25.0% and the State average of 26.9%.)

There were a number of important trends occurring between the 2006 and 2011 Censuses:

- The number of employed persons has grown strongly, with a 23% increase to over 26,000 since 2006. A major contributor to this growth is likely to be the construction activity for the new LNG plants occurring on Curtis Island. This is reflected in the pattern of employment change across industries.
- Construction employment increased by 45% to over 3,700 employed persons, a change in its share of total employment from 12.1% to 14.2%.

- Employed persons in professional, scientific and technical services almost doubled from 1,087 to 2,012, a change in the share of total employment from 5.1 to 7.7%. This is likely to be due in large part to the construction of three LNG plants on Curtis Island, and the associated demand for professional, technical and scientific services (e.g. engineers).
- There has been a decline in the relative employment in manufacturing in the region, from 20.8% to 17.6% of employed persons. Although employment in manufacturing actually increased by 165 employed persons over the period, this was not sufficient for manufacturing to maintain its share of a strongly growing workforce. The relative decline in manufacturing is likely to be related to both the high Australian dollar over much of the period and workers being attracted to other industries, such as mining.

Table 14: Employed persons by industry – Curtis Coast

	Employed persons			Percentage		
	2006	2011	Change	2006	2011	Change
Agriculture, forestry and fishing	276	190	-86	1.3	0.7	-0.6
Mining	354	851	497	1.7	3.3	1.6
Manufacturing	4,414	4,579	165	20.8	17.6	-3.2
Electricity, gas, water and waste services	536	722	186	2.5	2.8	0.3
Construction	2,560	3,707	1,147	12.1	14.2	2.1
Wholesale trade	561	636	75	2.6	2.4	-0.2
Retail trade	2,150	2,433	283	10.1	9.3	-0.8
Accommodation and food services	1,321	1,389	68	6.2	5.3	-0.9
Transport, postal and warehousing	1,633	2,061	428	7.7	7.9	0.2
Information media and telecommunications	130	128	-2	0.6	0.5	-0.1
Financial and insurance services	302	297	-5	1.4	1.1	-0.3
Rental, hiring and real estate services	416	448	32	2.0	1.7	-0.3
Professional, scientific and technical services	1,087	2,012	925	5.1	7.7	2.6
Administrative and support services	542	631	89	2.6	2.4	-0.2
Public administration and safety	853	948	95	4.0	3.6	-0.4
Education and training	1,441	1,598	157	6.8	6.1	-0.7
Health care and social assistance	1,321	1,705	384	6.2	6.6	0.4
Arts and recreation services	121	122	1	0.6	0.5	-0.1
Other services	668	849	181	3.2	3.3	0.1
Inadequately described/Not stated	520	721	201	2.5	2.8	0.3
Total	**21,206**	**26,027**	**4,821**	**100.0**	**100.0**	**0.0**

Source: ABS 2011 Census of Population and Housing.

Note: Based on place of enumeration.

3.2.2 Summary of socio-economic profile

The Curtis Coast has very favourable socio-economic indicators relative to other GBR regions. For example, it has a lower incidence of low-income families, and increasing boat ownership per capita is a signal of economic prosperity and rising incomes. The economic resilience in the area is related to the resources sector, particularly Gladstone's role as a major coal port and its future role in the export of LNG. Broadly, these characteristics of the catchment mean that implementing Water Quality Improvement Plan (WQIP) measures will impose less relative cost on the community than in other areas.

3.2.3 Industry profile

Port of Gladstone

The Port of Gladstone makes a very important contribution to Queensland's economy, serving as the port for exports of large volumes of bulk commodities, particularly coal. It is Queensland's largest bulk commodity port, and Australia's sixth largest.[56]

The importance of the Port of Gladstone is expected to increase with the construction of LNG export terminals on Curtis Island. It is expected that Queensland will export 21Mt of LNG by 2016 from the Port of Gladstone.[57] The value of these exports is expected to exceed $10 billion per annum.[58] Longer-term projections are for higher volumes of exports, with 33Mt projected by 2025. Queensland currently does not export LNG, with the first exports from Gladstone expected in 2014.

The economic benefits of LNG exports from Gladstone are large. As noted in the Queensland *Budget Strategy and Outlook 2013-14*:

> *...the ramp up in LNG production by 2015-16 will lead to growth in overseas exports of 23¼% in 2015-16 which, combined with a stronger domestic sector, should boost economic growth to 6% in that year.*[59]

Royalties from LNG production will contribute significantly to Queensland Government revenue, with other royalties expected to increase from $479 million in 2013-14 to $924 million in 2016-17, largely due to LNG production.[60]

Manufacturing and minerals processing

In part due to the benefits of proximity to the Port of Gladstone, manufacturing, including chemicals manufacturing and minerals processing, is very important to the Curtis Coast region. The region has 18% of the workforce employed in manufacturing compared with less than 10% for Queensland as a whole. Manufacturing in Gladstone accounts for around 21% or over $500 million of gross regional product (GRP).[61] Aluminium smelting is particularly important

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56 *Independent Review of the Port of Gladstone: Report on findings*, 2013, p.x.

57 Bureau of Resources and Energy Economics (2012) *Australia's Bulk Commodity Exports and Infrastructure: Outlook to 2025*, p. 67.

58 Queensland Government (2012) *Budget Strategy and Outlook 2012-13*, p. 40.

59 Queensland Government (2013) *Budget Strategy and Outlook 2013-14*, p. 31.

60 Queensland Government (2013) *Budget Strategy and Outlook 2013-14*, p. 171.

61 Based on SGS Economics and Planning (2010) *Prosperity 2030: Gladstone Region Economic Development Strategy*, p. 14.

in Gladstone, with Boyne Smelting Ltd employing 1,190 Gladstone residents.[62] The importance of manufacturing to the Curtis Coast economy will increase further from 2014-15 with the production of LNG from coal seam gas at three new processing facilities on Curtis Island.

Tourism

At the centre of the southern Great Barrier Reef, the city of Gladstone and its natural deep water harbour provide access to Heron and Wilson Islands and an abundance of leisure fishing opportunities. To the south, the coastal settlements of Agnes Water and the Town of 1770 provide access to the southern Great Barrier Reef and an escape to National Parks and pristine coastline. The hinterland and rural regions to the west include attractions such as Kroombit Tops National Park and Lake Callide.

Tourism is part of the broader economic structure in the Gladstone region and makes a significant contribution to the sustainable development of the regional economy and community.

In the year ending 30 September 2011, the Gladstone region was visited by:

- 499,000 domestic overnight visitors, comprising 217,000 holiday visitors, 142,000 people visiting friends or relatives, and 118,000 business visitors; and
- 52,000 international visitors.[63]

This visitation makes a significant contribution to the Fitzroy NRM region (which includes both the Capricorn and Curtis Coasts) with:

- 7,400 jobs in the Fitzroy NRM region directly supported by tourism in 2011-12; and
- tourism in the Fitzroy NRM region contributing in the order of $500 million to the Queensland economy in 2011-12.[64]

For the year ending September 2011, Gladstone recorded increases in domestic visitation driven by solid growth in holiday and business visitation. Travel close to home remained popular with many Queenslanders in recent years, with many consumers remaining budget conscious. This trend also benefitted the Gladstone region. An increase in locals holidaying in the region fuelled most of the growth. The Gladstone region also saw an increase in holiday visitation from Brisbane residents.[65]

For the same period, business visitors from Brisbane also boosted visitor numbers to Gladstone. The resources sector growth has had a significant effect on business travel to Gladstone.[66]

International visitors declined over the period due to the high Australian dollar and relatively weaker economies in Europe and the US. Europeans accounted for more than two thirds of all international visitors to Gladstone.[67]

Figure 12 shows visitor numbers for the Gladstone region.

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62 Gladstone Industry Leadership Group website, viewed 22 October 2013.

63 Tourism Queensland (2011) *Gladstone regional snapshot year ended 30 September 2011*.

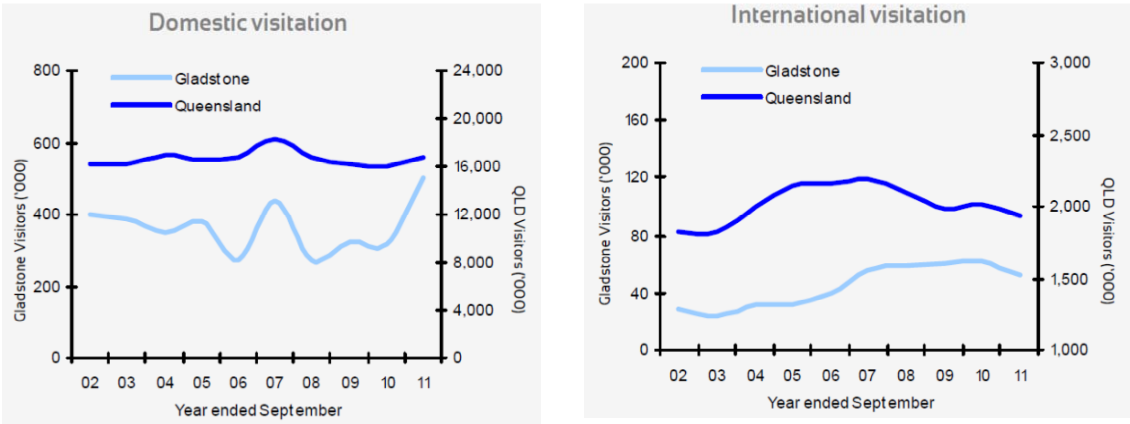
64 Deloitte Access Economics (2013) *Economic Contribution of the Great Barrier Reef*, p. 15.

65 Tourism Queensland (2011) *Gladstone regional snapshot year ended 30 September 2011*.

66 Ibid.

67 Ibid.

Figure 12: Gladstone region visitors for the year ending September 2011



Source: Tourism Queensland, 2011.

Agriculture

The agriculture industry is traditionally based on beef cattle and associated meat processing, but also includes fisheries, horticulture, plantation forestry and dairy. The Gladstone region has approximately 570,000 hectares of agricultural land, with approximately 90% of this area being used for livestock or grazing purposes. In 2005-06, the Gladstone region's agriculture sector contributed over $39.5 million of output to the region's economy.[68]

The region's agricultural industry is dominated by livestock. Over 2005-06, the estimated value of livestock products was around $27.5 million or around 70% of the total value of agricultural production in the Gladstone region.[69] In 2005-06, for the LGA of Gladstone, there were approximately 109,977 head of meat cattle and 2,261 head of dairy cattle in the region.[70]

Crop production accounted for $6.7 million worth of production (around 17% of total agricultural output) in the Gladstone region in 2005-06. Crop production was largely of grain and hay for livestock.[71]

The government has released an overall agriculture strategy with the aim of doubling agriculture production in the state by 2040. This may have implications for the agricultural industry in the Gladstone region, but any doubling of the industry in this region would be off a relatively low base.[72]

Mining

While the Curtis Coast economy, especially Gladstone, is highly dependent on resources sector exports and on minerals processing, there is currently limited mining activity within the region (Figure 13). However, oil shale mining and processing at Yarwun, near Gladstone, has the

68 SGS Economics and Planning (2010) *Prosperity 2030: Gladstone Region Economic Development Strategy*, p. 15.

69 Ibid, p. 20.

70 OESR, *Queensland Regional Database*, http://www.oesr.qld.gov.au/products/qld-regional-database/qld-regional-database/index.php.

71 ABS (2007), *Agricultural Commodities Small Area data 2005-06*.

72 DAFF (2013) *Queensland's agriculture strategy: A 2040 vision to double agricultural production.*

potential for a major new industry with associated investment and job opportunities. Small scale demonstration testing is underway.

There are two coal mines proximate to the region, in the Fitzroy Basin, namely Boundary Hill and Callide.

Figure 13: Operational mines – Curtis Coast

Source: Marsden Jacob, 2014.

3.3 Water quality in the Curtis Coast

EVs are the attributes of the water asset that support aquatic ecosystems and the multitude of direct and indirect human uses. Final EVs for tidal and non-tidal waters of the Curtis Coast are on the EHP website (www.whp.qld.gov.au). These include EVs for Curtis Island, Calliope Basin, and the Boyne Basin (including EVs for Gladstone Harbour and the Narrows). These are derived from the draft EVs established by FBA in conjunction with key local stakeholder organisations and the community, released for public comment in April 2014 [73] . EVs tables identify the presence of aquatic ecosystem and human use environmental values including:

- **Aquatic ecosystems.** Apparent across all freshwater (surface and groundwater), estuaries/bays and marine coastal waters where relevant. These values are negatively impacted by a number of land use activities across all sectors.
- **Agricultural use.** Water used for limited irrigation and stock and domestic use where relevant. The quality of water used by agriculture can have a marked impact on productivity.
- **Aquaculture.** Limited aquaculture use in the Calliope and Boyne Basins. Appropriate water quality is vital to aquaculture production that meets regulatory and market needs.
- **Fishing.** Commercial fishing is undertaken in the region, particularly in the marine and coastal zone. Water quality and waterway health has a significant impact on fish population dynamics, fish health, catch rates, and the quality of fish caught. Fish health and the associated impacts on commercial fishing enterprises has been a major issue in the Gladstone Region in recent years.
- **Recreation.** Both primary recreation (e.g. swimming, snorkeling) and secondary recreation (e.g. waterskiing, fishing) are relevant across all sub-regions of the Curtis Coast and secondary recreational values are very significant in the region (see Section 3.4.3 below). Declines in water quality have both direct and indirect negative impacts on these values through limiting opportunities to enjoy specific activities (e.g. swimming) and reducing recreational use (e.g. a decline in recreational fishing effort due to the quantity and quality of fish caught). Recreational uses are non-consumptive uses.
- **Visual appreciation and aesthetics.** Visual appreciation and aesthetics are key values in the region. These values can enhance values of adjacent land uses (e.g. residential, tourism) and any decline in aesthetics is often reflected in land values. This use is non-consumptive.
- **Drinking water.** Declines in water quality increase the cost of supplying potable water through higher treatment costs, and potentially the need to augment treatment standards where water pollutant thresholds are regularly exceeded. The majority of the drinking water consumed in the region is sourced from the Awoonga Dam and supplied by the Gladstone Area Water Board (GAWB).[74]
- **Industrial use.** Water consumption is a vital input for many industrial uses in the Curtis Coast. While the water quality is vital to industrial uses, the water quality requirements are not as high as potable supplies. Hence, the majority of the volume of water supplied by GAWB is untreated.[75]
- **Cultural and spiritual use.** There is also significant evidence of cultural and spiritual values attached to waterways by Traditional Owners, while some waterways also have a historical and cultural value to non-indigenous residents. These uses tend to be non-consumptive.

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73 See: Fitzroy Basin Association (2014) *Draft Community Consultation Report Establishing Environmental Values and Water Quality Objectives for Capricorn and Curtis Coastal Basins and Coastal Waters*, February 2014.

74 Gladstone Area Water Board (2012) *Annual Report* 2012.

75 Gladstone Area Water Board (2012) *Annual Report* 2012.

As can be seen from the EVs tables, there are a broad range of values relating to water quality and waterway health in the Curtis Coast. In addition, there is a relatively comprehensive suite of studies and data sets available to underpin development of EVs.[76]

A summary of current water quality monitoring data in Gladstone Harbour and associated waterways, post the January 2013 flood event, for a range of physic-chemical, nutrients and dissolved metal indicators is published at EHP's website (www.ehp.qld.gov.au). The *Analysis of Water Quality in Relation to Fish Health in Gladstone Harbour and Waterways September 2011 – September 2012* (Brisbane: Department of Environment and Heritage Protection, Queensland Government) included the following statements on water quality compliance within Port Curtis:

'*The current contaminant concentrations from Gladstone Harbour were generally less than, or comparable to, those measured from other industrialised harbours in Australia and around the world. In particular, dissolved concentrations of cadmium, nickel and zinc measured in Gladstone waterways were below the limit of reporting, or at the lower end of the concentration ranges for these metals measured in industrialised ports around the world, indicating a relatively low degree of water contamination of the harbour.*

'Metal concentrations were also generally low when compared to water quality guidelines (ANZECC and ARMCANZ 2000), except for occasional exceedances in the harbour. Repeated exceedances were measured for copper, as has been found previously for Gladstone Harbour (Jones et al. 2005; Angel et al. 2010). However, these exceedances for dissolved copper were mostly localised in the Marina and were not found consistently over the 12-month sampling.

'Apte et al. (2006) collected 59 sediment samples which ranged from surface samples to cores 45cm deep and analysed these for nine metals. They then compared these concentrations from Port Curtis with those from Sydney Harbour that has numerous contaminant inputs. The average benthic sediment concentrations in Port Curtis for copper and zinc were 18 ± 12 and 32 ± 29µg/g, respectively (Apte et al. 2005) and the corresponding concentrations in Sydney Harbour were 100µg/g and 700µg/g, respectively (Hatje et al. 2001). This indicates that particulate sediment concentrations for these contaminants at Port Curtis are not high in comparison.

'The fact that similar fish health issues have not been reported at other harbours, despite having higher concentrations of metals in the water and benthic sediments, indicates that metal contaminants are unlikely to be causing or contributing to any ongoing fish health issues in Gladstone Harbour.' (http://www.ehp.qld.gov.au/gladstone/pdf/water-quality-fish-health-gladstone.pdf

Compared with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000*, exceedance of the low reliability marine ecosystem protection level was noted for dissolved aluminium at the South Trees Inlet sites and for dissolved manganese at one site.

76 For a good summary see Llewellyn, L., Wakeford, M. & McIntosh, E. (2013) *Mapping and synthesis of data and monitoring in Gladstone Harbour. A report to the Independent Science Panel of the Gladstone Healthy Harbour Partnership*, August 2013, Australian Institute of Marine Science, Townsville.

3.3.1 Risks of current loads

Pollution loads in the Curtis Coast region are a function of natural variation, historical land use change and development, and more recent land use intensification for industry and dredging to expand the Port of Gladstone. Pollution loads are driven by land based point source, urban diffuse and rural diffuse sources of nutrients, sediments and toxicants and any turbidity impact of maintenance and capital dredging in Gladstone harbour. These matters are addressed under regulation (environmental authority) or best practice management.

Final water quality objectives are published on EHP's website at www.ehp.qld.gov.au. These are based on the guidelines stated in the draft report *Aquatic ecosystem water quality guidelines: Capricorn-Curtis Coast region* (DSITIA, February 2014), with updates following public release of draft materials.

Sampling of water pollution loads is undertaken across the GBR catchments and reported under the Reef Water Quality Protection Plan.[77] However, in the short-term, annual loads vary significantly depending on physical parameters such as rainfall as well as anthropogenic actions such as land use and changes in practice.

It is more instructive to consider an estimate of the natural loads, and estimates of the anthropogenic loads as this provides more insight into the degree to which loads have changed due to anthropogenic activity (e.g. changes in land use). The table below summarises key estimates for the region developed by CSIRO.[78]

77 Turner. R, Huggins. R, Wallace. R, Smith. R, Warne. M St. J. (2013) *Total suspended solids, nutrient and pesticide loads (2010-2011) for rivers that discharge to the Great Barrier Reef: Great Barrier Reef Catchment Loads Monitoring 2010-2011,* Department of Science, Information Technology, Innovation and the Arts, Brisbane.

78 Kroon F, Kuhnert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J, and Joo M (2010) *Baseline pollutant loads to the Great Barrier Reef*, CSIRO: Water for a Healthy Country Flagship Report series ISSN: 1835-095X.

Table 15: Estimated anthropogenic loads data for key pollutants – Curtis Coast

Area	Sediment - TSS (ktonnes/year)			Nutrients – TN (tonnes/year)		
	Natural	Total	Anthrop-ogenic	Natural	Total	Anthrop-ogenic
Calliope River	20	211	191	46	596	550
Boyne River	41	43	2	90	191	101
Curtis basins Total	61	254	193	136	787	651
Fitzroy Basin	1141	3409	2268	1311	12974	11663
Fitzroy NRM region*	1259	4109	2850	1672	15126	13454
Curtis basins total as % of Fitzroy NRM region	4.8%	6.2%	6.8%	8.1%	5.2%	4.8%
GBR total	3112	16075	12963	13891	89112	75221
Curtis basins total as % of GBR	2.0%	1.5%	1.4%	1.0%	1.0%	1.0%

Source: Kroon F, Kuhnert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J, and Joo M. 2010. Baseline pollutant loads to the Great Barrier Reef. CSIRO: Water for a Healthy Country Flagship Report series ISSN: 1835-095X.

Notes:

Anthropogenic loads were referred to as "baseline" loads in Kroon et al. (2010).

Loads for other pollutants are also reported in Kroon et al. (2010).

TSS=total suspended sediment; TN =total nitrogen.

** Fitzroy NRM region comprises Styx, Shoalwater Creek, Water Park Creek, Fitzroy, Calliope and Boyne river basins*

The key points to note from the CSIRO estimates are:

- The overall contribution of the mainland Curtis basins to total sediment loads is small (6.2% of the total Fitzroy NRM region loads and 1.5% of the total GBR loads). In comparison, the neighbouring Fitzroy Basin contributes over 80% of the region's sediment load, and 80% of its anthropogenic load;
- Estimated total sediment loads for mainland Curtis basins are around 4.2 times estimated natural loads, higher than the ratio for the Fitzroy NRM region as a whole (3.3 times), but lower than the ratio for the GBR as a whole (over 5 times);
- The overall contribution of the Curtis mainland basins to total nitrogen loads is small (5.2% of the total Fitzroy NRM region loads and 1.0% of the total GBR loads). In comparison, the neighbouring Fitzroy Basin contributes over 85% of the region's total nitrogen load and 80% of its anthropogenic load;
- Estimated total nitrogen loads for the mainland Curtis basins are around 5.8 times estimated natural loads, lower than the ratio for the Fitzroy NRM region (9.0 times), and the GBR as a whole (6.4 times); and

- Data available on other pollutants (e.g. phosphorus, herbicides) all indicate loads that are often several times natural loads across the region.[79]

3.3.2 Future load increases and risks to EVs

Without continued focus on best management environmental practice, the current and likely future development in the broader region is likely to increase risks to water quality and EVs. These pressures are a consequence of development within the Curtis Coast region and also a consequence of broader regional development, with much of the related trade being transported through the Port of Gladstone. This section briefly outlines some of the key economic and demographic drivers that will lead to changes in land use and other pressures on EVs on the Curtis Coast.

Final water quality objectives are published on EHP's website at www.ehp.qld.gov.au. These are based on the guidelines stated in the draft report *Aquatic ecosystem water quality guidelines: Capricorn-Curtis Coast region* (DSITIA, February 2014), with updates following public release of draft materials.

Drivers and risks to Environmental Values

Future risks to EVs are essentially a consequence of development patterns in the region. Table 16 below summarises likely key economic and demographic drivers and their potential relative contribution to future risks to EVs.

Table 16: Economic and demographic drivers and potential future risks to EVs

Sector	Future potential risk to EVs	Comments
State Development Area	Significant	Gladstone State Development Area (SDA) is located 15 km north-west of Gladstone. The designated area totals around 29,000 ha with targeted development types including: • large-scale, large-footprint industrial development • port-related activities and industries necessary to support major industrial development • LNG processing, storage and export facilities • materials transportation infrastructure and utility and service infrastructure • gas transportation infrastructure and other compatible infrastructure. All of the targeted development types will require significant changes in the intensity of land use, potentially resulting in growth in sediment and nutrient loads entering local waterways. Furthermore, the nature of the targeted industries will also trigger increases in pollution loads attributable to ongoing operations.[80]
Energy	Significant	Energy developments in the broader region may trigger other

79 For a comprehensive overview of estimates of loads, see: Kroon F, Kuhnert K, Henderson B, Henderson A, Turner R, Huggins R, Wilkinson S, Abbott B, Brodie J, and Joo M. (2010) *Baseline pollutant loads to the Great Barrier Reef. CSIRO: Water for a Healthy Country Flagship Report,* series ISSN: 1835-095X.

80 For an overview of the Gladstone State Development Area see www.dsdip.qld.gov.au/coordinator-general/gladstone-state-development-area.html

		developments and (potentially) increases in shipping and related infrastructure development. Long-term forecasts of energy production to 2050 are not available for Queensland. However, national forecasts show black coal production increasing from 11,500 petajoules (PJ) currently, to 18,400 PJ by 2035, before declining slightly to 18,000 PJ by 2050. Over this same period, exports are expected to increase from 11,664 PJ currently to 17,973 PJ by 2050. By 2050, exports will account for around 97% of production. Gas production is expected to rise rapidly from around 3,023 PJ currently to around 8,595 PJ in 2050. By 2050, exports will account for 71% of production.[81]
Minerals	Moderate	Some new projects starting in the broader region with indirect impacts via shipping activity. Growth in export-orientated production may be constrained in the short to medium term by a relatively high Australian dollar and worldwide commodity prices. Development of mining and processing of oil shale.
Industrial development	Significant	Possibility of further energy-intensive developments in the Curtis Coast region, but developments will be constrained by a relatively high Australian dollar and world commodity prices.
Construction	Significant	Significant changes to loads in the short term.
Infrastructure and transport	Significant	Current port expansion is the greatest short-term risk to EVs. Long-term growth prospects (particularly energy-related development) and energy export activity will continue to see risk to EVs into the future. See section on shipping activity below.
Cattle	Negligible/ moderate	The broader Fitzroy region has a significant competitive advantage in beef production. As incomes rise in developing economies, demand for meat also increases shapely. The FAO estimate worldwide beef consumption will grow by 1.2% per annum to 2050. However, growth in demand in developing economies (particularly in Asia) is likely to increase 1.9% per annum (up 40,000,000 tonnes per annum) by 2050.[82] Fitzroy producers are likely to meet part of this international demand growth, resulting in increased intensification and potential runoff. However, this is less likely to occur in the sub-regions of the Fitzroy relevant to this study. The management of rural diffuse sediment and nutrient emissions is being managed through industry-led BMP module development.
Irrigated agriculture	Negligible	Limited activity currently in region. Region does not have any apparent competitive advantage in domestic market. International competitiveness limited.[83]
Urban	Moderate	Population growth is significant[84] with subsequent development

81 BREE (2012) *Australian Energy Projections to 2050.*

82 Alexandratos, N. and J. Bruinsma (2012) *World agriculture towards 2030/2050: the 2012 revision*, ESA Working paper No. 12-03, FAO, Rome.

83 Apted, S., Berry, P., Short, C., Topp, V., Mazur, K., and Mellor, T. (2006) *International Competitiveness of the Australian Vegetable Production Sector*, ABARE eReport 06.5.

development		leading to increased runoff from housing development, associated infrastructure development (e.g. roads) and associated commercial and social development (e.g. commercial land, schools etc.).
Tourism	Negligible	GBR tourism in the Curtis Coast region is relatively negligible.

Source: Marsden Jacob and MainStream analysis.

The bottom line from the analysis is that the future risks to EVs are dominated by a continuation of energy development within the broader region and the downstream land, infrastructure and transport activity. Continued risk management will be needed, as addressed in the following sections.

Ports and growth in shipping

Shipping activity and the expansion of Gladstone Port's capacity is essentially a consequence of much of the economic growth and risk outlined in the previous section. This section briefly outlines relevant information relating to ports and growth in shipping.

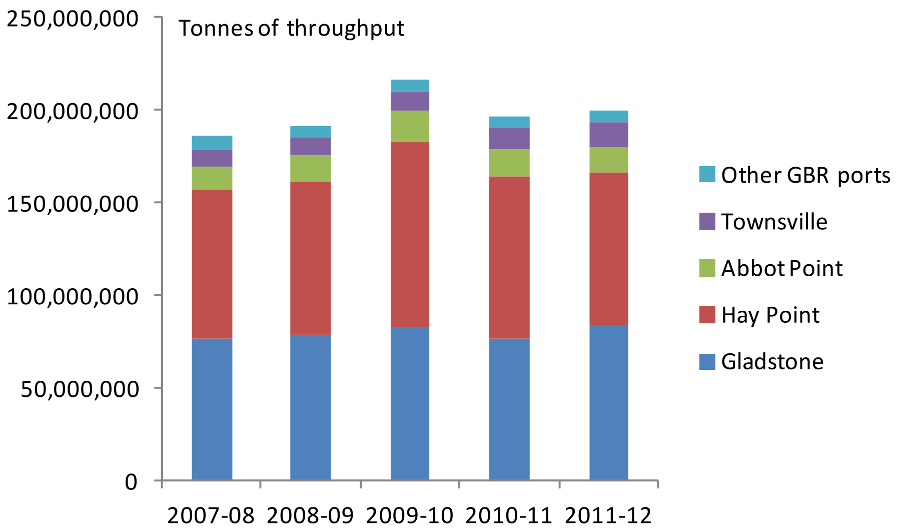
Throughput at the Port of Gladstone has gradually risen over the last half decade, although it declined in 2010-11 due to disruptions to coal production as a result of the 2010 floods (Figure 14). Exports are primarily coal and imports are primarily bauxite. Other exports include aluminium and cement/clinker. Other imports are mainly caustic soda and petroleum products. Gladstone, along with Hay Point near Mackay, accounts for the bulk of throughput (exports and imports) at GBR ports (Figure 15).

Figure 14: Throughput at Port of Gladstone

Source: Queensland Transport and Main Roads, 2013, Trade Statistics for Queensland Ports: For the five years ending 30 June 2012.

[84] OESR estimates.

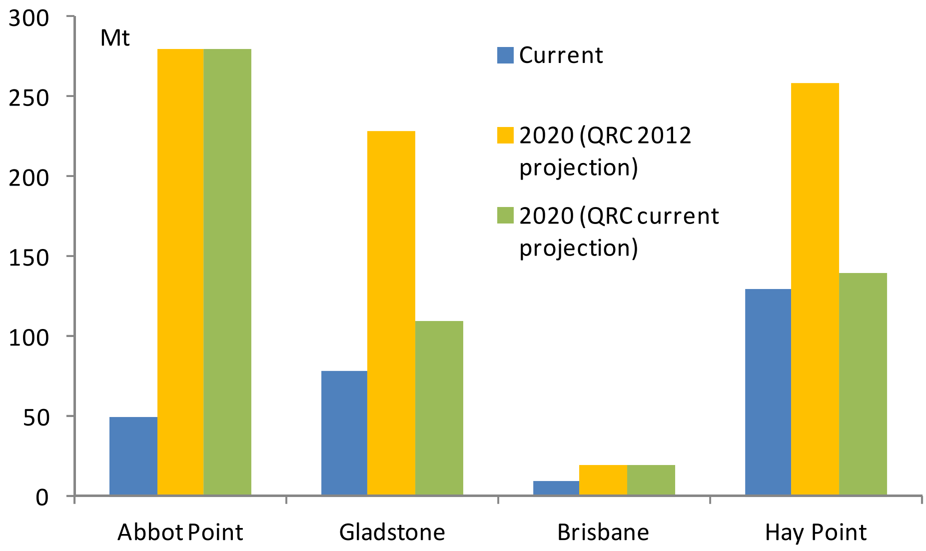
Figure 15: Throughput at GBR ports



Source: Queensland Transport and Main Roads, 2013, Trade Statistics for Queensland Ports: For the five Years ending 30 June 2012.

It is anticipated that the number of ship calls and the volume of trade at ports in and near the region will increase substantially over at least the next decade. However, given poorer market conditions and expectations in 2013 compared with 2012, previously published projections would need to be revised down, according to advice from the Queensland Resources Council (QRC).[85]

Figure 16: Projected port capacity

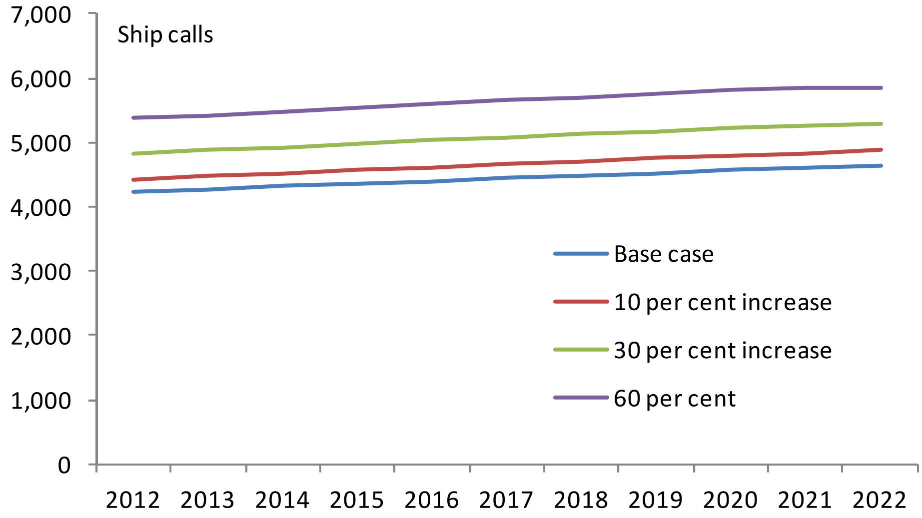


Source: BREE, 2012, Australian bulk commodity exports and infrastructure – outlook to 2025, p. 11, and consultation with QRC.

There are no official projections of ship movements at different ports. The Queensland Department of State Development, Infrastructure and Planning has only published projections for all GBR ports (Figure 17).

85 Email from David Rynne, Chief Economist, QRC, 12 June 2013.

Figure 17: DSDIP forecasts of ship calls under different scenarios of trade volumes



Source: DSDIP (2012) Great Barrier Reef Ports Strategy Economic Analysis.

3.4 Benefits of maintaining Environmental Values

There are multiple benefits from undertaking actions that will maintain EVs. This section briefly outlines some of the key benefits.

3.4.1 Aquatic ecosystems, ecosystem function and services

Consultation undertaken by FBA and previous research has consistently recognised the importance of maintaining the condition of freshwater and marine aquatic ecosystems in the planning region. Where the condition of the aquatic ecosystem declines, key ecosystem functions and services also decline (including impacts on fish breeding, recreation, and tourism, etc).

Healthy GBR aquatic ecosystems are among the most important biologically diverse and economically valuable ecosystems. They provide valuable and vital ecosystem services, the protection of coastlines from storms and erosion, habitat for living organisms, and jobs and incomes to local, regional and national economies from fishing, recreation, and tourism.

While much of the population may argue that the value of aquatic ecosystems in the region (particularly the GBR) is essentially priceless, economists are able to estimate values for the GBR based on what people are prepared to pay to protect and manage the Reef.

Rolfe, J et al[86] (2010) have framed the analysis in terms of marginal improvements to protection; that is the TEV[87] of a 10% improvement in GBR health (or avoiding a 10% decline in health). The TEV approach shows a 10% improvement in protection (or avoiding a 10%

86 Rolfe, J., Windle, J. and Prayaga, P (2010) *Assessing total economic value for protecting the Great Barrier Reef.*

87 Total Economic Value includes: direct use values of industries (producer surplus) e.g. from commercial fishing, recreational fishing and tourism; direct use values of tourists and recreational fishers (consumer surplus); indirect values of coastal protection; non-use values of Australians (who may not all visit); and non-use values for international residents.

decline) for 25 years to be $6.3 billion.

The analysis assumes that direct use and in-direct use values can be scaled to GBR health, i.e. a 10% decline in health would lead to 10% drop in use and values.

According to a United Nations estimate, the total economic value (TEV) of coral reefs range from US$ 100,000 to 600,000 per square kilometre per year.[88]

Other studies suggest that even a 1% improvement in the condition of the GBR would have a significant benefit to residents. Based on estimates of the number of households in the Curtis Coast region[89] and studies of households' willingness to pay[90], the mean annual value of a 1% improvement in GBR condition to Curtis Coast residents only is around $310,000. However, given the uncertainties in the surveying and economic modelling, values could be as high as $640,000 per annum. Other studies also indicate that aquatic ecosystems have significant economic values.[91] The key point to note is that all studies indicate the community's willingness to pay for waterway protection is significant.

In addition, there is a significant preference for protection of the GBR across Australia and internationally. Across Australian households, the average willingness to pay to protect the health of the GBR has been estimated at around $22 per household per annum for five years.[92]

The Great Barrier Reef National Survey carried out under the Social and Economic Long Term Monitoring Program (SELTMP) provides additional information on attitudes towards the Great Barrier Reef, and is available from the NERP Tropical Ecosystems Hub website: http://www.nerptropical.edu.au/sites/default/files/publications/files/NERP-TE-PROJ-10.1-SELTMP-2013-NATIONAL-SURVEY-Complete.pdf .

Specific direct use values are considered in the following sections.

3.4.2 Benefits to industry

There are a number of benefits to industry from maintaining waterway health.

Agriculture

Agriculture is not a major industry directly within the study area, although current agricultural production in the area will be impacted by changes in water quality (impacting on stock watering, irrigation efficiency, etc).

88 UNEP-WCMC (2006) *In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs*, Cambridge UK. Available online at http://www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series/24.cfm)

89 Based on OESR concorded estimates of 2011 Census data.

90 Rolfe. J and Windle. J (2010) *Assessing national values to protect the health of the Great Barrier Reef.*

91 For example: Rolfe, J. and Windle, J. 2011 Assessing community values for reducing agricultural emissions to improve water quality and protect coral health in the Great Barrier Reef, *Water Resources Research*, 47(12): W12506, doi:10.1029/2010WR010355.

92 Rolfe, J. And Windle, J. (2012) "Distance decay functions for iconic assets: Assessing national values to protect the health of the Great Barrier Reef in Australia", *Environmental and Resource Economics*, vol. 54, no. 3, pp. 347-365.

Commercial fisheries

Based on 2005 data, there are around 65 commercial fishing operators in the region[93] with a commercial catch worth around $3.2 million (see table below). Loss of fish habitat (area or quality) or closures of fisheries due to water quality considerations could have a significant impact on existing operators. The extent of those impacts would also be determined by the period of any negative impacts attributable to dredging and other port developments.[94]

Table 17: Gross value of commercial fishing catch (2005)

Fishing type	Tonnes	Effort days	Value of catch ($)
Trawl	37.9	288	$367,300
Pot - Crab	95.5	2534	$1,002,000
Trawl - Beam	7	77	$63,500
Trawl - Other	30.9	211	$303,800
Net	287	1249	$1,451,400
Total	458.3	4,359	$3,188,000

Source: http://chrisweb.dpi.qld.gov.au/chris/

While the gross value of the catch is not significant in a broader regional economic sense, commercial fishing is a long-term regional industry that is susceptible to changes in ecosystem function, which impact on catch rates and product quality. Furthermore, profit margins in the industry are generally low, making the industry particularly commercially susceptible to relatively small fluctuations in catch.

To the extent that EVs can be maintained, the long-term prospects of the commercial fishing industry will be improved.

Tourism

As discussed in Section 3.2.3 above, tourism in the region is relatively modest when compared to the rest of the GBR, but of major local economic importance. Tourism in the region will be impacted by changes in waterway health in a similar way to recreational fishing and boating.

Water service provision

The GAWB sources water from Awoonga Dam, which is less likely to be impacted by industries creating future risks to EVs (due to the location of the dam). However, any decline in water quality can have an impact on the cost of providing treated water.

3.4.3 Recreational fishing and boating

Fishing

Recreational fishing in the region provides a significant benefit to people, both local residents and visitors. In 2010, there were around 21,000 people who participated in recreational fishing

93 Here we have used commercial fisheries grid S30 as a proxy for the study area.

94 Hunt, C. (2011) *Compensation policy in relation to impacts on fishing and land-based dependent businesses of Gladstone Port Development*.

in the study area, with the bulk from the broader Fitzroy region and a smaller fraction coming from further south, from the Brisbane region.

This level of recreational fishing would generate a value to fishers (consumer surplus) in the order of $5 million per annum, or around $250 per fisher (Table 18). This is based on assumed consumer surplus of $80 per fisher per trip, consistent with empirical literature for Queensland and Australia.[95] These estimates should be taken as indicative only because the majority of empirical studies relate to freshwater fishing.

Table 18: Consumer surplus from recreational fishing in the Curtis Coast region

	Effort days	Consumer surplus $M
Private boat	40,062	3.20
Shore	26,007	2.08
Total	66,069	5.29

Source: Marsden Jacob estimates based on DAFF 2010 data.

The data clearly indicates the significance of recreational fishing to residents in the Curtis Coast region and the need to maintain waterway health and ensure this important social value is maintained for the community. Additional local research indicates that fishing effort has increased in recent years as population has risen. There has also been a general decline in catch rates that is likely to be a consequence of several factors, potentially including excessive fishing effort and declines in the extent and condition of suitable habitat.[96]

Boating

Boating is a popular recreational pastime in the region, indicated by the absolute and relative number of boat registrations. To the degree that waterway health can be maintained, the benefits of recreational boating can be maintained. Boat registrations recorded by Queensland TMR have grown strongly in the Gladstone Regional Council area over the last decade, much faster than population growth.

The number of boats per 100 people has risen from 8.6 to 12.3 per 100 people since 2001, indicating the significance of recreational boating to residents in the Curtis Coast region and the need to maintain waterway health and ensure this important social value is maintained for the community.

3.4.4 Other benefits

There are a number of other benefits that also need to be considered. These include:

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95 This value is based on a review of recent studies including: Deloitte Access Economics (2012) *Benefit of Basin Plan for the MDB fishing industries*; Rolfe, J. and Prayaga, P. (2007) "Estimating values for recreational fishing at freshwater dams in Queensland", *Australian Agricultural and Resource Economics*, vol 51; and Mazur, K., (2012) *Valuing gamefishing activity in Eastern Australia*, ABARES. It is a relatively conservative estimate because one relevant study estimates very high values for recreation: Rolfe, J., Gregg, D. And Tucker, G. (2011) *Valuing local recreation in the Great Barrier Reef, Australia*.

96 Bill Sawynok, John Platten, Wendi Parsons and Stefan Sawynok (2013) *Gladstone Recreational Fishing Project* and Gladfish (2012) *Assessing Trends in Recreational Fishing in Gladstone Harbour and Adjacent Waterways*.

- **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.
- **Human health.** Ensuring human health is maintained through reducing risks to water supplies and waters where human contact is likely.

3.5 Costs of improving or maintaining water quality objectives

3.5.1 Types of costs

Final water quality objectives are published on EHP's website at www.ehp.qld.gov.au. These are based on the guidelines stated in the draft report *Aquatic ecosystem water quality guidelines: Capricorn-Curtis Coast region* (DSITIA, February 2014), with updates following public release of draft materials.

There are a number of costs associated with undertaking actions to maintain/improve water quality and achieve the water quality objectives.

These include:

- the direct financial cost of actions (e.g. cost of building and running wastewater treatment plants);
- the opportunity cost of actions (e.g. reduced production areas); and
- program management costs (e.g. science and administration).

The following sections identify, scope and, wherever possible, quantify some of the key costs associated with reducing pollution loads into waterways.

3.5.2 Costs to primary industries

While primary industries are not a major contributor to the regional economy compared with other industries, they are the dominant land use in the region. Table 19 shows data from the QLUMP for the major primary industry land uses in the region. The key point to note is the dominance of cattle, around 72% of the total region, split roughly evenly between the Boyne and Calliope catchments.

Diffuse run-off of sediments and nutrients from rural lands is being managed through the development of industry-led BMP modules for grazing land management and soil health. The department has commissioned the FBA to develop industry-led BMP modules to assist graziers to maintain and improve land resources, maintain quality pasture cover throughout the year and keep soil on their properties—informed by local EVs and water quality objectives.

Mapping data also indicates a significant area of production forestry. The area of dryland and irrigated crops and plantation is only around 0.2% of the total region.

Table 19: Key rural land uses (2009)

Land use	Area (ha)	% of total region
Cattle grazing	388,133	71.5
Production forestry	41,964	7.7
Dryland crops and plantations	802	0.1
Irrigated crops and plantations	664	0.1

Source: QLUMP mapping data provided by EHP.

Comparisons of mapping data between 1999 and 2008 indicate the area under grazing has declined by around 8% over the period, while irrigated cropping is down around 31% (particularly perennial horticulture).

Grazing is the dominant rural land use and the land use that offers the greatest potential for sediment abatement in the region. However, groundcover data for the region shown in the table below indicates that mean long-term groundcover in the region is relatively high (>86%) and that only around 5% of the grazing area has had average groundcover of less than 50% over the 23 years to 2010. Groundcover outcomes in the region are significantly better than the average for the Fitzroy.

Table 20: Regional groundcover statistics

Region	23-year mean groundcover (%)	2010 mean groundcover (%)	Percentage of regional area with less than 50% groundcover averaged over last 23 years (%)	Percentage of regional area with less than 50% groundcover in 2010 (%)
Calliope	86.2	97.4	5.7	0.6
Boyne	88.2	97.5	3.4	0.9
Whole Fitzroy	80.1	93.5	9.3	1

Source: Reef Plan 2010 Report Card.

Furthermore, Reef Plan practice data for management practices for the whole Fitzroy show only around 9.3% of all grazing properties are currently using “D” practices. Over 50% are using “A” or “B” practices, with the remaining 40% using “C” practices. Given the groundcover results for the Curtis Coast are significantly better than the average for the Fitzroy, it is also likely that practices in the Curtis Coast may be better than the broader regional averages. In short, the opportunities for achieving major reductions in sediment loads entering waterways from enhancing grazing management practices may be limited as most producers are already at “A” or “B” practices, and relative levels of groundcover are high.

MJA has previously estimated the costs of abatement in the Fitzroy at around $48-68 per tonne (including any opportunity cost, reduced gross margin and program management costs).[97]

[97] Marsden Jacob based on 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 estimate was broadly in line with indicative estimates from Donaghy et al (2006) of around $56M to reduce sediment exports by 12% in the catchment.

However, analysis by Donaghy et al. (2007) indicates that the long-term costs and benefits of managing for target groundcover levels vary significantly, depending on the starting pasture condition and the dominant local land type. For example:

> *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…* [98]

Furthermore, initial findings from analysis currently underway under the auspices of the Reef Rescue R&D Program confirm that the costs of moving between practices can be relatively low (<$20/tonne TSS) for the dominant soil types in this study region, particularly where the pasture condition is already relatively good.[99] Often it is attitudes to risk[100] and other social factors[101] that create the greater impediment to improved management practices.

3.5.3 Urban diffuse costs

The region's population is developing rapidly, largely on the back of mining and energy developments. The increased population drives demand for further expansion of urban areas for residential, commercial and infrastructure land uses. Current best practice to avoid and mitigate urban diffuse water pollution loads involves the implementation of WSUD principles and actions.

Marsden Jacob has estimated the potential costs of addressing urban loads assuming that greenfield urban development will implement on-ground actions, particularly bio-retention basins as a key stormwater management strategy.

Using an updated version[102] of our economic model used for the business case for WSUD,[103] it is possible to develop broad estimates of the cost of managing urban diffuse loads in greenfield development over a reasonable planning time frame (10 years). It is also possible to establish broad estimates of the volume of pollution abatement attributable to the use of bio-retention basins.

The results of our analysis are shown in Table 21 below.

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

99 Star et al (2013 forthcoming) *Management practice trade-offs between, sediment and private benefits in grazing settings – implications of land type, land condition, grazing pressure and land regeneration.*

100 Rolfe at al (2013a forthcoming) *Risk – management tradeoffs in grazing and cane settings*.

101 Rolfe, J. et al. (2013b forthcoming) *Barriers and opportunities to adoption at the individual BMP and delivery scales.*

102 The original model does not include case studies for this study region. Therefore, we established proxy regional estimates for this region through interpolating the outputs from the Brisbane and Mackay case studies. Average annual rainfall data from the BOM was used to inform the interpolation exercise. It should be noted that all regions assessed had a dominant summer rainfall pattern, where higher and more intensive rains during dominant season drives the need for larger scale bio-retention basins.

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

Table 21: Urban diffuse management – estimated costs and load reductions over the next 10 years

Indicator	Estimate (range)	Comments
Number of properties (over 10 years)	5,180 - 6,380	Actual number will depend on dwelling makeup over time.
Capital cost over 10 years	$55 – 67 million	Actual costs will depend on multiple issues (dwelling type, variability in site constraints, availability/unit cost of inputs, etc).
Potential load reduction from business as usual		
TSS (tonnes per annum over 10 years)	390 - 470	Will depend on development site considerations and degree of compliance with WSUD best practice.
TP (kg per annum over 10 years)	620 - 720	As above.
TN (kg per annum over 10 years)	1,940 – 2,370	As above.

Source: Marsden Jacob and Mainstream estimates, 2014.

Notes: TSS=total suspended sediment; TP=total phosphorus; TN=total nitrogen.

The key points to note are that:

- Significant capital investments are likely to be made into WSUD infrastructure. To ensure the benefits of WSUD investments are maintained, local government will need to continue to maintain these assets once ownership is transferred from developers.
- The analysis assumes the above developments are all a part of large residential developments, involving land area thresholds of greater than 2500 square metres and requiring post-construction phase stormwater design objectives for sediments and nutrients to be met before site discharge.

The investments in mitigating urban diffuse loads will make a contribution to maintaining locally determined EVs through the protection of local water quality objectives.

3.5.4 Potential future expansion of Gladstone Harbour

The Queensland Ports Strategy was released in June 2014, and is available at http://www.dsdip.qld.gov.au/infrastructure-and-planning/queensland-ports-strategy.html.

The vision of the strategy is to '*drive economic growth through the efficient use and development of Queensland's long established major port areas, while protecting and managing Queensland's outstanding environmental assets*'. The strategy contains 18 key actions including:

- The Queensland Government will establishment of five Priority Port Development Areas (PPDAs) at long-established major ports (including Port of Gladstone)
- Within and adjoining the Great Barrier Reef World Heritage Area, the Queensland Government will prohibit dredging for the development of new, or the expansion of existing port facilities outside PPDAs, for the next ten years.

The Gladstone Ports Corporation plans to duplicate the existing shipping channel to create a two-way shipping passage in the outer Gladstone Harbour. Dredging could result in the disposal of spoil, even after actions to avoid and minimise environmental damage are undertaken.[104] While independent analysis shows that the sediments to be dredged will meet international compliance requirements for ocean disposal,[105] there will be some residual impacts on adjacent estuarine and seagrass areas and some coastal reefs. The Federal Environment Minister has instructed[106] the Queensland Government and the Gladstone Ports Corporation to consider only onshore dumping of dredge spoils from the construction of the proposed $400 million second shipping channel.

Recent analysis has indicated that modelling of sediment plumes for environmental impact statements in GBR ports has often underestimated the spread of sediment plumes, although risk assessments have indicated that relative risks to coral reefs are medium at worst (i.e. the likelihood is possible, while the consequences are minor).[107] Given the potential for risks and the degree of uncertainty in modelling, there remains a need to manage the environmental risks associated with the port development carefully.

Because of the recognised risks, all current and proposed port development activity is managed under a strict regulatory regime and subject to detailed and continuous monitoring.

While the regulatory regime should ensure port development and operations result in water pollution levels within regulated standards it is instructive to consider what the potential cost of an offset might be if it was required as part of an overall environmental management strategy.

The second Reef Plan Report Card[108] indicates sediment reductions of 192,000 tonnes to 2011 were achieved at a cost of approximately $600 /tonne of sediment.[109] However, it should be noted that there is significant variance in the cost of sediment load reduction across the catchment, and more efficient policy approaches would achieve much of the potential offset requirements at a fraction of the costs. Potential costs identified in available research are as low as $3/tonne.[110] Even at a relatively efficient offset cost of $100/tonne, offsetting the sediment attributable to port developments may be a cost effective means to meet regulated environmental targets.

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104 Anonymous (2012) *Independent review of the Port of Gladstone*, Information report.

105 Anonymous (2013) *Independent Review of the Port of Gladstone – Report on Findings – July 2013*.

106 Media Releases, 16 November; also reported at Bundaberg NewsMail, news ninemsn, WWF, The Australian Newspaper.

107 SKM/APASA – Asia-Pacific Applied Science Associates (2013) *Improved Dredge Material Management for the Great Barrier Reef Region*.

108 The State of Queensland (2013) *Great Barrier Reef Second Report Card 2010*, Reef Water Quality Protection Plan Secretariat, April 2013. www.reefplan.qld.gov.au

109 Gale, K. (2013) Presentation at NERP Tropical Ecosystems Hub and Reef Rescue R&D Conference 2013, 7-10 May, 2013, Cairns.

110 Marsden Jacob Associates (2013) *The economic and social impacts of protecting environmental values in Great Barrier Reef catchment waterways and the reef lagoon,* report prepared for Queensland Department of Environment and Heritage Protection

3.5.5 Point sources – town water treatment costs

Gladstone's potable water supply consists of bulk water storage (Awoonga Dam, operated by GAWB), a water treatment plant (owned by GAWB, but operated by Gladstone Regional Council), and distribution and reticulation infrastructure owned and operated by Council. Current potable water sales are currently around 11,200 ML.[111]

The water quality service is designed to meet the National Health and Medical Research Council's Australian Drinking Water Guidelines,[112] with key water performance indicators (pH 6.5 – 8.5, iron 0.3mg/L, colour 5 HU, turbidity 1 NTU, manganese 0.1mg/L, aluminium 0.2mg/L) and compliance targets (95% compliance).[113]

Available evidence suggests potable water supplies are consistently meeting standards,[114] indicating the current level of treatment is sufficient to manage variability in raw water quality from the catchment.

Estimated annual treatment operating costs are around $4.0 million. GAWB's long-term estimates of treatment costs to 2030 are to see costs double, primarily due to increases in input prices (chemicals, electricity). While augmentations to the Gladstone Water Treatment Plant have been undertaken in recent years to meet regulatory requirements, there is no evidence to suggest further capital augmentations would be required in response to declining raw water condition in the foreseeable future.[115]

3.5.6 Point sources – wastewater treatment costs

The Calliope River Sewage Treatment Plant treats over 95% of the region's sewage. Waste is treated to a secondary treatment level, removing solids and a large proportion of the organic material from the effluent. The water removed is then disinfected before being recycled. The annual operating cost of the wastewater treatment plant (WWTP) is around $14.2 million, excluding debt repayments.[116]

Recycled water is primarily used by Queensland Alumina Limited,[117] which uses approximately 2,500 ML of recycled water annually.[118]

BPEM wastewater treatment standards are required for upgrades to meet population increases or new developments. In these cases, capital costs are significant. Based on previous analysis undertaken by BDA consulting,[119] Marsden Jacob has estimated the range of costs involved in augmenting treatment standards. Costs are outlined in Table 22 and show the range of annualised whole-of-life costs required to remove a tonne of nitrogen and phosphorus via

111 GAWB (2012) *GAWB Annual Report*.

112 NHMRC (2011) *Australian Drinking Water Guidelines 6*.

113 Gladstone City Council (2007) *Water Supply and Sewerage Standards – Customer Service Standards*.

114 GAWB (2012) *GAWB Annual Report*.

115 GAWB (2009) *Expenditure Proposals for the 2010 Price review*, A submission to the QCA.

116 Gladstone Regional Council (2011) *Long Tem Financial Plan*, Appendix 5.

117 A small proportion of the recycled water is also sold to Gladstone Power Station for cooling, while some is consumed by Council for irrigation.

118 QAL Ltd (not dated) *Environmental Improvements Project Summary*.

119 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

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 (including incremental improvement in concentrations required). 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 22: Indicative wastewater treatment costs (annual $ per tonne of pollutant removed)

Indicator	Estimated cost - $/tonne/annum (range)
Unit annual $ / tonne phosphorus	82,000 – 602,000
Unit annual $ / tonne nitrogen	188,000 – 857,000

Source: MJA based on BDA Group (2006) Scoping Study on a Nutrient Trading Program to Improve Water Quality in Moreton Bay.

3.5.7 Point sources – power stations

Power generators are also a major user of water (requiring appropriate water quality) and regulated sources of point source loads. The major power station in the region is Gladstone Power Station, a coal fired station with a generating capacity of 1,680 megawatts via six 280 megawatt turbo generators. The power station is owned by a number of joint venture participants including major energy users such as Rio Tinto Ltd.

The station uses 245 ML of cooling saltwater every hour. Saltwater from Auckland Inlet is pumped through the station's condensers to condense used steam (from recycled water) to water for reuse in the boilers.[120]

Saltwater used for cooling is discharged into the Calliope River. This is a regulated discharge under the relevant regulations. This has recently resulted in upgrades of settling ponds being finalised in 2013 to manage discharge water.

Because the Gladstone Power Station is operated by NRG Inc. (located in New Jersey) as part of a portfolio of international energy generation and distribution assets, no site-specific data on environmental expenditure is available.

3.5.8 Other major projects and developments

Gladstone has undergone unprecedented growth in the past two decades and the region's status as a rapid growth region is unlikely to change in the foreseeable future. A number of the existing major industrial projects and projects currently under consideration/development are outlined in the table below.

Each of these projects poses different types and scales of risk to water quality through residual emissions into waterways. Each project is a regulated environmentally relevant activity and each will include project-specific actions to avoid, reduce and mitigate pollution into waterways entering the Curtis Coast. Thus emissions are significantly reduced. In addition, many projects are being developed with development precincts (e.g. Curtis Island) that have triggered a more

120 http://www.nrggos.com.au/page/About_Us/

integrated approach to addressing environmental issues for multiple projects within the same area.[121]

While there is often a reasonable level of publicly available data on direct environmental impacts, there is virtually no information on the levels of capital and operational expenditures embedded in the projects that could be attributable to mitigating impacts on water quality and waterway health. However, it is generally understood the costs of meeting environmental regulatory requirements are relatively insignificant.

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[121] For example see: GHD (2009) *Curtis Island Environmental Management Precinct Ecology, Environment and Heritage Study*.

Table 23: Major projects in the Curtis Coast region (established and emerging)

Industry / business	Project overview	Risks posed to WQOs
Established projects		
Alumina refining	Alumina refinery facilities (refining bauxite into alumina) with an annual production volume in excess of 3.5 million tonnes.	Emissions from processing including sulphur dioxide, nitrogen dioxide, fluoride and refinery effluent.[122]
Orica Australia	Ammonium nitrate plant producing 500,000 tonnes per annum. Product used in mining operations domestically and internationally.	Water emissions from processing via Yarwun trade waste facility. Potential pollutants include ammonia, nitrates and total cyanide.[123]
Cement Australia	Australia's largest cement plant with a production capacity of over 1.7 Mtpa. Plant also produces up to 250,000 tonnes of lime per annum for the sugar, aluminium and mining industries.	Emissions including wastewater and dust emissions from processing.[124]
Emerging projects		
Australia Pacific LNG Project (APLNG), at Curtis Island	A $24.7 billion coal seam gas (CSG) to LNG project involving two treatment trains on Curtis Island, each with a production capacity of 4.5 Mtpa. Refer http://www.aplng.com.au/	Impacts include clearing for pipeline (and associated sediment discharge), sediments from land use change for processing plant, dredging, discharge of brine for desalination plant, impacts on marine fauna due to boat strikes, light and noise.[125] Also refer Coordinator General's report on the environmental impact statement (November 2010), available from http://www.dsdip.qld.gov.au
Qld Curtis LNG project (QCLNG), at Curtis Island	Under construction since 2010. Queensland Curtis LNG is one of Australia's largest capital infrastructure projects, involving US$20.4 billion of investment from 2010-14. Refer http://www.qgc.com.au/qclng-project.aspx	As outlined in Coordinator General's report on the environmental impact statement (June 2010), available from http://www.dsdip.qld.gov.au
Gladstone Liquified Natural Gas (GLNG), at Curtis Island	The Santos GLNG Project is a US$18.5 billion pioneering venture to convert coal seam natural gas (CSG) to liquefied natural gas (LNG) for export to global markets. The project involves a two-train LNG	As outlined in Coordinator General's evaluation report for an environmental impact statement (May 2010), available from http://www.dsdip.qld.gov.au

122 Boyne Smelters Limited. Rio Tinto Alcan Yarwun (2008) *Gladstone Sustainable Development Report*.

123 Orica (2012) *Orica, Yarwun and the environment*.

124 Cement Australia (undated) *Committed to Sustainable Partnerships*.

125 Australia Pacific LNG Project (2010) *Environmental Impact Statement*.

Industry / business	Project overview	Risks posed to WQOs
	processing facility on Curtis Island in Gladstone. Refer http://www.santosglng.com/the-project.aspx	
Arrow LNG Plant at Curtis Island	The project has three key components: the LNG Plant and its supporting infrastructure, the feed gas pipeline (and tunnel), and dredging activities. The project received State approval on 10 September 2013 and Commonwealth approval (subject to conditions) in December 2013.	Relevant impacts include a loss of 58 ha of salt marsh, 6 ha of mangroves, impacts on water quality attributable to dredging, and risks associated with increased shipping movements.[126]
Fitzroy Terminal	Transshipping project using a combination of existing and new rail networks, an overland conveyor system, modern covered barges and purpose-built transhippers, the project will have the capacity to export up to 25 million tonnes per annum.[127] (N.B. DSDIP Coordinated Project declaration lapsed May 2014)	Increased turbidity attributable to barge movements. Risks attributable to spills.
Yarwun Coal Export Facility	Yarwun Coal Terminal Project (capacity 50 Mtpa) comprises rail infrastructure, coal stockyard, out-loading wharf and associated coal transport and materials handling infrastructure. Capital expenditure is $2.2 billion.	Potential impacts on marine water quality include increased turbidity from dredging, release of contaminants from dredged material, and sediment and contaminant release from filling. Negative impact on Port Curtis Wetland.[128]
QER	Potential shale oil mining and extraction from QER's Yarwun deposit.	Site impacts to be managed under any authority.

Source: Various.

Note: not all of the projects that have been subject to EIS processes have been listed as some have since been pulled for commercial reasons. For example, Border Steel went into liquidation in July 2013 and the Glencore Xstrata coal terminal was cancelled in May 2013.

The key points to note with respect to the major projects and developments are as follows.

- Many of the projects are large, even by world standards.
- Existing projects are already operating under relevant environmental regulations. Despite the existence of the regulatory regime requiring companies to avoid and mitigate pollutant loads wherever possible (often at great cost), residual discharges into waterways still occur.

126 Arrow Energy and Coffey environments (2013) *Arrow LNG Plant: Environmental Impact Statement*.

127 Anonymous (2011) *Fitzroy Terminal – Project Overview*.

128 Tenement to Terminal Ltd and GHD (2012) *Yarwun Coal Terminal Project. Initial Advice Statement*, April 2012.

However, the regulatory environment should ensure that any residual loads into waterways are within the long-term assimilative capacity of those waterways.

- Emerging projects will be required to meet environmental regulations, but residual pollutant loads will still occur during the operational phase. In addition, significant emissions will occur during the construction phase due to changes in land use and the requirements for extensive dredging.
- The costs of managing water quality and waterway outcomes are generally not available.

The projects outlined above, in conjunction with dredging operations, create the most public concern regarding water quality and waterway health in the Curtis Coast region. The recently completed independent review of the Port of Gladstone found that *"environmental management and governance within the Port of Gladstone is generally comprehensive. However, the multiple layers and mechanisms in place can contribute to stakeholder confusion and mistrust. The three key areas for improvement are:*

- *the need to incorporate world heritage and other environmental protection considerations in a single, comprehensive and consultative port planning process;*
- *the need for assessment and consideration of cumulative impacts;*
- *the need for meaningful and ongoing stakeholder engagement to improve information and community confidence in environmental management and governance."*[129]

These areas of improvement will have cost and benefit implications. However, they should ensure any cumulative impacts of development are assessed within the assimilative capacity of the environment.

[129] Tinney et al (2013) *Independent Review of the Port of Gladstone – Report on Findings – July 2013*. p. X.

4. Implementation issues

The independent review of the Port of Gladstone provides a useful starting point for the identification, scoping and choice of implementation options to enhance water quality and waterway health in the Curtis Coast and Capricorn Coast regions.

4.1 Intervention choice

The choice of intervention should be determined by its effectiveness (does it work?) and efficiency (is it cost-effective?).[130] Rarely will a single intervention approach be sufficient. Rather, a comprehensive and cohesive suite of interventions is necessary to maximise the likelihood that WQOs can be met at the lowest economic costs to business and the community. An initial review of possible interventions is shown in the table below.

This is separated into the broad sources of loads (point-source, urban diffuse, rural diffuse) and environmental assets (e.g. seagrass, inshore coral beds). This work draws heavily on detailed analysis undertaken in the South East Queensland context.[131] In addition, some interventions are better suited to the different risks to WQOs in the Capricorn and Curtis Coasts. Therefore, the final two columns indicate the potential effectiveness of each intervention type for each region where ✓✓✓= highly effective and ✓✓= moderately effective and ✓= least effective.

130 Bohm, P. and C. S. Russell (1985) “Comparative Analysis of Alternative Policy Instruments”, in A.V. Kneese and J.M. Sweeney (eds) *Handbook of Natural Resource and Energy Economics*, North-Holland, Amsterdam.

131 For a comprehensive overview of the considerations and options for choosing interventions see: MainStream Economics and Policy (2011) *Sharing the Load: A collaborative approach to investing in South East Queensland’s waterways*.

Table 24: Recommended intervention options

Source of load	Recommended intervention(s)	Comments	Capricorn Coast	Curtis Coast
Point source	WWTPs to manage urban and industrial point source emissions	WWTPs provide an effective and relatively efficient means to address the bulk of nutrient and phosphorus loads from point sources. However, the marginal cost of augmenting WWTPs to meet stricter regulated concentrations of emissions can be very high. Therefore, a robust benefit–cost analysis and assessment of alternatives will be necessary before WWTP investments are undertaken.	✓	✓✓✓
	Limited emissions trading – WWTPs and industrial discharges	The marginal cost of abating future loads is likely to be very high because most of the low-cost options have already been exploited. This is particularly the case where all emissions must meet minimum standards. Previous research has indicated the pollution abatement cost savings from limited emissions trading under a trading regime for emissions entering Gladstone Harbour.	✓	✓✓✓
	Offsets (physical and financial)	Where loads cannot be effectively abated on site due to physical constraints or inefficient financial costs, the use of offsets should be adopted. Given the physical constraints for offset provision within the Curtis Coast region, it may be prudent to broaden the geographical coverage of offset arrangements, and to ensure intersectoral offsets for the same load type (e.g. WWTP nutrient loads offset by rural diffuse load abatement). Queensland introduced a new environmental offsets framework in July 2014. Refer: http://www.qld.gov.au/environment/pollution/management/offsets/	✓	✓✓✓
	Pricing reform – licence fees for environmentally relevant activities	While the existing arrangements for charging licence fees for ERAs send a price signal to polluting entities, the fees do not necessarily match the marginal cost of abatement, reducing the efficiency of the policy approach. Moving to a more efficient charging structure, similar to the load based license charging system used in NSW, would provide a better economic	✓	✓✓

Source of load	Recommended intervention(s)	Comments	Capricorn Coast	Curtis Coast
		incentive to reduce loads at the lowest cost.		
Urban diffuse	WSUD	Current regulatory requirements to manage erosion and loads attributable to development via WSUD will slow the growth in loads, but significant residual loads will persist without further reform.	✓	✓✓
	Offsets (physical and financial)	Where loads cannot be effectively abated on site due to physical constraints or inefficient financial costs, the use of offsets should be adopted. Given the physical constraints for offset provision within the Curtis Coast region, it may be prudent to broaden the geographical coverage of offset arrangements, and to ensure intersectoral offsets for the same load type (e.g. WWTP urban diffuse nutrient loads offset by rural diffuse load abatement).	✓	✓✓✓
Rural diffuse	Suasion and information	Some on-ground actions, such as improving fertiliser use practices can provide financial benefits to landholders and environmental benefits to the community. Often, the impediments to enhanced practice change are a lack of information or understanding of private benefits or the actual on-ground actions required to realise those private benefits. Information and capacity building (via targeted extension) have the potential to significantly change behaviour at a low cost.	✓✓	✓✓
	Direct investment via positive financial investments	There is a general understanding that there are often insufficient private benefits to landholders to rehabilitate degraded land causing erosion. The existing science indicates that much of the load reductions can be achieved through on-ground works in just a fraction of the region. Because of this, and the significant variability in load reductions and costs, there are significant efficiency gains to be made through targeted direct investment on-ground.	✓✓✓	✓✓✓

Source of load	Recommended intervention(s)	Comments	Capricorn Coast	Curtis Coast
		Cost effectiveness could be enhanced even further through astute use of market approaches to allocate funding such as the use of reverse tenders.		
	Structural adjustment loans	Emerging research suggests that some practices (e.g. moving grazing from "C" practice to "B" practice) can have long-term financial benefits, but short-term costs that may also require capital investments. The astute use of structural adjustment loans may provide a long-term efficient means to overcome economic impediments to practice change.	✓	✓
	Offset provision	Research indicates that changes in rural land use can provide very cost-effective load abatement for TSS, TN and TP. To achieve cost-effective load management, policies should be implemented to enable offset provision from rural areas.	✓✓✓	✓✓✓

Source: MainStream Economics and Policy (2011) Sharing the Load: A collaborative approach to investing in South East Queensland's waterways.

4.2 Enhancing intervention efficiency

The previous section outlined a number of potential intervention choices. To a certain degree, interventions can be partial or full substitutes for each other. Therefore, when selecting interventions a number of issues need to be considered, including:

- ***Institutional arrangements.*** Ensure the appropriate institutional and regulatory arrangements are in place to underpin effective use of each intervention. This may require joint delivery and coordination.
- ***Substitutability and measured equivalence.*** There are multiple actions that can provide similar types of load abatement. This substitutability needs to be recognised as a prerequisite for enabling the use of cost-effective measures. Furthermore, measures of equivalence between loads and alternative abatement actions need to be established that consider load and abatement attributes such as pollutant, volume, location, variability, temporal scales etc.
- ***Cost effectiveness.*** The choice of intervention can be informed by assessing the relative cost effectiveness of alternative abatement opportunities. This is particularly important where the objective is to maximise WQO outcomes from a given level of investment.
- ***Multiple benefits.*** Where an abatement action delivers multiple benefits (e.g. reduces more than one load and enhances habitat), this should be encompassed in technical and economic assessments.

- ***Sequencing and packaging.*** Rarely will a single intervention be sufficient. Therefore, it is important to determine what and how interventions should be packaged to ensure effective and efficient on-ground action. This may also include sequencing the introduction of interventions (e.g. use of suasive approaches before any direct investment).
- ***Load abatement vs. system repair/maintenance.*** Given the scale of development in the Curtis Coast, even in the context of best practice environmental management, some increase in contaminant loads may occur beyond opportunities to offset any growth in loads. This raises a tradeoff issue - is it better to invest in load abatement (e.g. reduce sediment loads to reduce the risks of damage to seagrass beds), or invest in system repair/maintenance (e.g. proactively establish new seagrass beds as habitat in areas less prone to runoff), or both? These decisions should be underpinned by robust technical and economic assessments.

Given the magnitude of risks to WQOs in the region and the scale of investment occurring, the potential gains from ensuring that interventions are efficient will be significant.