Burrum Catchment

Water Quality Improvement Plan

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Burnett Mary Regional Group
...for Natural Resource Management Inc

Wide Bay Water Corporation

PREPARATION STATEMENT

The Burrum Catchment Water Quality Improvement Plan (WQIP) was drafted by Dr Michael Walker, Water Management Officer, Mary & Burrum, Wide Bay Water Corporation (WBWC). Funding for this task was provided jointly by the Burnett Mary Regional Group for Natural Resource Management (BMRG) and Wide Bay Water Corporation under a strategic partnership to improve water quality.

The Burrum Catchment Water Quality Improvement Plan covers the Burrum, Cherwell, Gregory and Isis River catchments, which discharge via the Burrum estuary to Hervey Bay.

Assistance was provided by Dr Graeme Esslemont Water Quality and Equitable Use Coordinator, BMRG (formerly a member of the short term modelling project team set up to assist NRM bodies with their target setting responsibilities under the Reef Water Quality Protection Plan). Dr Esslemont undertook the necessary modelling work (SedNet and ANNEX) one of the tools used to set water quality targets utilised in this plan.

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ACRONYMS

BMRG	Burnett Mary Regional Group for Natural Resource Management
CCI	Coastal Catchments Initiative
COAG	Council of Australian Governments
DEW	Department of Environment and Water (formerly Department of Environment and Heritage [DEH])
DLPG	Department of Local Government and Planning
DPIF	Department of Primary Industries and Fisheries
EPA	Environmental Protection Agency
EPP (W)	Environmental Protection Policy – Water
FBRSG	Friends of the Burrum System Group (Inc)
GPA	Global Programme of Action for the Protection of the Marine Environment
ICM	Integrated Catchment Management
IROL	Interim Resource Operating Licence
NAPSWQ	National Action Plan for Salinity and Water Quality
NRM	Natural Resource Management
NRW	Department of Natural Resources and Water (formerly Department of Natural Resources and Mines [DNRM])
NWQMS	National Water Quality Management Strategy
PMF	Probable maximum flood
RMP	Riverine Management Planning
WBWC	Wide Bay Water Corporation
WMU	Waterway Management Units
WQIP	Water Quality Improvement Plan
WQM	Water Quality Management
WRP	Water Resource Plan
YPc	yellow podzolic soils

1.0 CHAPTER 1: BACKGROUND TO THE BURRUM CATCHMENT WATER QUALITY IMPROVEMENT PLAN

1.1 INTRODUCTION

All catchments in Australia, with the exception of the Lake Eyre Basin, ultimately discharge to estuarine or marine ecosystems. This, along with the fact that a quarter of Australia's population lives within three kilometres of the sea means that significant sections of coastline have been affected by urban, industrial and recreational activity.

The health of marine and estuarine ecosystems is inextricably linked to the catchments with which they interact. Consequently, many land-based activities have a significant effect on our coastal environments. It is estimated that some 80 percent of water quality impairment in Australia is caused by broad scale landuse activities[1]. The two most concerning problems facing our marine and estuarine ecosystems are increasing nutrient and sediment loads.

The main pollutants, listed in approximate order of significance, which affect marine and estuarine water quality in Australia, are:

- Nutrients;
- Sediments;
- Acid sulphate soils;
- Organochlorines;
- Heavy metals;
- Oil and hydrocarbons; and
- Pathogens.

Nutrients
Agricultural and urban runoff, wastewater treatment plants and septic tanks, are the major sources of nutrients to Australia's rivers, estuaries and coastal waters. Elevated loads of nutrients (nitrogen and phosphorus) can result in algal blooms, which in turn may adversely impact coastal waters by preventing light reaching benthic plants, and by producing toxins detrimental to animal and human health. Furthermore, the death and decay of algal blooms can reduce the amount of dissolved oxygen available to aquatic life, sometimes causing extensive fish kills.

Sediments
Land use changes since European settlement including land clearing, poor cultivation practices and urban development has led to wide spread soil erosion that significantly increases the amount of sediment discharging to coastal waters.

Excessive sediment loads have many undesirable effects on receiving waters including the smothering of aquatic ecosystems, increased turbidity and reduced light penetration causing changes to primary production. In many instances sediments may also transport significant loads of nutrients, heavy metals and organochlorines attached to sediment particles further polluting the water.

The State of the Environment Queensland (1999) report estimates that of the total yield of suspended sediment from six north Queensland catchments 26% is attributable to natural processes, 66% to grazing practices and 8% to cropping.

[1] SoMER, 1995

Acid Sulphate Soils
Acid sulphate soils (ASS) are found in low-lying coastal areas and contain high concentrations of sulphide minerals (mainly iron pyrite, FeS2).

ASS are relatively harmless in their undisturbed (submerged) state but may generate large quantities of sulphuric acid when exposed to the atmosphere through excavation, dredging or lowering of the water table. In addition, iron and aluminium metals may become soluble under acid conditions. (Al3+, Fe2+ and Fe3+) and enter rivers and estuaries where they may have detrimental effects on aquatic organisms.

Major fish and crustacean kills, outbreaks of red-spot disease in fish and increased incidence of disease-carrying acid tolerant mosquitoes have been linked to the disturbance of these soils.

Organochlorines
Organochlorines are synthetic compounds developed for agricultural and industrial use and are often found in urban and agricultural run-off. Whilst these compounds are usually not detectable or only present in extremely low concentrations in seawater, they can concentrate in organisms high up the food chain (bioaccumulate) to toxic levels.

Pesticides such as diuron and dieldrin are present in marine sediments of the Great Barrier Reef, and significant levels of residues have been found in the Reef's dugongs and dolphins. There is little information available about the effect of organochlorines in Australia's coastal waters however, these compounds are suspected of causing kidney damage in Arctic birds and mammals.

Heavy metals
Heavy metals enter marine and estuarine ecosystems through the discharge of industrial waste, treated sewage, stormwater run-off, mining operations and other diffuse sources (such as from vehicles). The most common heavy metal pollutants are arsenic, cadmium, chromium, copper, nickel, lead and mercury.

Heavy metals persist in the environment and so tend to accumulate in soils, sediments and living organisms, thereby affecting local fisheries and aquaculture operations.

Oil and hydrocarbons
Oil and hydrocarbon pollution of coastal waterways is largely linked to industrial and stormwater discharges. Many of the compounds in crude oil and other petroleum products have been known to smother organisms, lower fertility and cause disease in aquatic organisms.

Pathogens
Pathogens such as faecal coliforms and enterococci enter the marine environment through the discharge of sewage via ocean outfalls and from stormwater system overflows to rivers and streams. These pathogens pose threats to human health through gastro-enteritis, hepatitis and other diseases.

Unacceptable faecal discharges to coastal waters may arise from aging sewage and stormwater infrastructure, combined system overflows after heavy rains or inadequate wastewater treatment. Human health may therefore be at risk from direct contact with contaminated waters or from consumption of contaminated seafood.

1.2 UNITED NATIONS GLOBAL PROGRAMME OF ACTION

Land-based sources of marine pollution are recognised internationally as a major environmental issue. The international community, through the United Nations Environment Programme, has initiated actions to address this issue, specifically through the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (the GPA).

In response to the widespread pollution of the marine environment, 108 governments (including Australia) and the European Commission declared their commitment to protecting and preserving the marine environment from the adverse environmental impacts of land-based activities. As a result, the GPA was adopted in 1995.

The 20th Session of the United Nations Environment Program Governing Council resolved (in 1999) to undertake the First Intergovernmental Review (IGR) of the GPA, which was held in Montreal, Canada from 26 to 30 November 2001.

The IGR meeting reviewed progress on implementation of the GPA at the global, regional and national levels. Australia’s national report was coordinated by Environment Australia, in collaboration with State and Territory governments. This report considered national coordination of efforts to address land-based sources of marine pollution, including the application of the following National policies and programs.

1.3 NATIONAL POLICIES AND PROGRAMMES

Australia meets its obligations under the GPA through implementation of the policies, principles and industry guidelines such as the National Water Quality Management Strategy.

The National Water Quality Management Strategy (NWQMS) provides a consistent approach to water quality management throughout the country. The strategies aim is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

The strategy was developed jointly by the Australian and State/Territory Governments and forms part of the Council of Australian Governments Water Reform Framework.

The NWQMS provides guideline documents to assist in the collaborative development of catchment based management plans.

1.3.1 Framework for Marine and Estuarine Water Quality Protection

The Framework for Marine and Estuarine Water Quality Protection was developed as a nationally consistent approach to protecting the marine environment from the effects of land based pollution, therefore contributing to meeting Australia’s obligations under GPA.

Central components of the Framework are:

- Identification and achievement of reductions in pollutant loads
- establishment of end of river targets
- development of Coastal Water Quality Improvement Plans (WQIP’s)

The WQIP process helps prioritise actions to improve water quality by looking at ways to prevent high loads of nutrients and sediment entering waterways at "hotspots" throughout catchments and identifies the most cost effective and timely projects for investment by the government, community, environmental groups and regional NRM groups.

1.3.2 The Great Barrier Reef Water Quality Protection Plan (Reef Plan)

In 2001 the Great Barrier Reef Ministerial Council authorised the development of a Water Quality Action Plan to reduce the pollutant loads to the reef over a 10 year period. The Plan identifies the pollutant load reductions to be achieved for each of the 26 catchments contributing to the Great Barrier Reef lagoon.

The Queensland and Australian Governments reached agreement on the plan, known as the Reef Water Quality Protection Plan (Reef Plan), in late 2003. The Plan is based on previous reviews that had identified the extent of water quality deterioration since European settlement. The causes were identified as being land degradation within the catchments, urban development, vegetation clearing, water use practices, wetland drainage leading to reduced trapping of sediments and nutrients, and coastal developments on acid sulphate soils. While there was little evidence of these developments causing degradation of the outer Barrier Reef, there was clear evidence that they were affecting the inshore reefs, estuaries, and important near-shore areas. At the same time, the Plan was sensitive to the economic importance of industries within the coastal catchments including beef, sugar, horticulture, tourism, mining, and fishing industries.

Reef Plan has 2 objectives:

- To reduce the load of pollutants from diffuse sources (e.g. agriculture) in water entering the Great Barrier Reef Lagoon; and
- To rehabilitate and conserve areas of the Reef catchments which play a role in reducing/removing water borne pollutants.

The Reef Water Quality Partnership was established to enhance coordination and collaboration between governments and regional natural resource management (NRM) bodies in improving water quality for the reef. The Reef Water Quality Partnership supports the implementation of the Reef Plan and regional water quality improvement plans by providing a strong science foundation for setting targets, modelling, monitoring and reporting progress.

1.3.3 Coastal Catchments Initiative

The Australian Government, through the Coastal Catchments Initiative (CCI), is committed to improving the condition of Australia's coastal waters through joint action with State and local governments. As a first step this will be achieved through the **development of Water Quality Improvement Plans (WQIPs) to coastal waters.**

The Water Quality Improvement Plans will be consistent with existing government strategies such as the National Water Quality Management Strategy and (where relevant) the National Principles for the Provision of Water for Ecosystems. The Plans will incorporate the environmental values of coastal waters, the water quality issues that are threatening these values, the sources (diffuse and point, including atmospheric and internal sources) of pollutants that are contributing to these issues, the pollutant load reductions to be sought from these sources, the river flow objectives for maintaining ecosystem health, the management interventions needed to achieve pollutant load reductions, and the "reasonable assurance" from local and State governments that they can and will achieve these interventions. Monitoring systems will be established in the targeted catchments to allow the effectiveness of these interventions to be assessed.

Because this process is complex and because there are many unknowns in estimating the water quality targets, the sources of pollution, the necessary pollutant reductions and the effectiveness of management interventions it will be necessary to take an adaptive management approach, drawing on the monitoring data, whereby the WQIPs are regularly reviewed and modified.

Some of the parameters governing the development of WQIPs include:

- Local ownership and leadership;
- Cooperative action between the three levels of government;
- Use of best available scientific knowledge;
- Community involvement, including sectoral groups;
- Contributions to regional objectives.

1.4 STATE/REGIONAL POLICIES AND PROGRAMS

1.4.1 Environmental Protection (Water) Policy

Environmental Protection (Water) Policy 1997 (EPP) is Queensland State policy that aspires to achieve the objective of the Environmental Protection Act (QLD) 1994, to protect the environment in a way that allows developments that improve quality of life while maintaining the ecological process that life depends.

The EPP sets a framework to:

- identify environmental values for Queensland waters,
- determine water quality guidelines and objectives to enhance or protect the environmental values,
- make consistent and equitable decisions about Queensland waters that promote efficient use of resources and best practice environmental management,
- collaborate with the community through consultation and education, and promoting community responsibility.

Environmental values (EV's) are the characteristics of waterways that need to be protected from the effects of pollution, water discharges and deposits to ensure healthy aquatic ecosystems and waterways that are safe and suitable for community use. They reflect the ecological, social and economic values and uses (e.g. swimming, fishing, agriculture) of the waterway and are developed through a process of community consultation.

WQO's are measurable indicators or parameters needed to protect EV's of particular waterways.

WQO's may be defined for a range of:

- **physical parameters** (turbidity, suspended sediment, & temperature);
- **chemical parameters** (phosphorus, nitrogen, biochemical oxygen demand and toxicants);
- **biological parameters** (algae, diatoms, macroinvertebrates and fish); and
- **catchment condition** (erosion levels, riparian vegetation and channel morphology).

Environmental values and water quality objectives determined using the framework set out in the EPP inform both statutory and non-statutory planning.

1.4.2 Water Resource Planning

There are no current **statutory** links between Riverine Management Planning (RMP) and Water Resource Planning (WRP) or Water Quality Management (WQM). To minimise duplication of effort the Department of Natural Resources and Water (NRW) commissioned the Technical Advisory Panel for the Mary Water Resource Plan to also carry out the Mary River Process Study[2].

As part of the process of preparing a WRP for the Mary Basin NRW and the Environmental Protection Agency (EPA) were seeking to develop a planning framework which more closely integrated the WRP, RMP and WQM[2]. The three planning processes (RMPs, WRPs and WQM) have clear overlaps in their goals.

EV's must be considered by the Minister when preparing a WRP. There is no statutory requirement for EV's to be considered in a Riverine Management Plan.

WATER RESOURCE PLANS

Water Resource Planning is carried out by the Queensland Government under the provisions of the *Water Act 2000*, Division 2. The Department of Natural Resources and Water is the lead agency in the process, although other agencies such as EPA, Department of Primary Industries & Fisheries (DPI & F) and the Department of State Development (DSD) are also involved.

The purpose of the *Water Act 2000* is to provide for the sustainable management of water and other resources, through the establishment of a regulatory framework for providing water and sewage services, and the establishment and operation of water authorities.

The water resource planning framework, established under the *Water Act 2000* is at two levels:

- Water Resource Plans (WRPs) define environmental flow objectives, water allocations and security objectives at a strategic level
- Resource Operational Plans (ROPs) operationalise the objectives defined in the WRPs

There are several types of WRPs:

- Those that enable the establishment of transferable water allocation, i.e. have legal title and can be transferred separately to the land e.g. within the Burnett Basin WRP
- Those which establish water licenses which can not be transferred separately to the land e.g. Cooper Creek WRP
- Alternatively a single WRP can have both water allocations and license areas

Water Resource Plans have a 10 year life and reviews commence within this 10 year period.

[2] Brizga, 2002

Key elements of a Water Resource Plan (WRP) include:

- plan outcomes, including ecological outcomes and strategies to achieve these outcomes
- the water and natural ecosystem monitoring requirements to assist in assessing the effectiveness of the proposed management strategies in achieving the plan outcomes
- criteria for assessing degradation that has occurred in natural ecosystems
- environmental flow objectives
- water allocation security objectives
- performance indicators for environmental flow objectives
- priority areas for conversion to or granting of water allocations

Technical Advisory Panels (TAPs) are used to provide independent specialist advice on environmental matters relating to the development of Water Resource Plans.

Section 98 of the Water Act 2000 outlines the content or a Resource Operating Plan (ROP). Key elements include:

- how the ROP addresses WRP outcomes
- identification of any water infrastructure to which the ROP is intended to apply and how it will be operated
- environmental management rules, water allocation transfer rules, and seasonal water assignment rules
- the water and natural ecosystem monitoring practices that will apply in the ROP area

The Burrum basin is covered by both the Mary WRP and the Burnett WRP.

RIVERINE MANAGEMENT PLANNING

Riverine Management Plans (RMPs) are non-statutory plans that are used as a basis for Department of Natural Resources and Water's decision making. This relates to applications for riverine quarry materials permits, as well as forming a policy basis for broader planning in relation to riverine management.

Department of Natural Resources and Water's legal jurisdiction under the *Water Resources Act 1989* extends to authorising activities (such as native vegetation removal, sand and gravel extraction activities, excavations and filling) that are proposed between the banks of non tidal streams. Under this act it also has responsibility for protecting and enhancing the stream's physical integrity which includes:

- physical shape and form (including habitat)
- stability
- riparian vegetation
- geomorphic features

Riverine Management Plans have developed out of the process for preparing Riverine Quarry Materials Management Plans and take a broader view of river management.

Two Riverine Quarry Materials Management Plans have been prepared to date (Mary and Upper Brisbane), and 2 RMP's are currently in preparation (Logan Catchment and Mary Catchment).

1.4.3 Regional Coastal Management Plan

The Queensland State Coastal Management Plan aims to prepare and manage long term challenges associated with natural and anthropogenic changes to the State's coastline.

Under the State plan the Queensland coast has been divided into eleven coastal regions. Each region has a Regional Coastal Management Plan which identifies key coastal sites that require special management within the region.

The coastal region relevant to this plan is the Wide Bay Coast region. At the time of writing this report the regional coastal management plan for the Wide Bay Coast was still under development.

1.4.4 The Wide Bay Burnett Regional Plan

The Wide Bay Burnett Regional Plan 2007-2026 was released by the Queensland Government in 2007. It is the principal regional strategy for guiding growth and sustainability in the Wide Bay Burnett region.

The regional plan objective regarding water quality is ***to maintain water quality standards across the region which provide for maintenance of aquatic systems and services***.

Guiding policy principles include:

2.5.1 Regional water quality planning is underpinned by reliable local knowledge

2.5.2 Improved community understanding of the interaction between human activities and water quality is fostered and actions which contribute to improved local water quality are supported.

1.4.5 Natural Resource Management Plan

The Australian Government, during the 1990's introduced the principle of Integrated Catchment Management (ICM), which recognises the necessity of involving the community in achieving positive Natural Resource Management (NRM) outcomes. Today regional arrangements, supported under the Natural Heritage Trust (NHT) and the National Action Plan for Salinity and Water Quality (NAPSWQ) builds on this recognition that positive NRM outcomes are unlikely to occur without comprehensive community support and involvement.

The Burnett Mary Regional Group for Natural Resource Management (BMRG) was established as the regional body to achieve natural resource management outcomes in the Burnett and Mary Catchments.

Country to Coast – a healthy sustainable future is the Burnett Mary Regional Group's integrated natural resource management plan for the Burnett Mary region. The plan covers the catchments of the Baffle, Burnett, **Burrum**, Kolan, Mary & Fraser Coast.

The aim of BMRG's Water Quality and Equitable Use Program" is *to ensure water resources and associated ecosystems are managed, protected and harvested in an efficient, equitable and sustainable way for social and economic benefits whilst maintaining optimal environmental flows and ground water health now and for the future*.

BMRG's water resource management actions (**WRIA-O**) are concerned with setting end of catchment targets and developing Water Quality Improvement Plans (WQIPs) to achieve long-term improvements in water quality in the region. This supports the objectives of the Reef Water Quality Protection Plan (RWQPP) to halt the long term and reverse the decline of water quality in the Great Barrier Reef (GBR) lagoon and provides the framework for a more collaborative approach between the Australian Government, Queensland Government, Local Government and community organisations.

The WQIP's for the Mary and Burrum catchments are largely being driven by the objectives of the NRM plan.

1.5 WATER QUALITY IMPROVEMENT PLAN

Water Quality Improvement Plans (WQIP's) outline how to reduce impacts on freshwaters, estuaries, coasts and marine areas. The legislation and policies detailed above are all linked to their development.

The water quality improvement planning process establishes community endorsed environmental values (EV's) for a catchment, and then determines the water quality objectives (WQO's) and targets needed to protect these values. Management strategies that best meet environmental, social and economic goals are then used to achieve water quality targets.

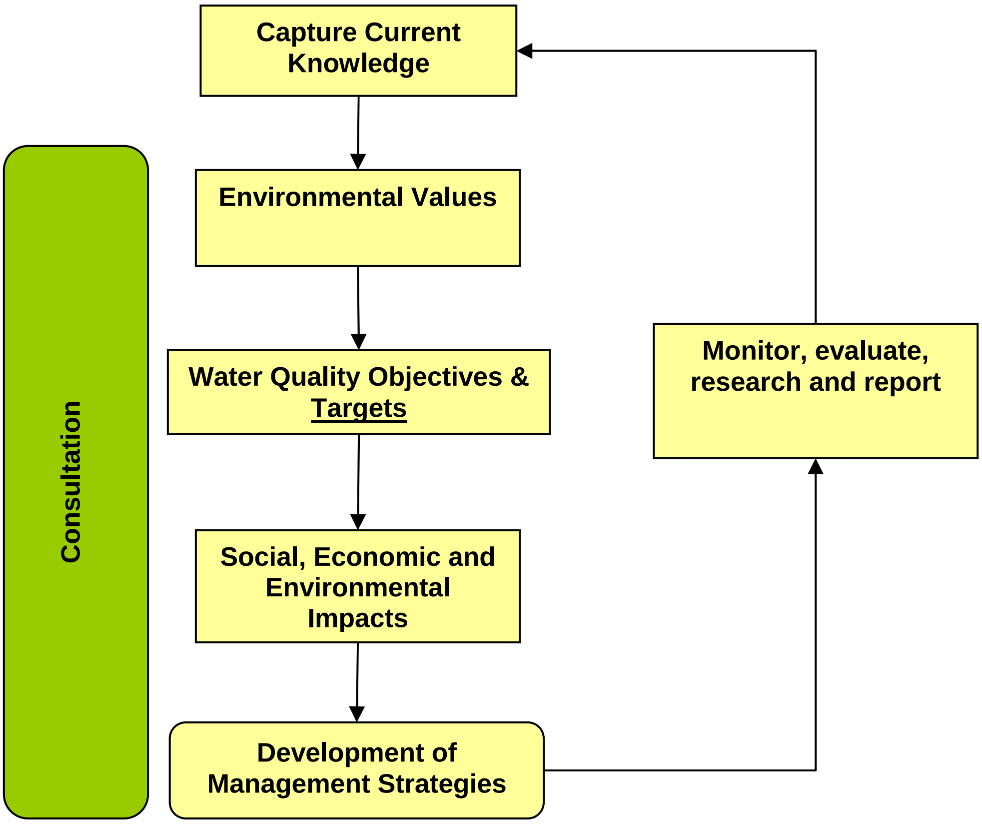
WQIP's must be integrated with other plans including:

- Water Resource Plans;
- Coastal Management Plans;
- Stormwater Plans;
- Regional NRM plans;
- Regional investment strategies; and
- Regional management plans.

The development of WQIP's broadly involves the following inter-related activities (Figure 1.1):

- capture of current knowledge;
- establishment of environmental values in consultation with key stakeholders;
- development of water quality targets (concentration and load) which include and integrate management practice, catchment water quality and reef ecosystem targets;
- identification of appropriate management strategies to achieve water quality improvement targets (i.e. linking management action targets to resource condition targets);
- development of an implementation plan, modeling, monitoring and adaptive management strategies;
- preparation of an assurance statement that describes how implementation of the plan will achieve the plan's objectives.

Figure 1.1: Water Quality Improvement Plan Development Process



A broad group of representatives from across the whole community is consulted during the WQIP development process to ensure that the best available local, indigenous, social, economic and scientific knowledge is brought together.

WQIP's are prepared in accordance with:

- Australian Government's Framework for Marine and Estuarine Water Quality Protection [3]
- Water quality management framework in the Environmental Protection (Water) Policy 1997 [4]
- (where appropriate) National Principles for the Provision of Water for ecosystems [5]

Since our understanding of catchment processes, land-use impacts and management strategies is continually improving, the implementation of WQIP's will be adaptively managed to ensure they reflect the most current information available.

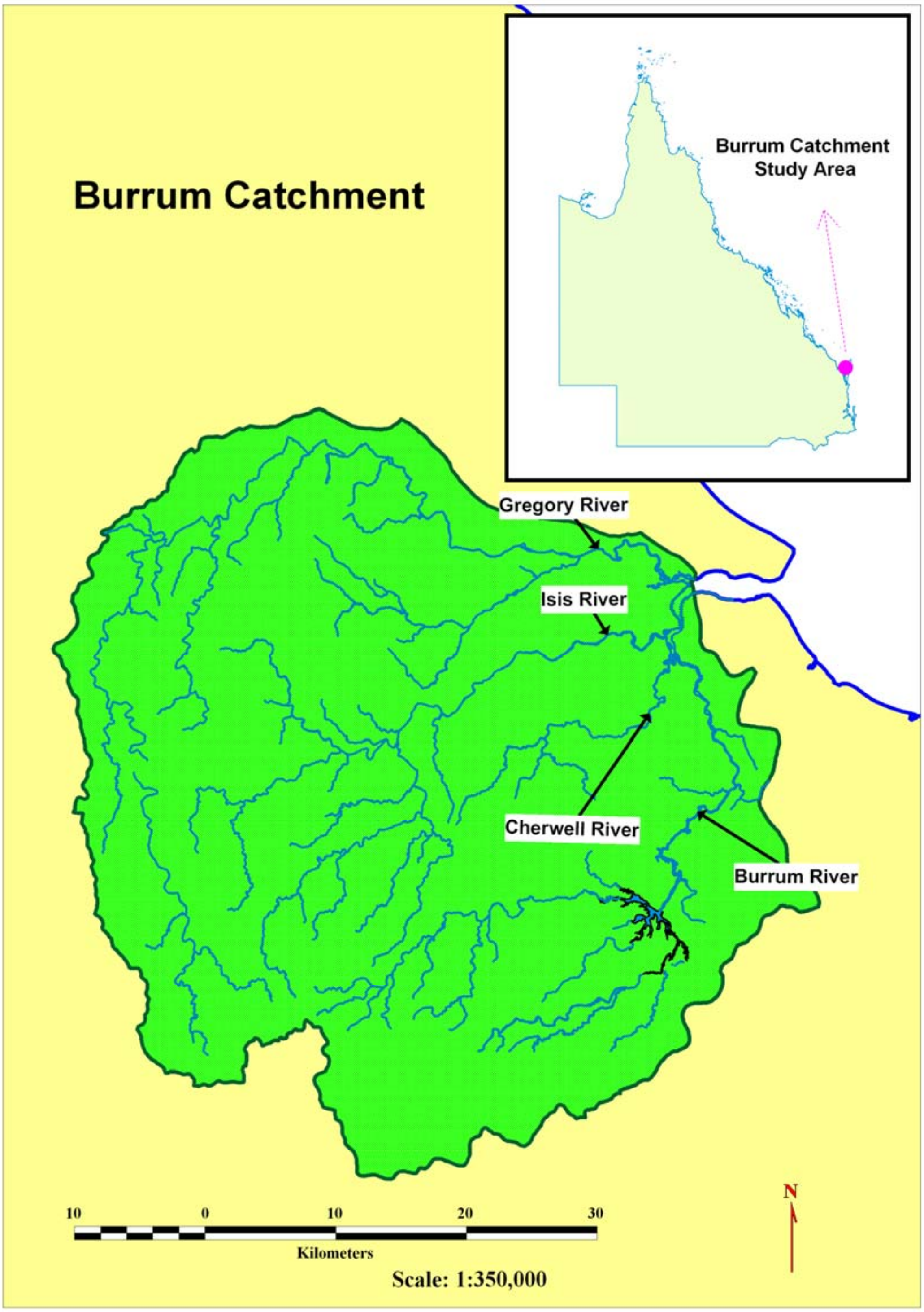
[3] http://www.environment.gov.au/coasts/pollution/cci/framework/index.html
[4] http://www.legislation.qld.gov.au/OQPChome.htm
[5] http://www.environment.gov.au/water/publications/index.html#ecosystems

2.0 CHAPTER 2: THE BURRUM RIVER CATCHMENT (PHYSICAL CHARACTERISTICS, ACTIVITIES, GEOGRAPHY, ECONOMY, PEOPLE, GOVERNANCE)

2.1 THE BURRUM CATCHMENT

The Burrum Catchment Water Quality Improvement Plan covers the catchments of the Burrum, Cherwell, Gregory and Isis Rivers. The catchment discharges via the Burrum estuary to the coastal waters of Hervey Bay Figure 2.1). The catchment covers an area of 280,000ha and is located between the Mary and Burnett catchments in southeast Queensland.

Figure 2.1: Burrum Catchment



The general relief of the Burrum Catchment is low and flat, typical of a coastal catchment of its size. The Burrum Catchment has a low profile relative to the Burnett Mary Region, in terms of average topography (46m above sea level), minimum topography (0.5m above sea level), and relief contrast (362metres).

The lower reaches of the main rivers that make up the Burrum Catchment are each very flat e.g. the Burrum River rises by only 20m between the river mouth and Lenthall Dam, approximately 40km upstream, an average bed slope of 1 in 2000. Topographic relief is also slight with the majority of the catchment to the east of the Bruce Highway, below 20m elevation. Further to the west the catchment is gentle sloping, rising to approximately 200m at the catchment divide. The Burrum River rises up to just over 300m in the Seaview Range, along the western extremity.

The breakdown of catchment area by river is detailed in Table 2.1, with the Burrum River making up 44% of the total catchment.

Table 2.1: Catchment Area

River	Catchment Area (Ha)	Percent of Catchment Area
Burrum	121,000	44%
Cherwell	11, 200	4%
Isis River	52,600	19 %
Gregory	91,400	33 %

2.1.1 Burrum Estuary

The Burrum River Estuary is formed by the mouths of the Burrum, Isis and Gregory rivers. The upper Burrum estuary is defined by Brizga *et al.*, 2002, as ending at the mouth of the Cherwell and the lower estuary as from the mouth of the Cherwell to Burrum Heads.

The main body of the estuary is approximately 12km long and varies in width between 500m and 2km. The estuary consists of shallow sand banks with a meandering main channel. Vegetation has been established on several low islands just downstream of the Gregory River.

The estuary includes intensive inter-tidal flats, sand-flat systems and is fringed by inter-tidal mangroves along a significant length of its north shore and at isolated pockets along the southern shoreline. Large sand shoals extend beyond the mouth a further 5km into Hervey Bay and the Great Sandy Marine Park.

Major habits include:

- seagrass beds
- mangrove low forests
- salt-marshes
- sand-flats exposed at low tides
- beach ridges
- closed heath communities

The area is habitat for at least 21 species of migratory birds and is an area where many native plant species are at their geographical limit.

Hervey Bay is of special conservation value by virtue of:

- its bordering World Heritage Area Fraser Island
- its proximity to Great Sandy Straits RAMSAR Wetland a wetland of international significance
- its populations of migratory shore birds
- diverse marine fauna (including coral reefs)
- its dugong population
- its role as a resting area for hump back whales and their calves on the southward migration

The economy of Hervey Bay largely depends on these natural assets as well as upon the water resources of the Burrum Catchment.

Figure 2.2: The Burrum Estuary

2.1.2 Burrum River

The Burrum River begins life as Duckinwilla Creek, at the headwaters of the Doongul and Duckwinia Creek sub-catchments in the Seaview and Robinson Ranges and becomes the Burrum River at the confluence of Doongul Creek, at AMTD 34.3km. The upper Burrum catchment is dominated by the Clifton Range, with a number of mountains between 200-300m in height i.e. Doongul Mountain, Musket Flat Mountain, Grout Mountain and Cabbage Tree Mountain[6].

The river flows southwest within the Wongai State Forest (No 1294) and its main trunk extends some 72.5km inland. The river enters the Burrum Estuary at Burrum Heads. The catchment is typical, for its size of a Queensland coastal catchment, in terms of relief as being low and flat.

[6] BMRG PAP 5F, 2005

For the purposes of this assessment the Burrum River is split into the following 5 zones:

- **Upper freshwater** defined as Lenthall Dam and its catchment
- **Lower freshwater** defined as the Burrum weir pondages
- **Upper estuary** defined by Queensland Water Quality Guidelines as 19.2km upstream of the junction with Gregory River. However due to the installation of Burrum Weir #1 the historic upper estuary has been shortened and now overlaps with the middle estuary
- **Middle estuarine** defined from Burrum Weir no 1 to confluence of the Cherwell River
- **Lower estuarine** defined as upstream of Cherwell River to Burrum Heads

The mean annual discharge for the Burrum River, measured at gauging stations 137303A at 34.4km AMTD and 137304A at 34.3km AMTD, is 153,000(ML/a) and the mean annual runoff 151mm/a[7].

2.1.3 Cherwell River

The Cherwell River headwaters (Kolbore Creek) are located east of Childers in the Wongai State Forest, entering the Burrum River estuary approximately 15km from Burrum Heads. The Cherwell River only makes up 5% of the Burrum Catchment and covers 11,200ha.

2.1.4 Gregory River

The Gregory River makes up 28% of the Burrum Catchment covering approximately 91,400ha. The Gregory is relatively unregulated apart from the Gregory River Weir, located at the downstream end near the tidal limit[8].

2.1.5 Isis River

The Isis River makes up 23% of the Burrum Catchment covering 52,600ha. Like the Gregory, the Isis River is relatively unregulated compared to the Burrum River except for the Isis River Weir near the downstream tidal limit[7].

7 DNRM, 2005g
8 BMRG, 2005

2.2 PEOPLE & ECONOMY

The Burrum catchment spans the jurisdiction of two of the recently amalgamated local government authorities;

- **Fraser Coast Regional Council; and**
- **Bundaberg Regional Council.**

Hervey Bay (part of Fraser Coast Regional Council) is considered the gateway to the World Heritage Listed Fraser Island and is home to migrating Humpback whales, from July through to November. Urban and rural areas adjacent to the coast are under significant pressure from residential and tourism development, with Hervey Bay and Burrum Heads focal points for urban growth[8]. Hervey Bay is regarded one of Australia's fastest growing regional cities, with the population growing from 30,000 in 1991 to 54,000 in 2006[9]. Growth in the regions local economy is equivalent to the regions growing population particularly in tourism, service industries, retailing and light industries.

The local economy of the Burrum Catchment is dominated by agriculture (including intensive horticulture) and grazing within the non-coastal areas, while native forest reserves, forest plantations and national parks are also common (refer Chapter 4)[7]. The northern sections of the catchment, particularly along the Gregory and Isis rivers, are important agricultural areas with a rural population of 6,600 people[9].

2.3 EXISTING WATER INFRASTRUCTURE

Major water infrastructure on the Burrum River includes Lenthall Dam and 2 weirs (Burrum Weir No1 and Burrum Weir No 2). Details of this infrastructure are provided (Table 2.2).

Lenthall Dam was built at the confluence of the Woolmer, Duckinwilla, Harwood, Powell and Logbridge Creeks (**Error! Reference source not found.**), which are typically comprised of a series of adjoining river terraces merging into associated undulating hills. The western portion of the dam catchment has its origins in the steep areas of Mt Doongul and Seaview range but most of the catchment is relatively flat and undulating.

The Burrum River water supply infrastructure is the principal water supply for Hervey Bay, Burrum Heads, Torbanlea, Howard and Toogoom. The system is currently operated primarily for urban water supply with a current allocation of 14200ML/year. Agricultural allocations along the Burrum River total 405ML/year.

The catchment upstream of the dam consists of relatively flat to undulating coastal plains intersected by a series of major creeks and some low ridge systems.

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[9] DIP, 2007

Figure 2.3: Lenthall Dam

Lenthall Dam was raised by 2m in 2007 through the installation of crest gates. The crest gates give the capacity to significantly affect the shape of the downstream hydrograph. The raising of Lenthall Dam increased the storage capacity of the dam to 28,411ML and the surface area of the dam from 367ha to 766ha.

Table 2.2: Existing major infrastructure on the Burrum River

Storage Name	Stream Distance (km)	Catchment Area (km 2)	Storage Capacity FSL (ML)	Storage Level AHD (m)	Inundated Area at FSL (ha)	Date Completed
Lenthall Dam	34.2	513.5	17,256	24.00	367	1984
Lenthall Dam raised	34.2	-	28,411	26.00	766	2007
Burrum Weir No 2	28.2	592.6	2,242	10.97	62.6	1951
Burrum Weir No 1	23.3	623.5	1,715	4.87	36.9	1900

Changes resulting from 2m raising of Lenthall Dam:

- Reduces the peak and long term average flow rates
- Extreme floods in the Burrum River mobilise sediment and flush the estuary. An elevated dam slightly reduces this effect and reduces the frequency of flooding
- In contrast, medium to low flows have the opposite effect, i.e. carry sediment into the estuary but are not of sufficient magnitude to wash out into Hervey Bay
- Frequent medium to small events can cause accretion to the estuary
- Equally they may reduce the sediment supply and erosion may occur
- Dams capture coarse sediment

2.4 CLIMATE & RAINFALL

The Burrum Catchment region has a subtropical climate with most of the rainfall occurring during the summer months of December to March. Winters are typically dry.

The mean annual rainfall for a common 44 year record[10] was calculated at several rainfall stations in the district (Table 2.3). The mean annual catchment rainfall is reasonably uniform across the contributing river systems and is between 1000mm to 1100mm. The Mary Basin Water Resource Plan, 2003 states that average rainfall varies between 1100mm in the upper catchment near the Seaview Ranges to 900mm in the Cherwell River Catchment[11] the same report estimated the annual stream flow for the Burrum River to be 153,000ML/annum and the mean run off to be 151mm/yr.

Most of the Burrum River catchment receives 800-1000mm of rainfall each year, tending to be wetter (1101-1200mm/year) along the coastal strip east of Howard that drains into the tidal estuary. The Doongul Creek valley in the headwater region that supplies Lenthall Dam also receives more rainfall (1101-1200mm/year) than the catchment average.

The estimated PMF peak discharge for Lenthall Dam is estimated to be 5500m3/s [9].

The similarity of catchment characteristics and rainfall indicates that each river system will have similar flow characteristics. Long term average flow from each catchment can be expected to be proportional to catchment area.

Rainfall records at Howard indicate the average daily rainfall before 1972 was 2.9mm, with a maximum of 497mm in January 1905. The daily rainfall yield after 1972 has decreased slightly to a recorded average of 2.8mm, and a maximum of 245mm in February 1992. The long term record indicates an 18-22 year period in annual rainfall peaks.

Table 2.3: Mean Annual Rainfall Burrum Catchment + environs (1950-1994)

Station	Mean Annual Rainfall (mm)
Bundaberg Aero	1070
Bundaberg Bingera	1052
Gin Gin PO	1060
Wallaville PO	976
Cordalba	1055
Booyal	946
Childers PO	1099
Torbanlea	982
Howard	1101
Duckinwalla	1012
Dicot	753
Biggenden	896
Maryborough	1182
Mungar Junction	1071
Teddington	1098
Tiaro	10676

[10] GHD, 1995
[11] NRM, 2003a

2.5 GEOLOGY & SOILS

The **Burrum River catchment** features **Cainozoic sedimentary rocks** along the **coastal strip east of Howard,** and **crystalline rocks** in the **headwaters inland from Howard.** The sedimentary rocks contribute to landscape function by providing aquifer and stream recharge potential. Their permeability to groundwater movement contributes to the high salinity hazard rating of this region. Some geologically young coastal sediment deposited in estuarine and shallow marine environments during the Holocene sea level rise may host acid sulphate soils.

Acid sulphate soils contain the mineral pyrite (iron sulphide), which is stable when protected by high groundwater levels, if the groundwater lacks oxygen. When groundwater is drained from these soils during seasonal fluctuations of the groundwater table, or by human intervention the pyrite oxidizes to form sulphuric acid with adverse environmental outcomes. Acid sulphate soils can occur along the coastal strip up to 5m above the present sea-level (more typically less than 2m above the current sea level). Acid sulphate soils are commonly activated where groundwater tables have been drained for urban and agricultural development. After rainfall, recharged groundwater tables seep into rivers and estuaries, transporting associated acid and heavy metals into these receiving waters. Epizootic Ulcerative Syndrome (EUS) or 'red spot disease' in fish has been linked to acid sulphate soils with cases of the disease reported in the Burrum estuary.

Crystalline rock formations of the Burrum River headwaters are quartz-bearing intrusive rocks and andesites, which weather to clays and coarse sediments. Coarse river sand and quartz grains in loam soils assist soil permeability after rainfall. The clays have some anion-exchange capacity to fix phosphate ions, are prone to erosion where they have sodic properties, and therefore can contribute to the delivery of particle-bound phosphorus to rivers. Sodic soils are prone to erosion if other contributing factors (slope, rainfall intensity, lack of vegetative cover) are active.

Hydrosols occur in areas of low topographic profile. These are inherently unstable soils, but tend not to move because they occur on flat landscapes. They act as sumps that accumulate salts and nutrients, with low potential for nutrients to leach through the soil profile. They are often associated with salinity and acid drainage in coastal areas.

Surface soils are sandy and have a low nutrient content. The sodium percentage is low and below levels which results in poor structure. A high proportion of magnesium may result in hard setting soils with high runoff. The behaviour of cations following immersion is dominated by the ionic composition of catchment water. Erosion of surface soils will yield sediment with a low clay proportion.

Soil profiles around Lenthall Dam were sampled during the preparation of the Environmental Impact Statement[10]. Eight locations were sampled and the results are briefly summarised below.

Undisturbed soils into solution

A1	0.100/150mm	Grey, organic stained, sand, silty sand
A2	100/150-300/400mm	Pale grey, sometimes bleached, silty sand, loamy sand
B1	300/400-600/900mm	Yellow, light grey or light brown, iron stains and mottles increasing with depth, loamy sand increasing with clay content
B2	600mm +	Yellow or brown, pronounced iron stains and mottles up to 40%, sandy clay

2.5.1 Dam Rubble Sediment

An onsite dump site was established in 1985 for material excavated during the original dam construction.

In 1988 QDPI Forestry had samples of the 2 sediment types (yellow and black) analysed for a suite of physical, chemical and agronomic factors.

The results of this analysis indicated that the material was acidic with high sulphate content, with potential to form highly acidic sediment. This high acidity has brought a high level of aluminium and iron. Complete acid digestion and analysis revealed that the rocks are unlikely to release toxic levels of heavy metals or arsenic. The combination of low pH (pH 3), high iron and high sulphur content indicates that the dam rubble is capable of generating acid sulphate sediment.

Drainage paths from the construction area, the quarry site, and areas that are not regenerating should be regularly monitored for pH. The high dilution factor in river water is expected to keep any changes in pH to 0.2 of a pH unit. Likewise river water immediately downstream of the drainage path should be tested for pH. If pH is more than 0.2 units below background levels then river water should also be tested for aluminium, iron and sulphur. If pH is below 5.0 then a range of heavy metals should be tested including: copper, manganese, lead, mercury and cobalt. Although the surface soils of the dam pondage area are low in metals the acid leachate water may dissolve metals from the construction rock. If, during low flow events, river water remains less than pH 5.5 (or 0.5 units less than background), it may be necessary to install a lime dosing unit to trickle feed calcium carbonate into river water. This can be calibrated to return the water to background pH levels. Additional remediation of the quarry either by bunding the sediment, or managing the surface water drainage, should also be considered as a means to prevent the acid runoff from the catchment.

2.5.2 Soil suitability

Wilson *et al.* (1999) undertook a land suitability study for the Maryborough to Hervey Bay area. **Sugar cane is the main crop grown in the area** and is prevalent along the Gregory and Isis rivers. Wilson *et al.* (1999) found that of the 315,400ha area, 12,438ha were suitable (class 1-3) for sugar cane using travelling irrigators or other overhead irrigation systems. Other crops such as lychees and small crops also have relatively large areas suitable for production. Most of the land in the Burrum Catchment was classified as either class 3 (suitable land with moderate limitations) – class 4 (marginal land which is presently considered unsuitable land due to extreme limitations. Only a small amount of land was suitable for sugar cane production.

2.5.3 Soil erosion

Surface soils in the catchment are sandy, with low nutrient content. Sodium levels are also relatively low and below levels that result in poor structure. The high magnesium content of the soils may result in hard setting soils with high runoff. Erosion of surface soils will yield sediment proportionally lower in clay.

Catchment surface soils, where exposed to surface runoff, are prone to erosion. Deeper soils (>900mm) have a high clay content and are regarded as relatively resistant to erosion. Upper soils (400-900mm deep), with a low clay content, are prone to erosion. The exposed shoreline of Lenthall Dam will always be open to potential erosion as demand levels fluctuate, depending upon dam supply and demand rates. Erosion is also predicted in the land cleared for the new inundation area. Inundated land by the dam extension will be exposed, with low levels of vegetation cover, when water levels fall. A crust of organic debris forms on the dam floor, helping to reduce soil erosion. However, during high intensity rainfall events erosion within ponded areas will occur. The high clay content of sub-soils resists erosion, but is ultimately exposed in areas with a higher slope.

Lenthall Dam shoreline is subject to wave action during periods of windy weather. High wind speeds acting over a long fetch of water can develop waves with erosive energy. The 2m raising may increase the fetch by a factor of up to 3. Waves will be able to lose their energy without serious erosion on gently sloping shorelines, which applies to most of the ponded area. The north eastern shoreline is considered to be steeper.

Wind direction data from the Maryborough[12] suggests that winds from the south-west occur about 9% of the time, indicating that the north eastern shoreline will be less exposed to wave action. However, isolated high wind speed events can still be expected and some shoreline erosion is anticipated. Where there are exposed sections of sloping shoreline erosion of the upper 400-900mm of sand topsoil can be expected over time. It is additionally imperative to keep shoreline disturbance by power boats to a minimum. Wide Bay Water Corporation manage Lenthall Dam to ensure a maximum speed limit of 6 knots no wash is not exceeded, thereby preventing excessive bank erosion caused by boat wake.

Overall it is considered unlikely that extensions to the dam ponded area will result in any significant changes in water quality[10].

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[12] National Climate Centre

2.6 ESTUARY DYNAMICS

2.6.1 General

Tidal flows in estuaries are continually changing towards achieving equilibrium with estuary geometry. Changes to the volume of the tidal prism, brought about by erosion or sedimentation in the estuary, effect volume of seawater exchange and cause a readjustment of mouth characteristics. Usually there is a feed forward mechanism for change within an estuary, e.g. with deposition of sediment within the inter-tidal zone, the tidal prism becomes reduced. Thus, with a smaller volume interchanged each day, the tidal velocities reduce leading to further sedimentation and an acceleration of the trend in the estuary, which will continue until some other factor takes over, such as a major flood event.

Some short term effects which govern estuary behaviour include:

- large or medium flow events which either deposit or mobilise sediment causing continued erosion or accretion
- dredging which effects the tidal prism in the inter-tidal zone
- alteration to the mouth such as the building of rock walls or groins

Long term influences on estuary behaviour include:

- changes to the frequency of flooding either due to natural climatic variation or the influence of dams
- changes to the mean sea level such as induced by global warming
- changes to coastal movements
- changes to the supply of sediment to the estuary

Most or all of these factors are currently affecting the Burrum estuary.

2.6.2 Tides

Tidal energy redistributes sediment within the Burrum River estuary, and is a primary driver for the formation of mudflats, tidal channels, and distributary channels that cut through mangroves. As such, tidal cycles are an important driver of physical habitat in the Burrum estuary. Section 2.3 described the significant development of water supply infrastructure along the Burrum River; this has resulted in changes in flow regimes in the upper estuary. Impacts on the lower estuary are mitigated by inflows from the Cherwell, Isis and Gregory Rivers, which are relatively underdeveloped[13].

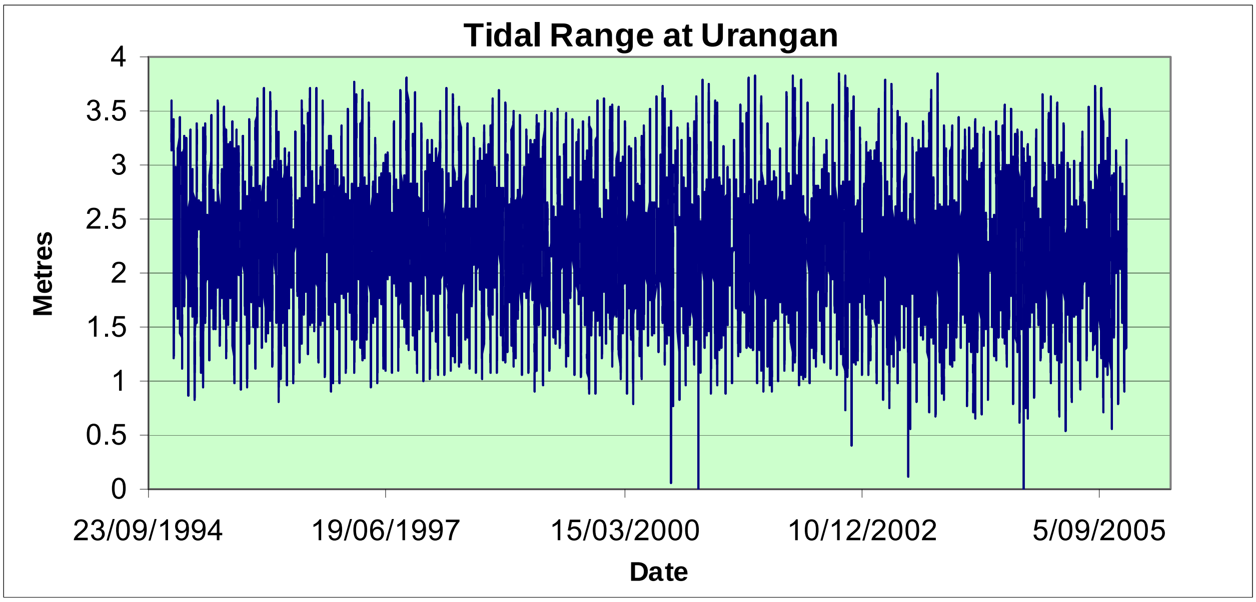
Tidal heights were measured at the Urangan Storm Surge Gauging Station (station number 058009B), between July 1981 and December 2005 (Figure 2.3).

Statistically significant tidal cycles occur at 111, 106, 66, 62, 56, 50, 36, 28, and 4 day periods. The average diurnal tidal range is 2.3m, with the maximum tidal range (3.8m) recorded on 9/3/2001.

[13] Country to Coast - A Healthy Sustainable Future Volume 2 Burnett Mary Regional Integrated NRM Plan

The highest recorded tide is 4.37m.

Figure 2.4: Tidal ranges measured at the Urangan Storm Surge Gauging Station, Hervey Bay



2.6.3 Tidal Flows

Stable tidal channels, unless geologically restricted, have been shown to exhibit a relationship between tidal prism volumes and the entrance cross sectional area. This relationship develops as the estuary adjusts until an equilibrium of bed shear is achieved.

In the absence of detailed survey data, the cross sectional area of the mouth of the estuary was estimated by GHD[10], to be 750m^2. Assuming the average depth too be below 1.5 AHD, the mean spring tidal prism is determined to be of the order of 4 times the average daily flow.

Thus under average flow conditions the hydraulics of the estuary is likely to be dominated by tidal flows and not river flows.

3.0 CHAPTER 3: CURRENT WATER QUALITY

3.1 MONITORING PROGRAMS

Continual water quality monitoring programs occur within the Burrum River catchment and environs and is summarised in Table 3.1. Figure 3.1 identifies the location of sample sites. These programs provide indicative data of the condition of the Burrum Catchment as the programs listed do not cover the entire catchment (mainly focussed to water infrastructure on the Burrum and the Burrum estuary).

For the purpose of this WQIP, continual monitoring is defined as:

- **a water quality monitoring program that samples water quality at least on a quarterly basis**
- **a water quality monitoring program that is currently in operation and has been in operation for at least 2 years**

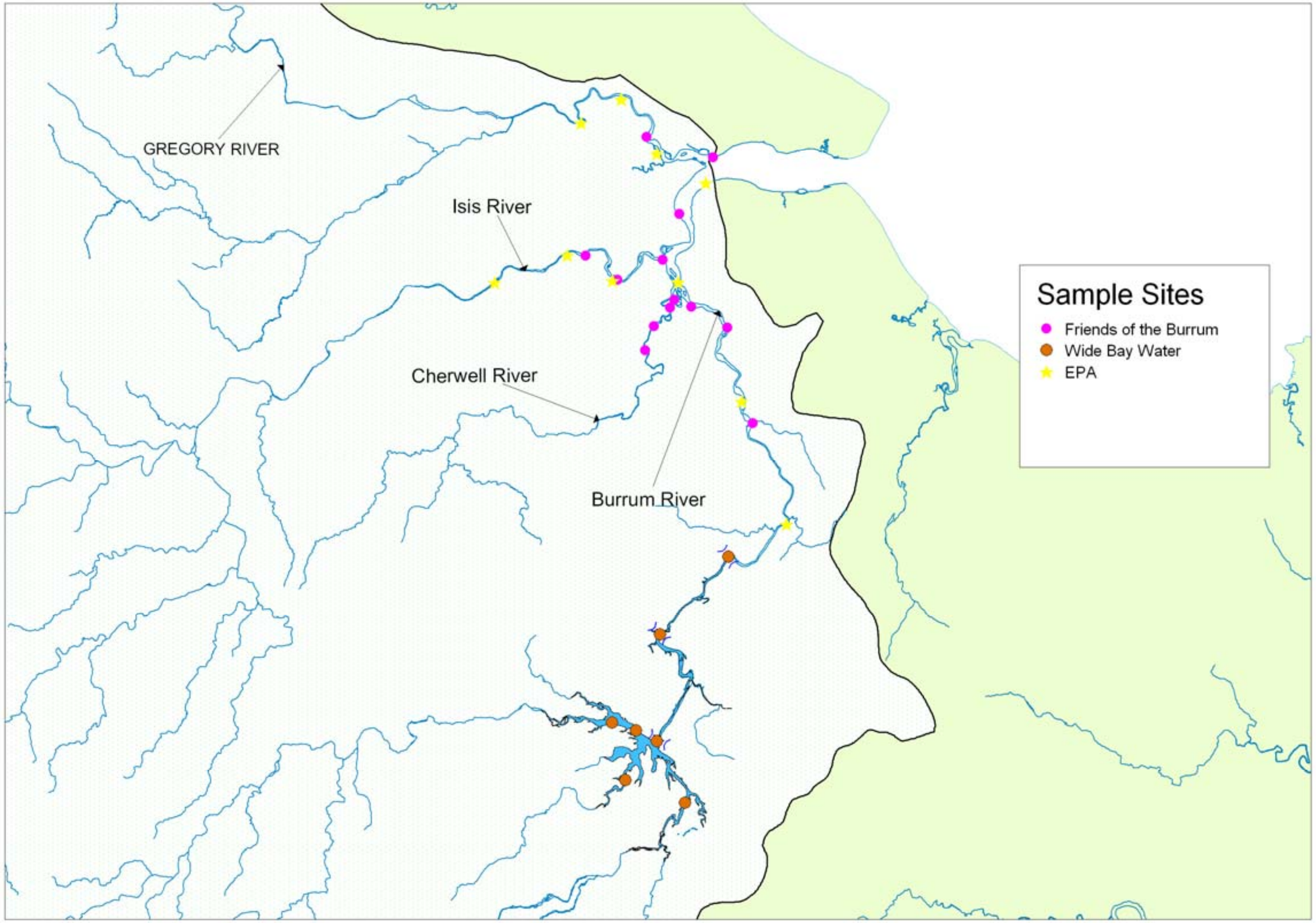
Table 3.1: Burrum River Catchment currently operating water quality programs

Organisation undertaking Water Quality Monitoring in the Burrum River Catchment	No of sites monitored	Water Zone
Wide Bay Water Corporation	5	Lower Freshwater (impoundments)
Wide Bay Water Corporation	2	Burrum Weirs
Environmental Protection Agency (EPA)	4	Burrum Estuary
Friends of the Burrum	6	Burrum Estuary
Friends of the Burrum	3	Cherwell Estuary

Table 3.2: Parameters Monitored

Parameter	WBWC	EPA	FBRSG
Ammonia as N	✓	✓	
Nitrate as N	✓		
Nitrite as N	✓		
Oxides of Nitrogen	✓	✓	
Organic N		✓	
Total N		✓	
Chlorophyll a	✓	✓	
Electrical Conductivity	✓	✓	✓
Dissolved Oxygen	✓	✓	✓
Iron, Manganese	✓		
pH	✓	✓	✓
Phosphorous	✓	✓	
Total P		✓	
Temperature	✓	✓	✓
Turbidity	✓	✓	✓
Total Dissolved Solids	✓		
Faecal Coliform		✓	
Secchi Depth		✓	✓

Figure 3.1: Sample Sites



3.1.1 Wide Bay Water Corporation (WBWC)

Lenthall Dam is the primary water source for Hervey Bay. Wide Bay Water Corporation (WBWC) test 'raw' water quality as a pre-treatment check for water treatment purposes and for water supply scheme licence requirements.

WBWC conducts monthly monitoring of five sites within Lenthall Dam and a further 2 sites in the Burrum Weirs (refer table for a list of parameters). Sampling commenced in 1997/98. Sample sites within the Lenthall Dam impoundment were initially selected on a relatively random basis throughout the dam. Sampling is undertaken at the surface and at 0.5m intervals to the bottom depending upon the depth. The areas of the dam where major sources of water enter are also monitored (e.g. Doongul, Harwood and Duckinwilla Creeks). Parameters tested are listed in Table 3.2.

Quality assurance related to WBWC monitoring is considered high given the Corporations NATA accreditation.

3.1.2 Environmental Protection Agency (EPA)

The EPA's water quality monitoring of the Burrum River Estuary is part of EPA's state wide ambient water quality monitoring program. Four sites have been monitored since 1980 with sites located at (Figure 3.1):

- Burrum River 0.0 km at the mouth of the junction with the Gregory River
- Burrum River 5.5 km upstream of its junction with the Gregory River
- Burrum River 12.7km upstream of its junction with the Gregory River
- Burrum River 19.2 km upstream of its junction with the Gregory River

Sampling is undertaken from a boat and is based on high tide, so as to measure water quality parameters in a freshly charged system. Parameters tested are listed in Table 3.2.

EPA has developed a complete quality assurance manual for all components of the EPA water quality monitoring program. EPA equipment is calibrated weekly during use with dissolved oxygen being calibrated daily. Quality assurance from the EPA monitoring program is considered high.

3.1.3 Friends of the Burrum River System Group (FBRSG)

The Friends of the Burrum River System Group (Inc) commenced monthly water quality monitoring at 27 sites throughout the Burrum, Cherwell, Gregory and Isis Rivers in November 2005.

The objective of this monitoring program is:

- to ensure that all residential and commercial development on the Burrum River System is conducted according to Ecologically Sustainable Development (ESD) principles
- to preserve outstanding ecological values of the Burrum River System and adjoining reserves (i.e. Fish habitat Areas, Marine Parks, World Heritage Areas)
- to ensure that benefits to the wider community (i.e. fishing , boating, water sports and bird watching) derived from the Burrum River System are preserved

FBRSG were supported in this endeavour by a grant from the Burnett Mary Regional Group for Natural Resource Management (BMRG) and by support from Dr Andrew Moss of EPA (in terms of sampling design and location) and by Dr Graeme Esslemont (in training regarding the use of water quality sampling equipment and with the provision of some extra water quality equipment).

From June 2007 a new monthly sampling program was funded by BMRG, which involves 15 sampling sites and scientific support from the Wide Bay Water Corporation Scientific Laboratory and the Coastal Water Quality Alliance Officer.

This program builds on the experience of the previous grant.

The program samples (Figure 3.1):

- 3 sites in the Gregory (1 in the lower estuary and 2 in the mid estuary)
- 3 sites in the Isis (all in the mid estuary)
- 3 sites in the Cherwell (all in the mid estuary)
- 6 sites in the Burrum (1 in the lower estuary, 3 in the mid estuary and 2 in the upper estuary)

Sampling is undertaken from a boat on an ebbing low tide to provide an indication of impacts of run off from the land.

It is difficult for water quality sampling activities of volunteers to provide quality assurance. The group is now supported in training and quality assurance by the Coastal Water Quality Alliance. Prior to commencement of activities Dr Graeme Esslemont, (formerly NRM & WQSIP program, now with BMRG) assumed some of this responsibility. Additional support is provided to FBRSG and the Coastal Water Quality Alliance by the WBWC Scientific Services Laboratory.

3.1.4 Historical Water Quality Monitoring

GHD Water Quality Sampling Program for HBCC (Lenthall Dam Raising EIS)

Prior to 1995, when the GHD HBCC EIS was undertaken, water quality data was limited.

Water quality data was collected downstream of Burrum Weir No. 1, the primary off take for the Hervey Bay water supply. Temperature and DO (dissolved oxygen) profiles suggest that Lenthall Dam is strongly stratified. Of note is the rapid DO depletion coupled with increase in turbidity with depth, a further feature of a low production stratified reservoir. Low nutrient input into the dam has resulted in low algal blooms relative to other dams of similar size and location (e.g. North Pine dam).

Chlorophyll-a measurements from Burrum Weir No. 1 are relatively high and at levels regarded as mesotropic 2-15ug/l. Increased nutrient input from this could see levels approach eutropic levels i.e. > 15ug/l. Phosphorus was measured at 0.03mg/l and is within ANZECC guideline (0.05mg/l) and nitrogen at 0.8 mg/l exceeding the TN guideline of (0.5 mg/l).

Given the size of the lower weirs, it is likely that the rate of primary production will be significantly higher than the reservoir. Water management techniques of releasing water from Lenthall Dam as required and not flushing the weirs leads to the relatively high chlorophyll 'a', encountered at Burrum Weir no 1. The source of nutrient is assumed to be diffuse. Dominating land uses for the catchment are native forest, pine forest and pasture. Table 3.3 estimates land use type and its nutrient contribution[10].

Table 3.3: Nutrient Loadings

Land use	Loading kg/ha/yr TP	Loading kg/ha/yr TN
Native Forest	0.2	5
Pine Forest	0.35	7.5
Pasture	0.5	10

Conclusions of Brizga *et al*, 2002

Brizga *et al.* (2002) rate water quality in Lenthall Dam and the 2 Burrum Weirs as good in terms of the aquatic ecosystem, recreation and aesthetics and for the purpose of drinking water and primary industry use. They rate the 2 reaches downstream i.e. Burrum Weir no 2 to mouth of the Cherwell River and from the Cherwell River to the River Mouth as good in terms of recreation, moderate in terms of the aquatic ecosystem but poor in terms of dinking water and primary industry water quality standards (Table 3.4).

Table 3.4: Review of water quality data for the Burrum Catchment (taken from Brizga *et al.)*

Burrum Catchment Reach	Aquatic Ecosystem	Primary Industry	Recreation and Aesthetics	Drinking Water (assuming disinfection)
Lenthall Dam	Good	Good	Good	Good
Lenthall Dam to Burrum to Weir no 1	Good	Good	Good	Good
Burrum Weir no 1 to Burrum Weir no 2	Good	Good	Good	Good
Burrum Weir no 2 to Cherwell River	Moderate	Poor	Good	Poor
Cherwell River to River Mouth	Moderate	Poor	Good	Poor

Rating description:

Poor Guideline values for most or all parameters only rarely met, extreme values often encountered.

Moderate Guideline values for most parameters met frequently, few instances of extreme values.

Good Guideline values usually met in all but extreme conditions e.g. high flow events.

3.2 CURRENT WATER QUALITY COMPARED TO WATER QUALITY OBJECTIVES

The current water quality condition was assessed using the Guidelines Tool[14] developed for the Water Quality State Investment Project (WQSIP), referenced against the Water Quality Objectives described in Table 5.3. Reference values for the Burrum region (for slightly too moderately disturbed aquatic ecosystems), were used in relation to freshwater lakes/reservoirs, lowland freshwaters, and mid-estuarine guidelines (as detailed in Table 5.3: Water Quality Objectives for Waters in the Burrum, Gregory, Isis and Cherwell Catchments (EPA, 2007)). Water Quality models and the trend analysis detailed in s3.2 was completed by Dr Graeme Esslemont (BMRG).

Data was sourced from the monitoring programs of the Queensland EPA (estuarine section) and from WBWC (impounded freshwater section – Burrum River).

Table 3.5 compared nutrient related water quality results and identified that filterable reactive phosphorus concentrations in the estuary and freshwater section downstream of Lenthall Dam are within guideline limits. Nitrogen species bordered, or exceeded guideline limits at some sampling points, and chlorophyll-a exceeded guideline limits at every point sampled in the estuary and freshwater.

Table 3.5: Median nutrient concentrations in the Burrum River Catchment (values for Chlorophyl a are µg/L and all other nutrients mg/L)

Sampling Location	Nutrient Related Water Quality Indicators					
	Ammonium	Oxides of Nitrogen	Organic Nitrogen	Total Nitrogen	Filterable Reactive Phosphorus	Chlorophyll a
Burrum estuary at the junction of the Gregory River						1.7
Burrum estuary 5.5km upstream of the Gregory River junction						2.9
Burrum estuary 12.7km upstream of the Gregory River junction	0.01	0.0135	0.2	0.21	0.002	9.1
Burrum estuary 19.2km upstream of the Gregory River junction						7
Burrum estuary 23.2km upstream of the Gregory River junction	0.003	0.002	0.5	0.5	<0.002	
Burrum Dam 1	0.016				0.007	10
Burrum Dam 2	0.011				0.007	7
Lenthalls Dam 1 at 1m depth						
Lenthalls Dam 1 at 8m depth						
Lenthalls Dam 4 at 1m depth						
Lenthalls Dam 4 at 3m depth						
Lenthalls Dam 4 at 7m depth						

Green - within specification
Orange - borderline (a result where water quality is poor some of the time, but good most of the time)
Red - outside specification

[14] Marsh *et al*., 2006

Table 3.6 compares the physical-chemical parameters against guidelines, using the same traffic light system. Results were within guideline limits in the estuary section seaward of the 5.5km sampling point, but borderline to poor results were observed at the sampling point slightly downstream of Howard (19.2km from the Gregory confluence). Turbidity, suspended sediment, and secchi depth readings were relatively poor at this point. Dissolved oxygen failed guideline values in the estuary near the base of Burrum Dam 2.

The freshwater and dam sections were within guideline values for turbidity, suspended solids, and filterable reactive phosphorus. pH values were borderline, which could result from the influence of organic acids that occur as a natural driver in this river system. A deepwater section of Lenthall Dam (below 3m at site 4) failed guideline values for dissolved oxygen and pH.

Table 3.6: Median physical-chemical parameters in the Burrum River Catchment

Sampling Location	Physical - Chemical Parameters				
	Dissolved Oxygen (% saturation)	pH	Secchi (m)	TSS (mg/L)	Turbidity (NTU)
Burrum estuary at the junction of the Gregory River	94	8.1	2		2
Burrum estuary 5.5km upstream of the Gregory River junction	91	8	1.8	9	4
Burrum estuary 12.7km upstream of the Gregory River junction	85	7.8	1	15	7
Burrum estuary 19.2km upstream of the Gregory River junction	87	7.7	0.6	22.5	13
Burrum estuary 23.2km upstream of the Gregory River junction	74	7	1.4	6.5	3.5
Burrum Dam 1	93	6.6		3.8	2.3
Burrum Dam 2	95	6.6		3.6	3.1
Lenthalls Dam 1 at 1m depth	94	6.8			2.8
Lenthalls Dam 1 at 8m depth		6.4			3.6
Lenthalls Dam 4 at 1m depth	99	6.5			
Lenthalls Dam 4 at 3m depth	81	6.6			2.8
Lenthalls Dam 4 at 7m depth	28	6.4			

Green - within specification
Orange - borderline (a result where water quality is poor some of the time, but good most of the time)
Red - outside specification

3.3 WATER QUALITY TRENDS

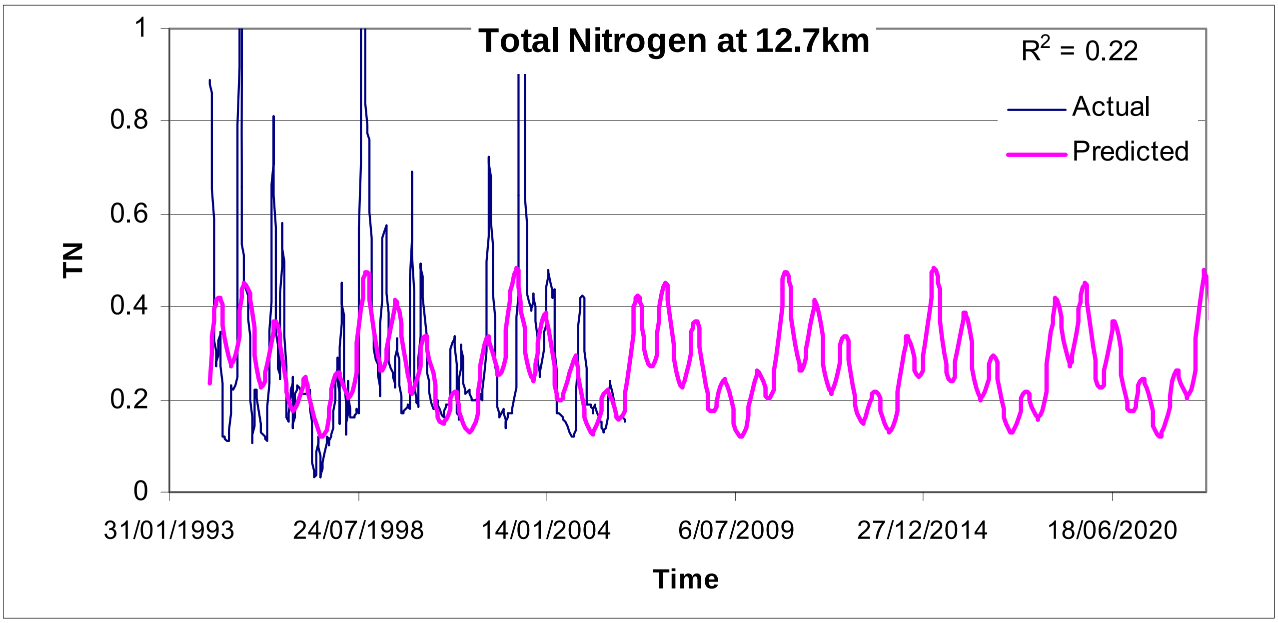
Business as usual projections indicate that water quality in the lower estuary, seaward of the 5.5km sample point, is improving with respect to light penetration and dissolved oxygen. This part of the estuary is already in good condition with respect to these parameters.

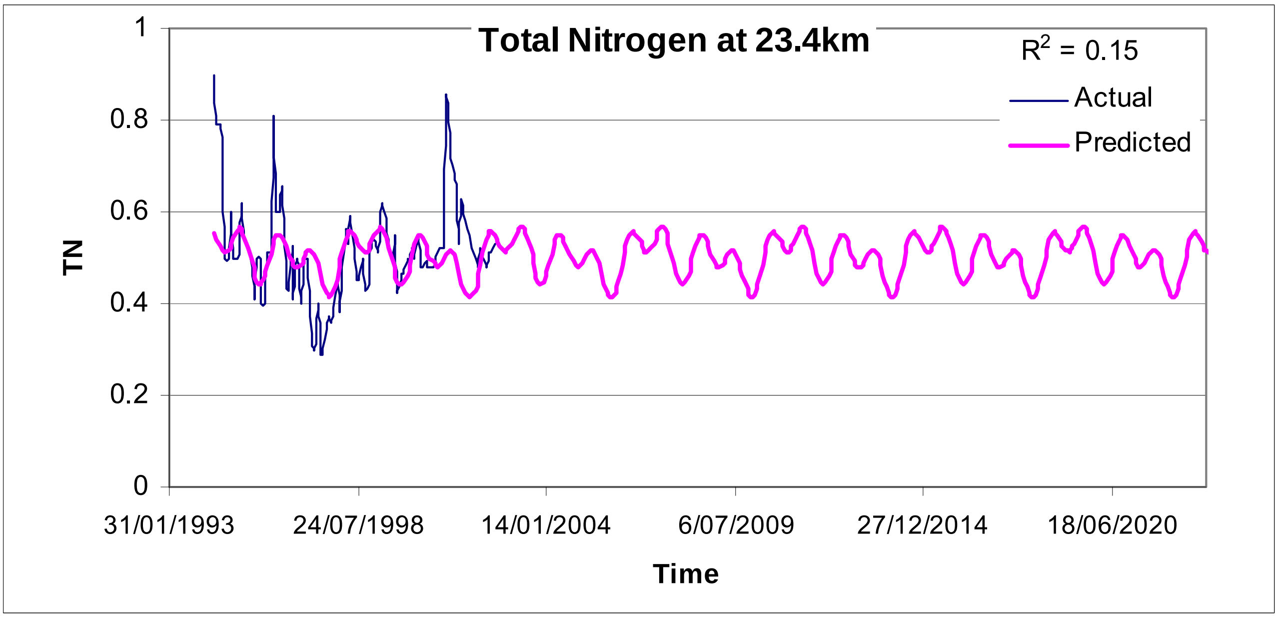
The 19.2km sample point immediately downstream of Howard had a declining water quality trend for pH (though current values are good), and stable but poor to borderline values for turbidity, light penetration, chlorophyll-a, and dissolved oxygen. This part of the estuary is where several indicators show water quality problems.

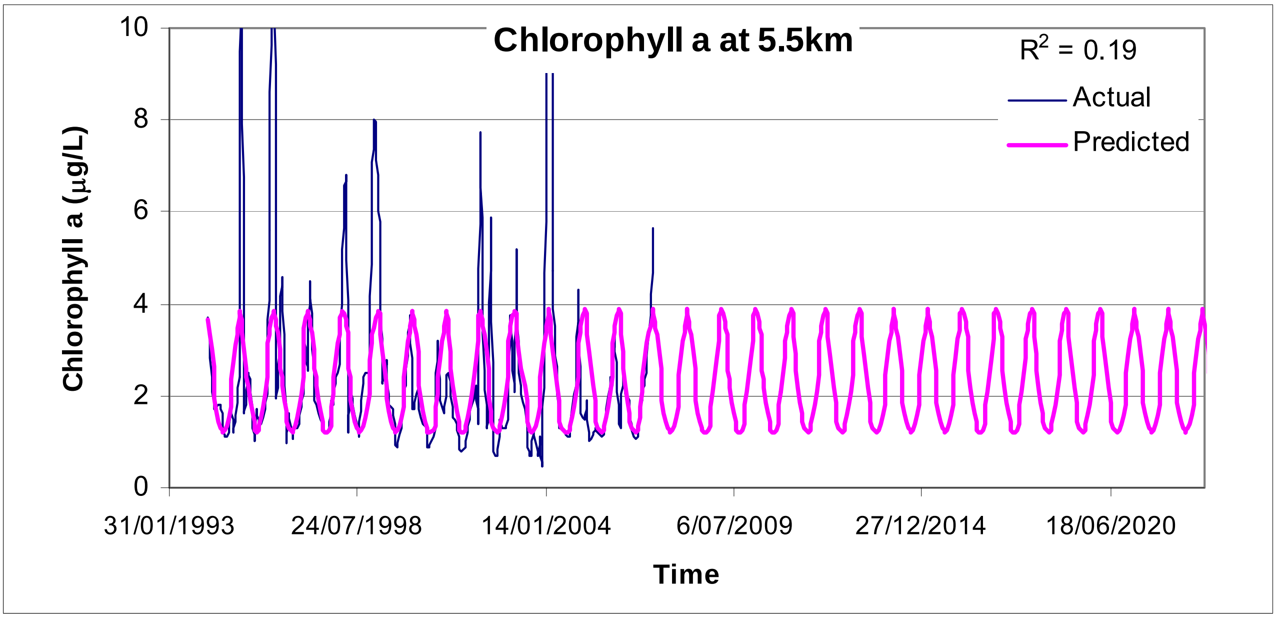
3.3.1 Nutrient trends

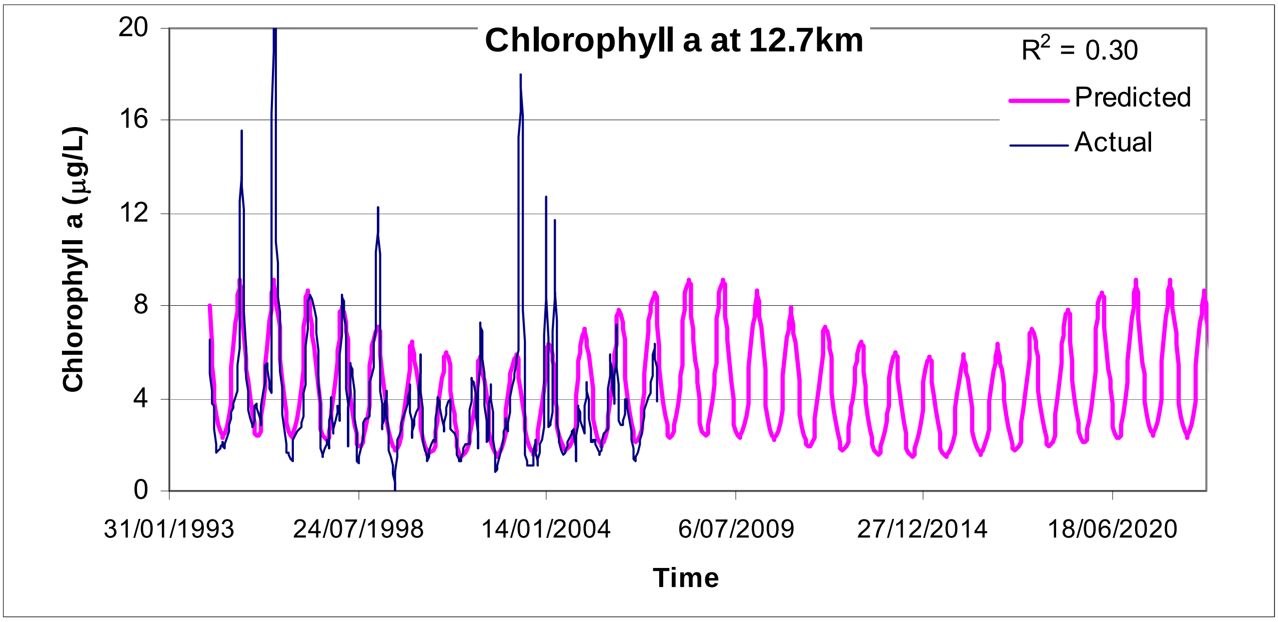
Time series models were developed for variations in total nitrogen concentrations in the Burrum estuary, at sampling points 12.7km and 23.4km upstream from the Gregory River confluence. No long term trends were observed, but clear seasonal cycles occurred annually, and at 2 and 4 year cycles. Amplitudes of seasonal trends were more pronounced at the 12.7km site (0.3, 0.12, 0.29 mg/L at 4, 2, and 1 year cycles), compared with the 23.4km site (0.05, 0.08, 0.05 mg/L at 4, 2, and 1 year cycles).

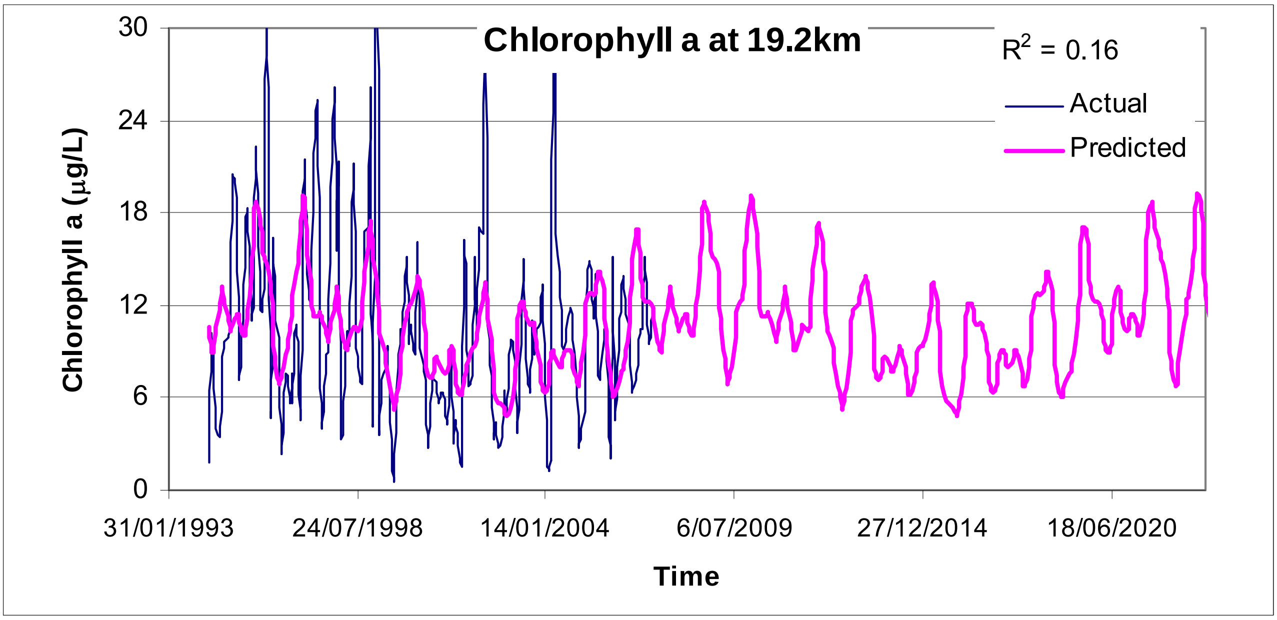
Chlorophyll-a provides an indication of primary production within the catchment. High Chlorophyll-a levels can indicate a eutrophic or high nutrient condition while low Chlorophyll-a could indicate an oligotrophic or low nutrient condition. Chlorophyll-a models also varied seasonally, with different cycles at different parts of the estuary. Annual cycles were observed at all sample locations, with 0.5 and 1.6 year cycles at the 19.2km site. These cycles were predictable (correlations with modelled data were 16-43%). There is statistically insignificant suggestion of a 13 year cycle at the 12.7km and 19.2km sample locations, which needs to be confirmed by continued monitoring. High frequency (2.4 and 8.4 month), low amplitude (0.03 and 0.01µg/L), noisy cycles (correlations with modelled data were only 5%) occur at the most upstream point of the estuary, immediately below Burrum Weir No. 1.

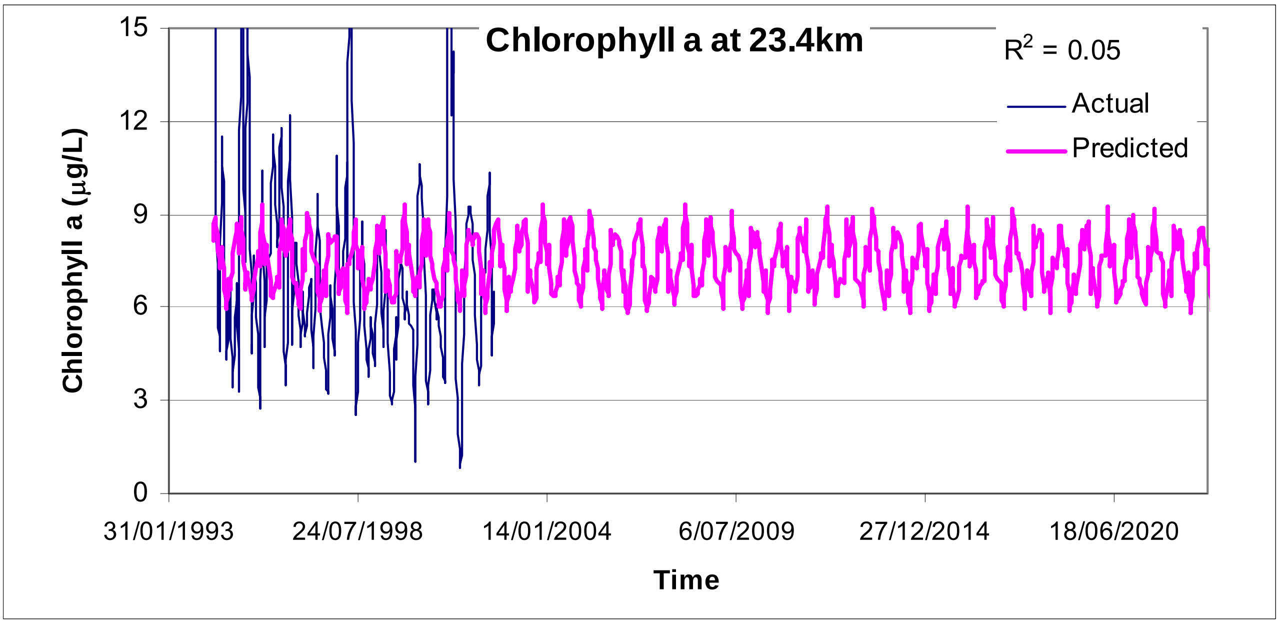

Total Nitrogen at 12.7km
R^2 = 0.22
Actual
Predicted
TN
1
0.8
0.6
0.4
0.2
0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time


Total Nitrogen at 23.4km
R^2 = 0.15
Actual
Predicted
TN
1
0.8
0.6
0.4
0.2
0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time


Chlorophyll a at 5.5km
R2 = 0.19
Actual
Predicted
Chlorophyll a (µg/L)
10
8
6
4
2
0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time


Chlorophyll a at 12.7km
R2 = 0.30
Predicted
Actual
Chlorophyll a (µg/L)
20
16
12
8
4
0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time

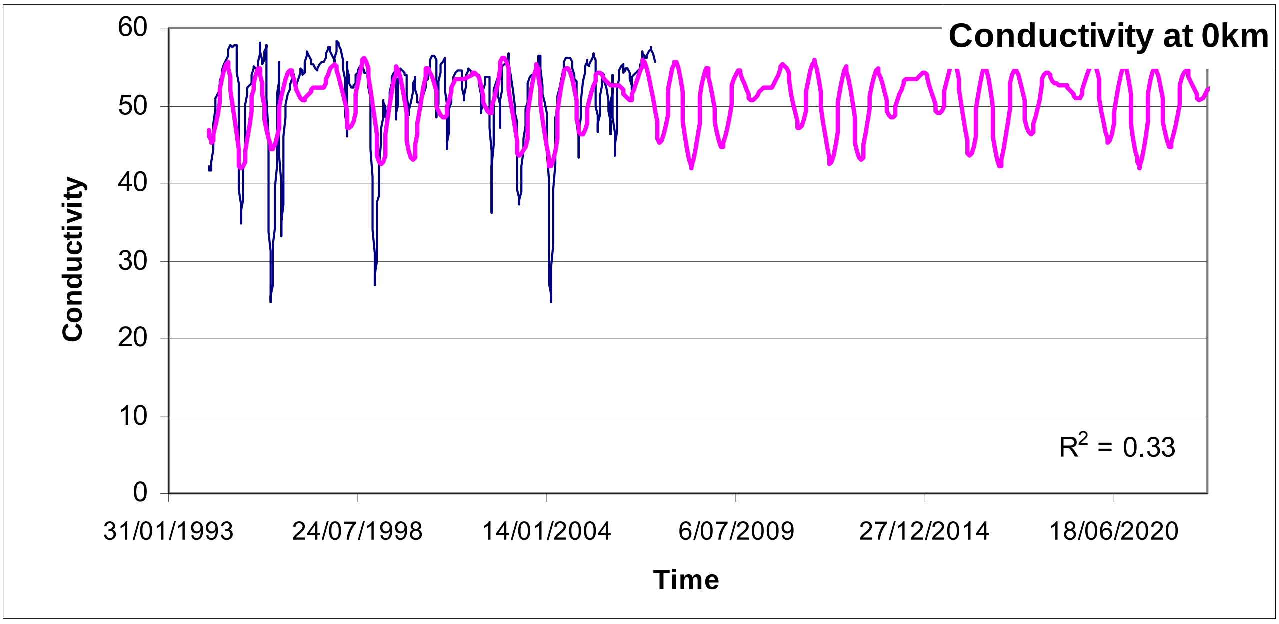

Chlorophyll a at 19.2km
R2 = 0.16
Actual
Predicted
Chlorophyll a (μg/L)
30
24
18
12
6
0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time

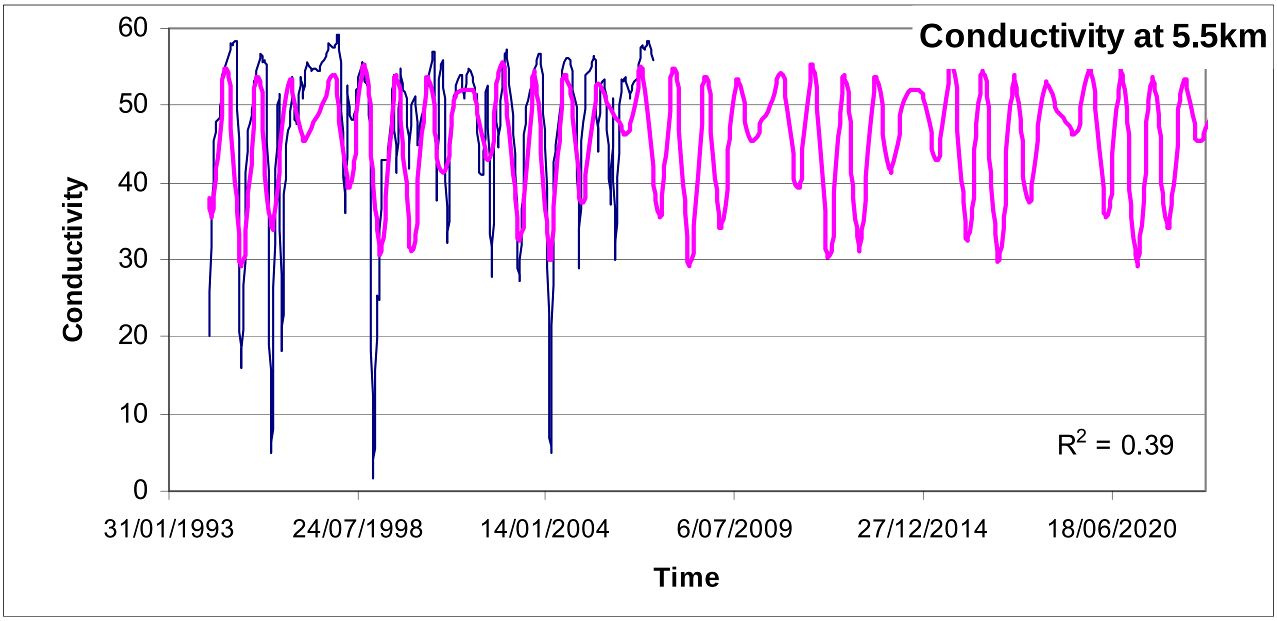

Chlorophyll a at 23.4km
R2 = 0.05
Actual
Predicted
Chlorophyll a (μg/L)
15
12
9
6
3
0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time

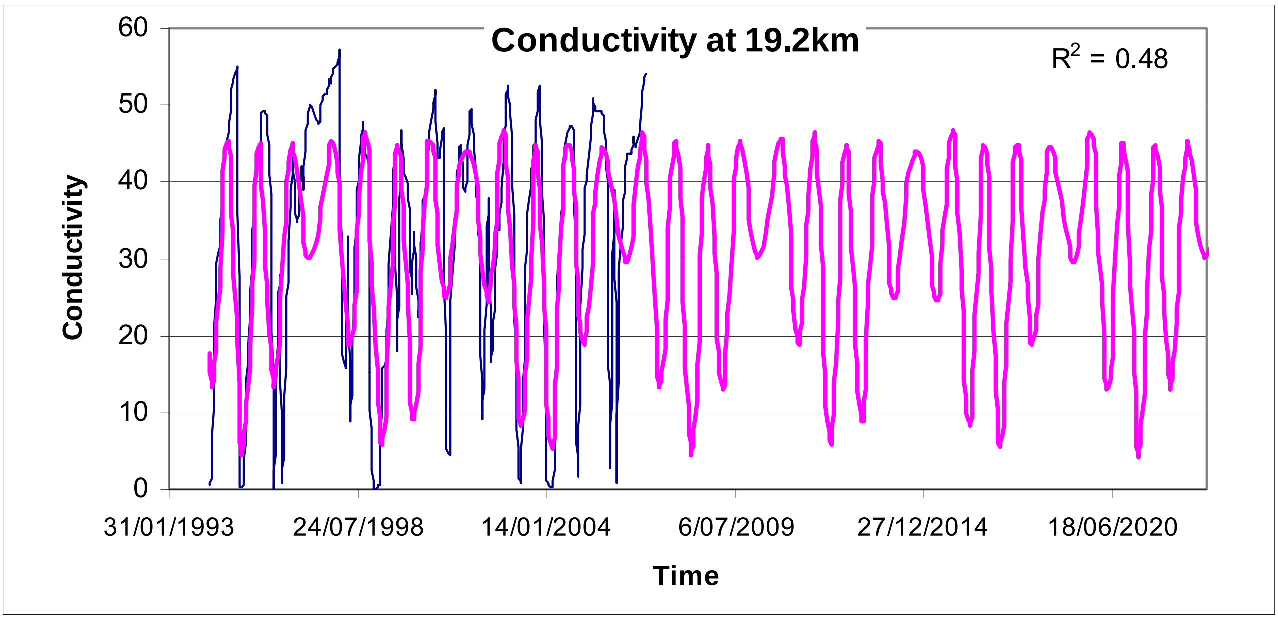
3.3.2 Physical-chemical trends

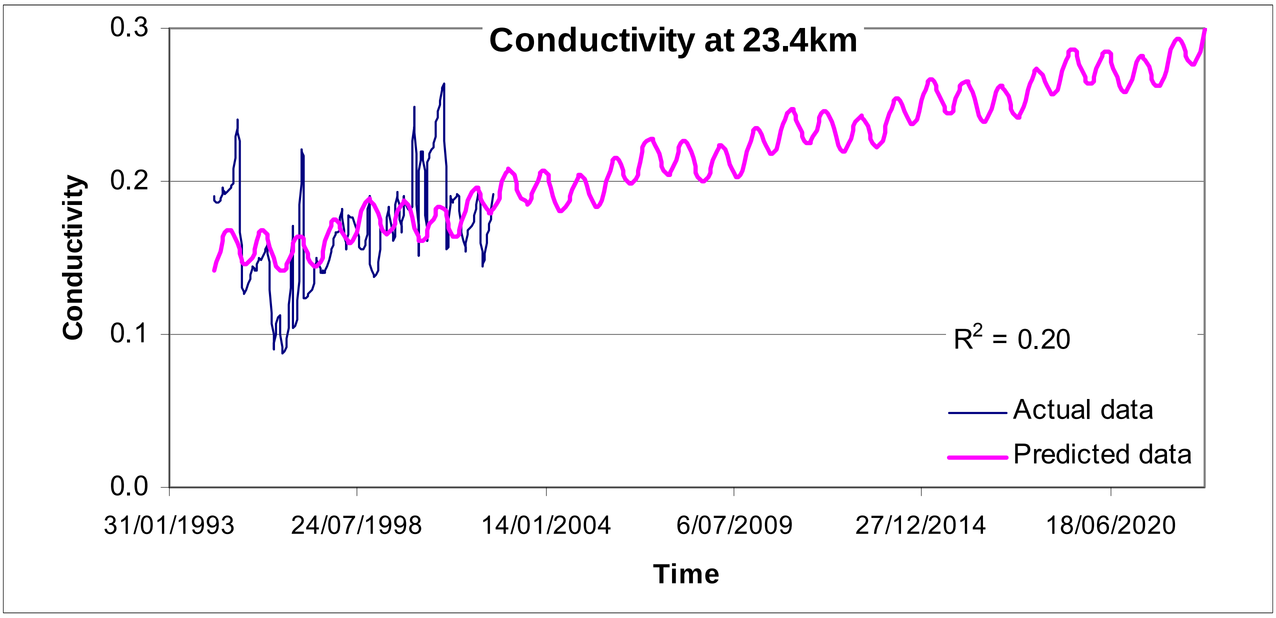
3.3.2.1 Conductivity

Conductivity in the Burrum estuary varies seasonally, with variations in the amplitude of cycles in different parts of the estuary. Seasonal decreases in salinity were observed at 0.8, 1, and 3.25 - 4.3 year cycles, with amplitudes of all three seasonal cycles, increasing directly with downstream position. The 23.4km sample was fresh, with a possible two-fold increase in electrical conductivity by 2020.



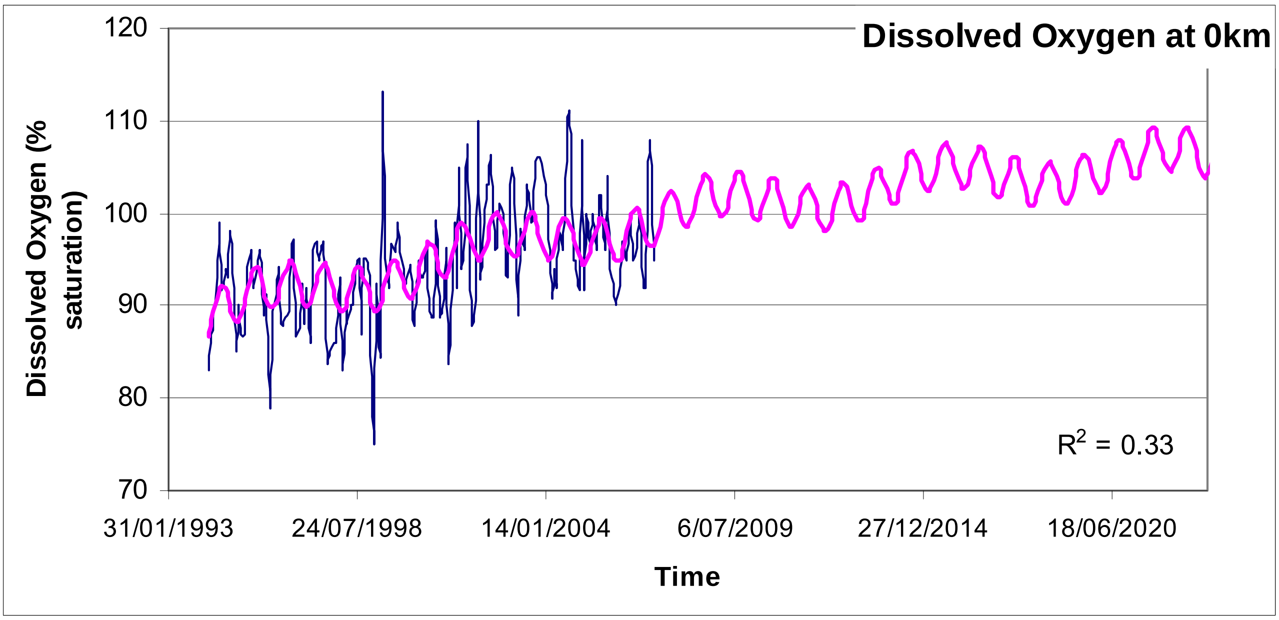


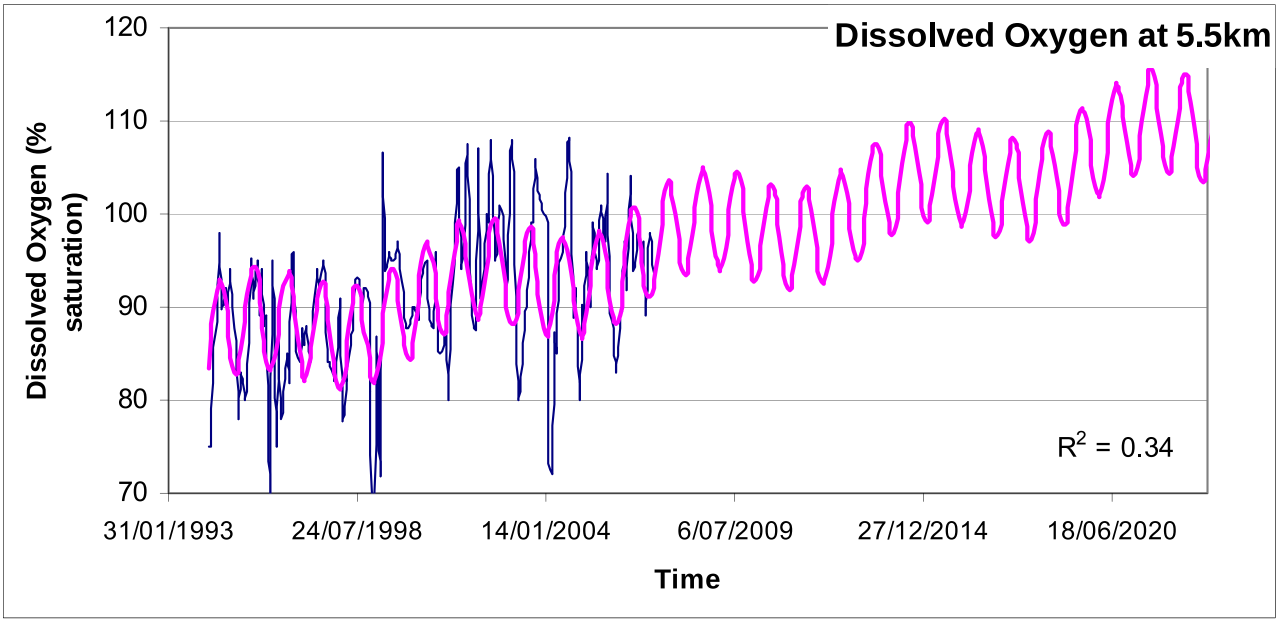

Conductivity at 19.2km
R² = 0.48
Conductivity
Time
60
50
40
30
20
10
0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020

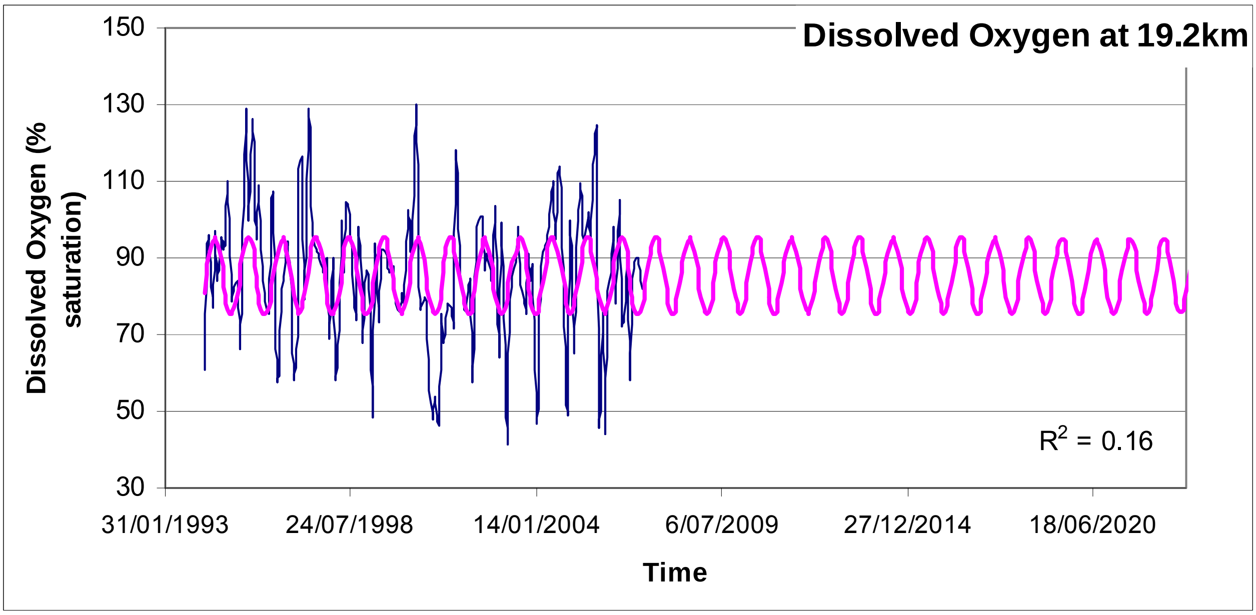

Conductivity at 23.4km
R² = 0.20
Actual data
Predicted data
Conductivity
Time
0.3
0.2
0.1
0.0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020

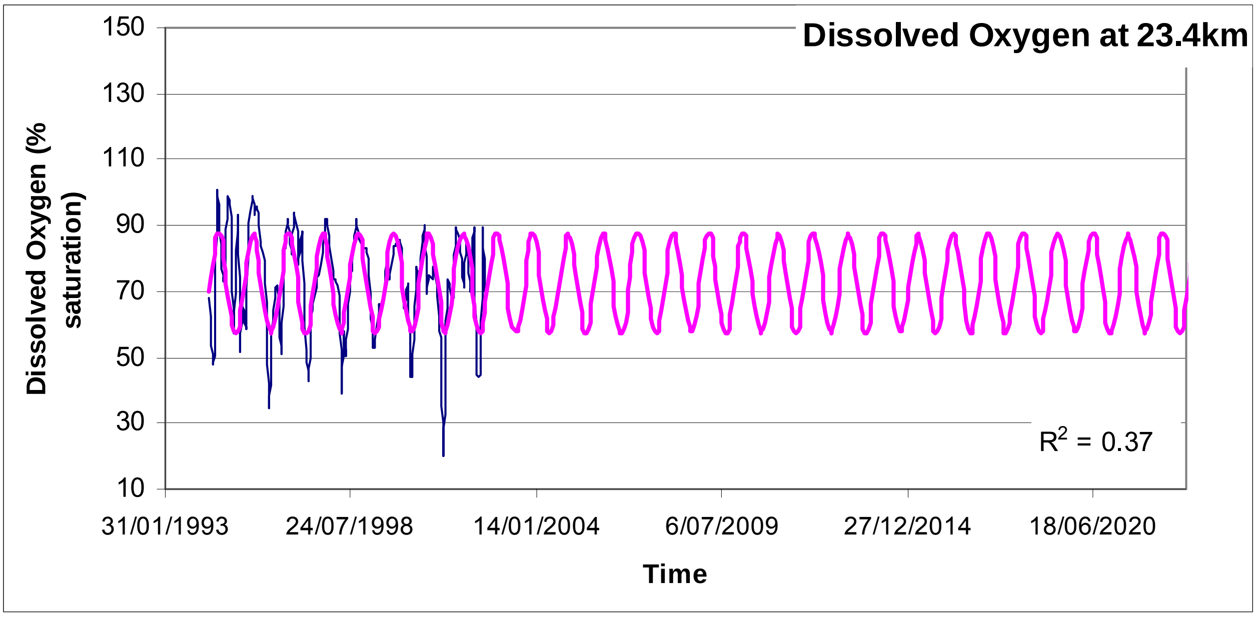
3.3.2.2 Dissolved Oxygen

Dissolved oxygen concentrations in the Burrum estuary vary annually, with expected improvements in the seaward part of the estuary by 2020. A 6.5-year cycle is also present in this seaward part of the estuary. Further downstream in the estuary, concentrations of dissolved oxygen decreases and seasonal drawdown are more pronounced.



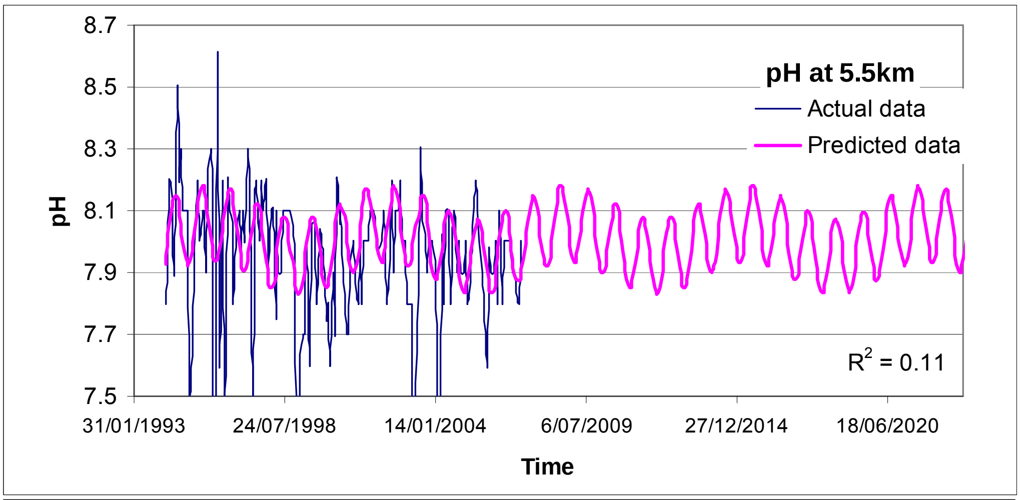


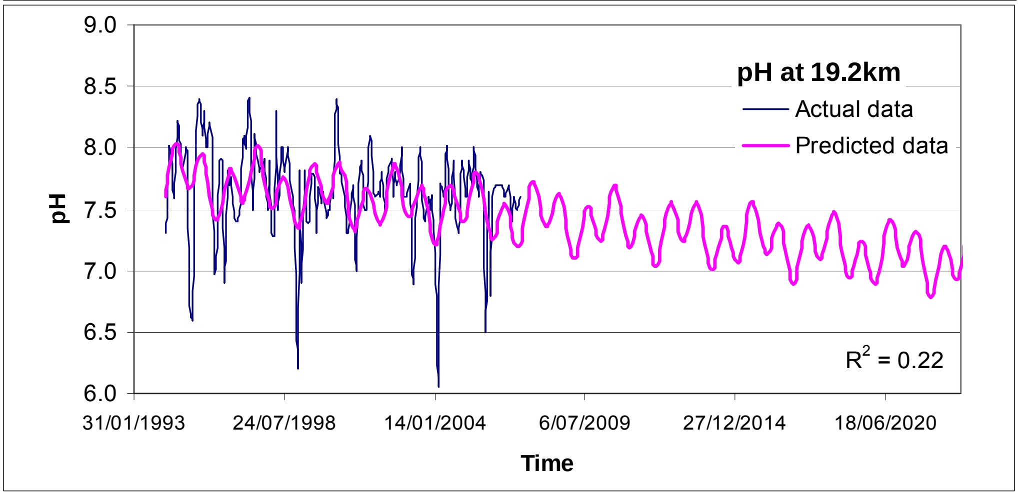

Dissolved Oxygen at 19.2km
Dissolved Oxygen (% saturation)
150
130
110
90
70
50
30
R^2 = 0.16
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time

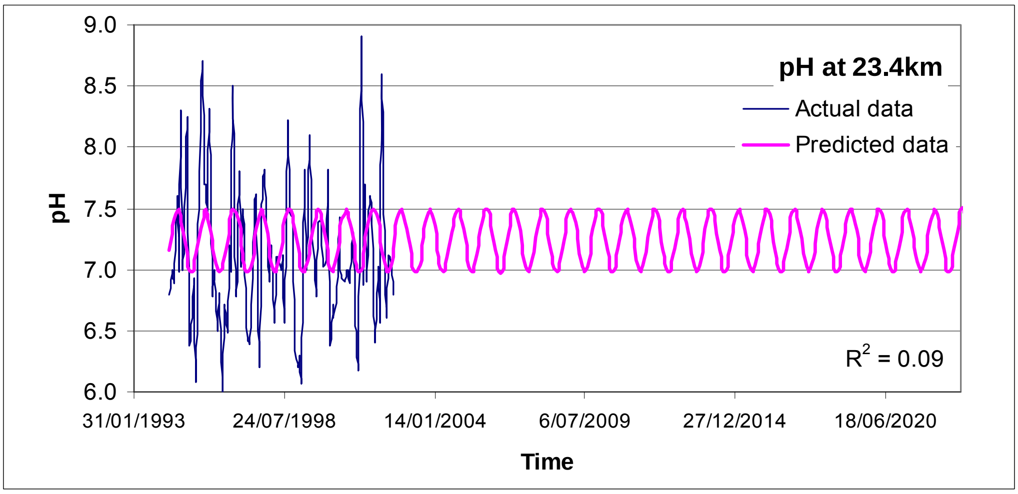

Dissolved Oxygen at 23.4km
Dissolved Oxygen (% saturation)
150
130
110
90
70
50
30
10
R^2 = 0.37
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time

3.3.2.3 pH

pH in the Burrum estuary varies annually, with statistically insignificant suggestions of 6.5 and 2.6 year cycles respectively at 5.5km and 19.2km upstream from the confluence with the Gregory River. pH decreases linearly with upstream position, with a decline in pH over time at the 19.2km sample point. pH at this point is expected to decline by 2020 by 1 pH unit. Seasonal variations become more pronounced with linear distance downstream from the Gregory River confluence.

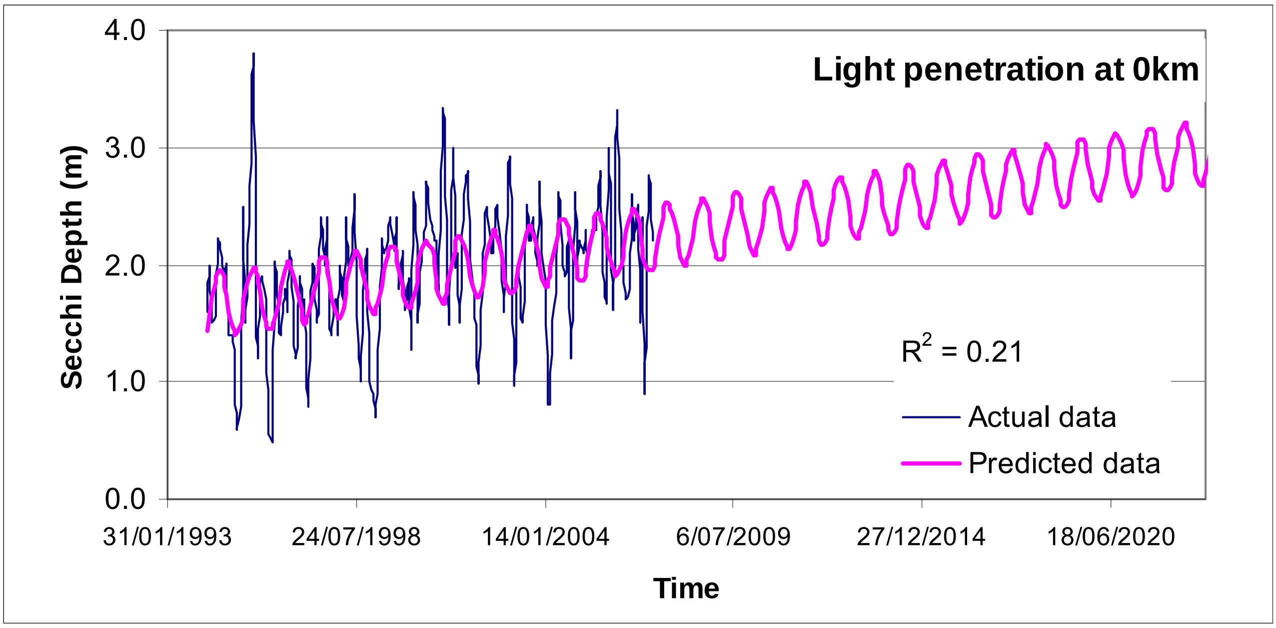


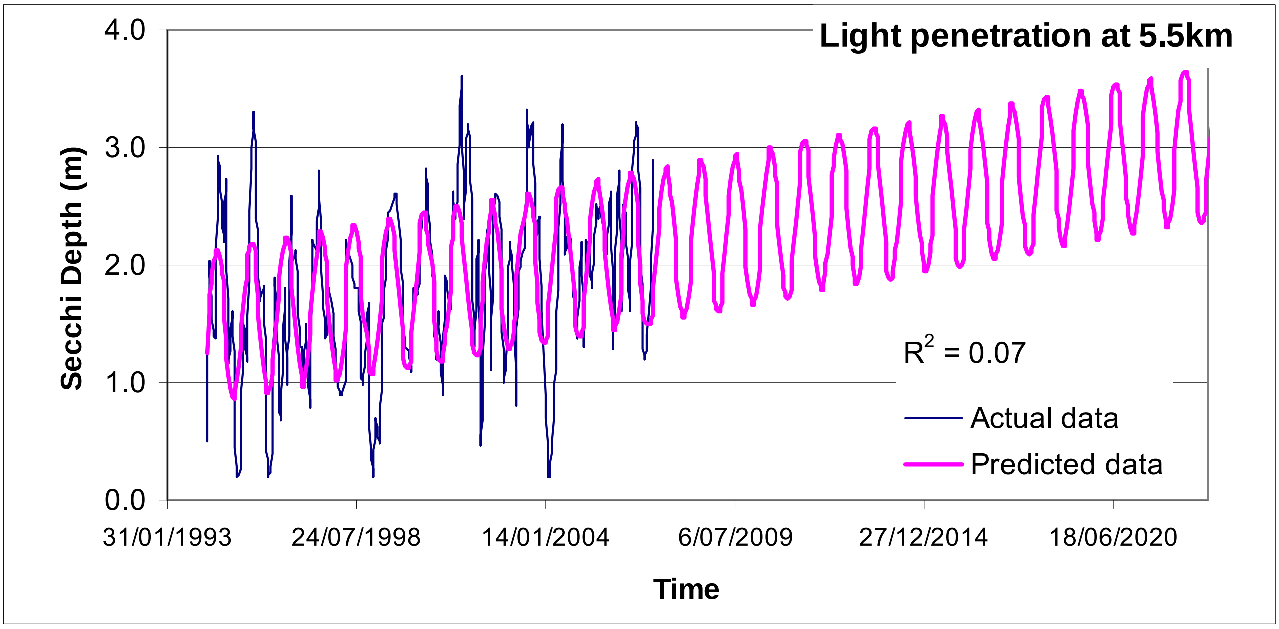


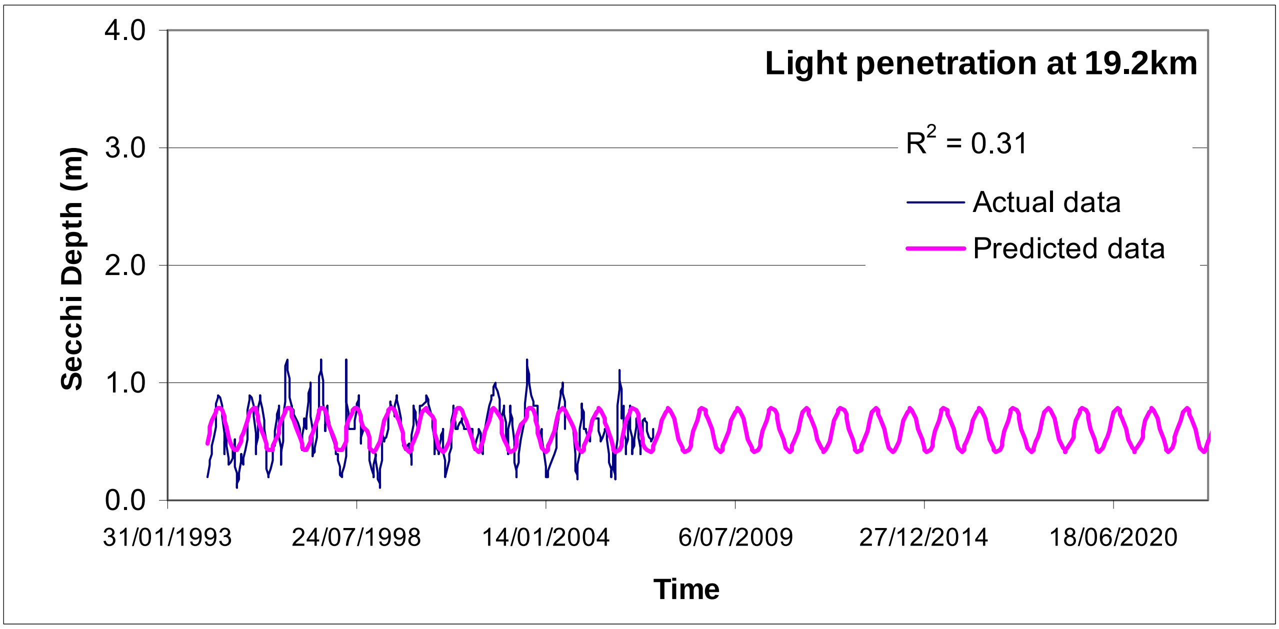


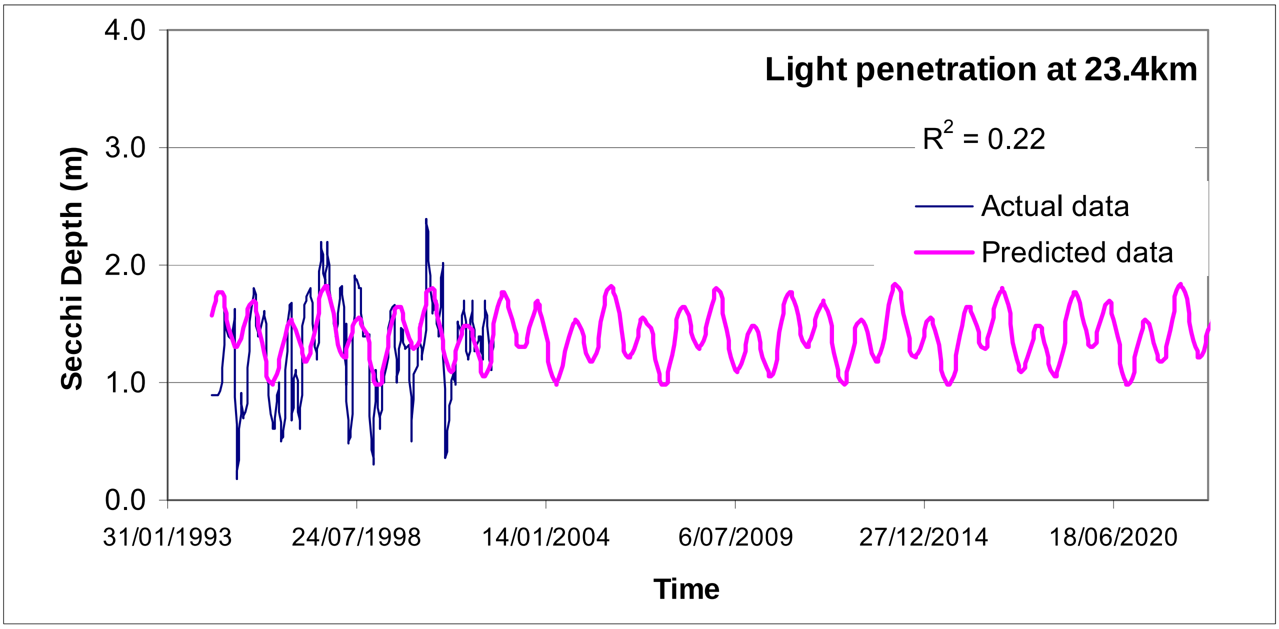
3.3.2.4 Turbidity

Light penetration is improving in the Burrum Estuary seaward of the 5.5km sample point. The lowest light penetration occurs at the 19.2km sample point (just downstream of Howard). Light penetration varies seasonally, with water clearer during the dry season, and there is also a 2.75 year cycle in light penetration at the 23.4km sample point.



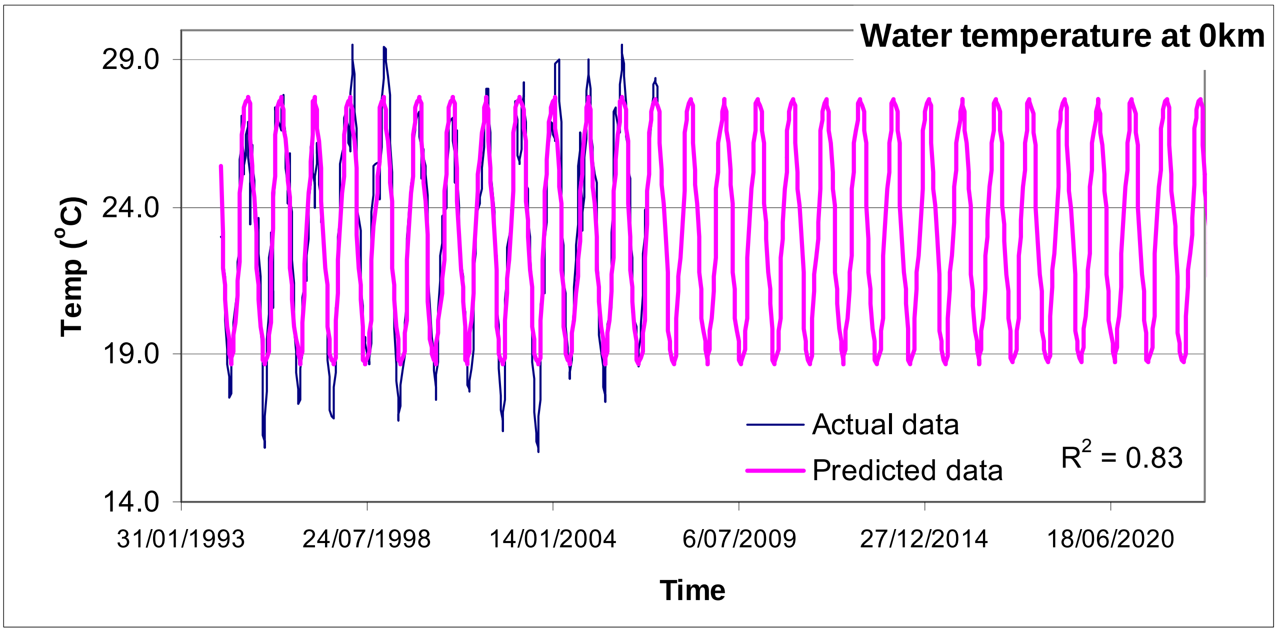


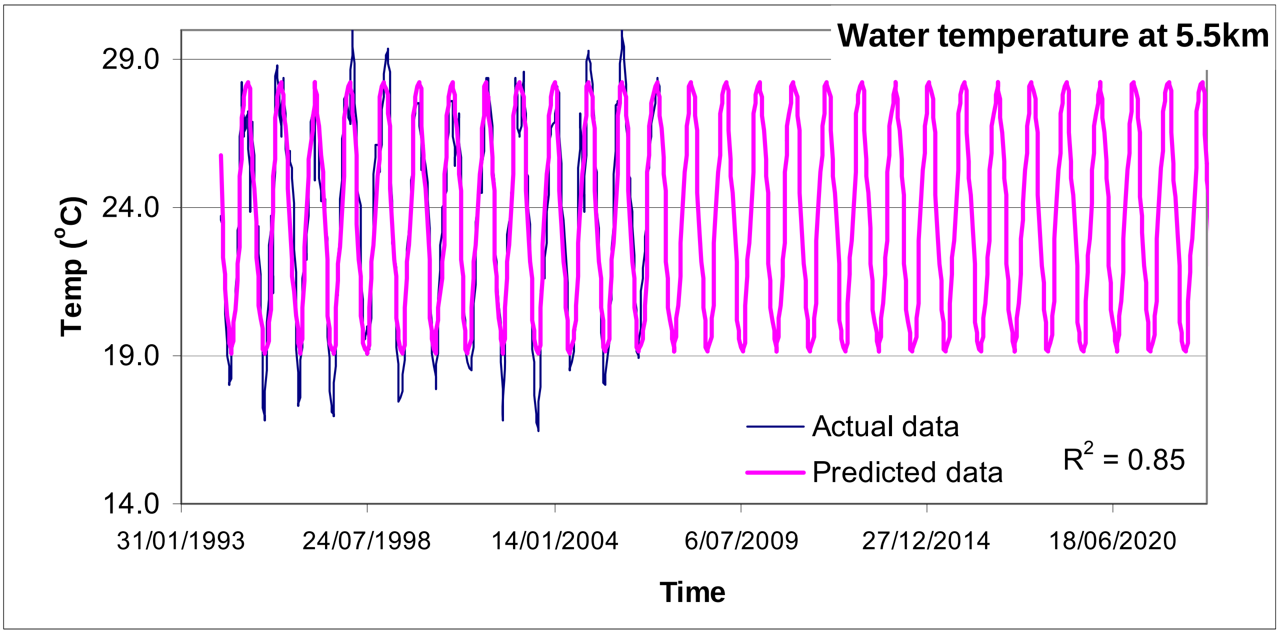

Light penetration at 19.2km
R^2 = 0.31
Actual data
Predicted data
Secchi Depth (m)
4.0
3.0
2.0
1.0
0.0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time

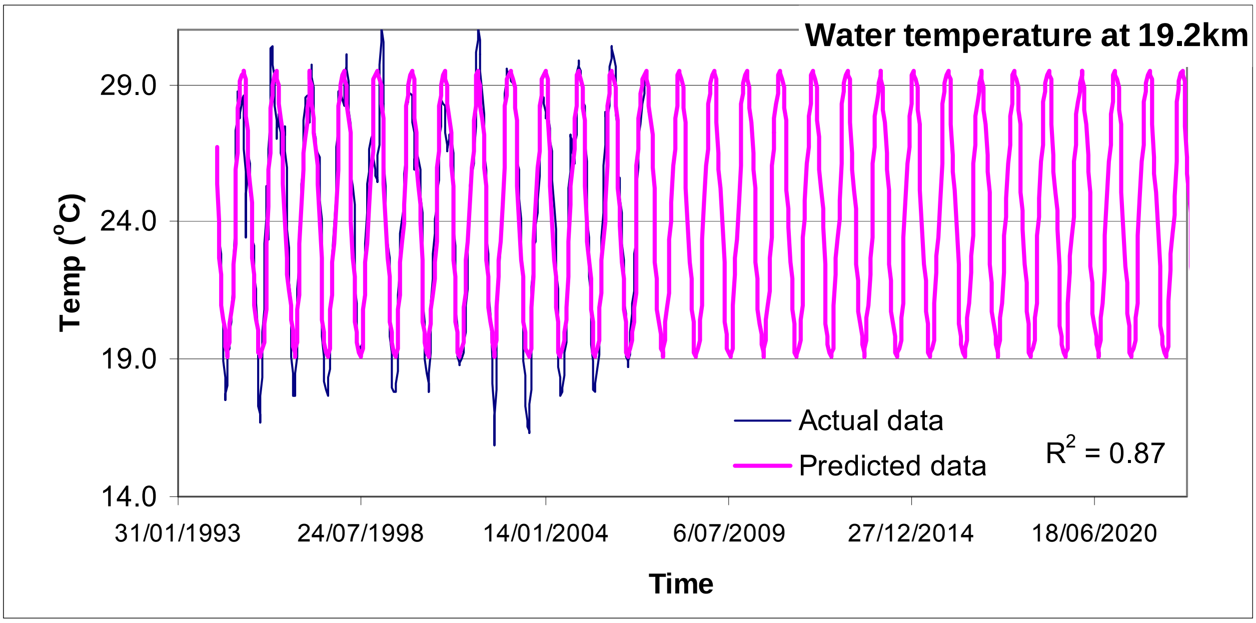

Light penetration at 23.4km
R^2 = 0.22
Actual data
Predicted data
Secchi Depth (m)
4.0
3.0
2.0
1.0
0.0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time

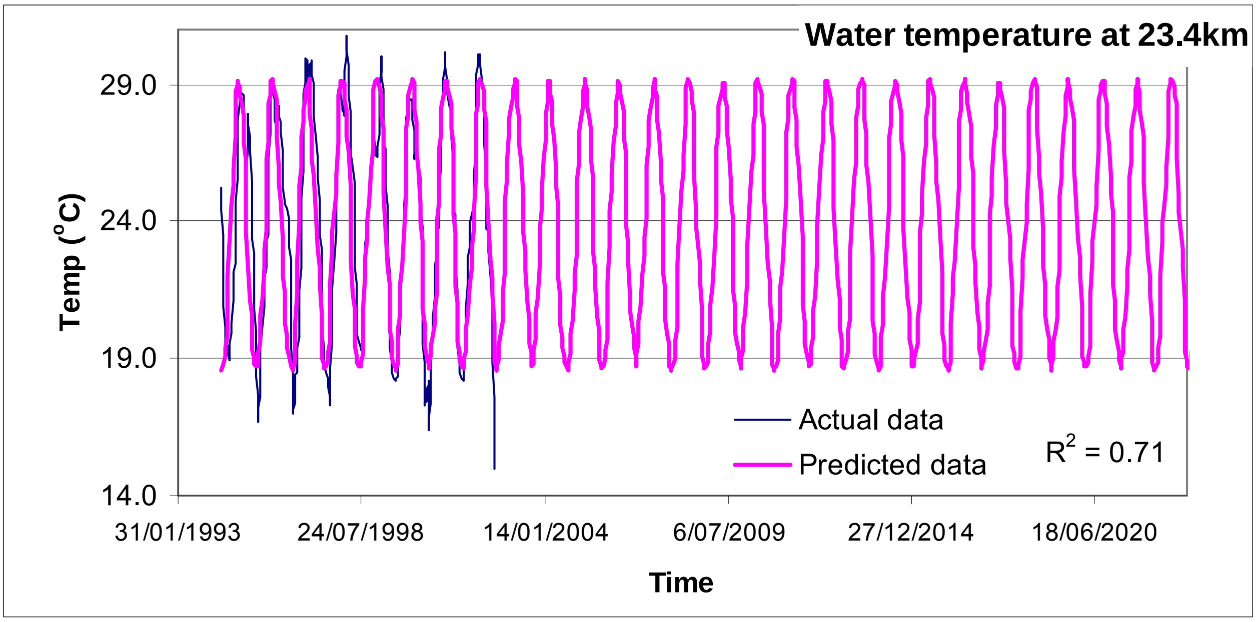
3.3.2.5 Temperature

Temperature is strongly seasonable and predictable (70-90% is predicted by the model). The seasonal temperature range is slightly larger in the downstream part of the estuary.






Water temperature at 19.2km
Temp (oC)
29.0
24.0
19.0
14.0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time
Actual data
Predicted data
R2 = 0.87


Water temperature at 23.4km
Temp (oC)
29.0
24.0
19.0
14.0
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
Time
Actual data
Predicted data
R2 = 0.71

3.4 WHAT'S HAPPENING IN THE CATCHMENT REGARDING DETERIORATING WATER QUALITY

3.4.1 Water Quality

Water quality monitoring and modelling results indicate areas of concern regarding water quality in the catchment.

Modelling of pH indicated that it is decreasing in the freshwater reaches. The pH trends at the site 19.2km upstream from the confluence of the Gregory River indicate a lowering pH. Section 2.5 (Geology and Soils) identified potential for acid sulphate soils to occur in the catchment, with evidence of this found at the dump site for material excavated during the original Lenthall Dam construction (located adjacent to the dam wall).

Seepage water from the construction area and the dump site has the capacity to effect river water downstream of the drainage path, although dilution factors are expected to keep changes to 0.2 of a pH unit. Further investigation is required to determine the cause of lowering pH at the 19.2km sample site as well as a broadening of water quality modelling to investigates trends in the upper freshwater zones.

Secchi disc readings indicate that visibility is low in the middle estuary (<1m) compared with sample sites up and downstream. Catchment surface soils identified in section 2.5 have potential for erosion. Catchment landuse including grazing lands and urban development along the Burrum River downstream of Howard may be the cause of low visibility at this point. Clearing of riparian vegetation and development in riparian areas that leads to erosion of the river bank is likely to be a major reason for turbidity in this zone. Storm water is also likely to be a source of sediment supply and turbidity (Sources roads, Howard, Torbanlea to Burrum Heads Townships, peri urban development adjacent to the Burrum). Further investigation is required to determine the reason for poor visibility at this location.

The suspended sediment loads for Australian rivers are supply limited[15], i.e. rivers have a high capacity to transport suspended sediment, so that sediment yields are limited by the amount of sediment delivered to streams not the discharge of the river itself. Thus if sediment delivery increases sediment yield increases proportionally. In contrast, the presence of impoundments, which change natural flow regimes, significantly impacts the transport and yield of suspended sediment.

Deposition of suspended sediment usually becomes significant when flows extend out onto floodplains or enter reservoirs, both dramatically reducing the velocity of flow. The amount of deposition on a floodplain depends on residence time of water and the sediment concentration of flood flows. Some rivers have narrow floodplains with deep, fast over-bank flows, providing short residence times of water and little opportunity for deposition. Others have broad open flood plains on which water can sit for several weeks, providing adequate opportunity for deposition.

Sediment deposition in reservoirs is a function of an empirical rule based on the mean annual inflow into the reservoir and its total storage capacity[16].

[15] Olive and Walker, 1982; Williams, 1989
[16] Heinemann, 1981

The major reason to model sediment budgets in catchments is to determine the parts of the landscape which are producing sediment which impact on coastal ecosystems. If these sediments are negatively affecting these ecosystems, it is important to be able to implement management strategies to reduce these impacts. To be able to do this it is important to understand the spatial distribution of these source areas. Not all sediment which is generated within a catchment makes it to the coast. Depending upon the characteristics of the catchment there is opportunity for deposition within the catchment and remobilisation over time.

3.4.2 Riparian Areas

Further investigations are required to assess the quality of riparian vegetation in the Burrum catchment. The resulting maps of the Queensland Wetland Programme could be used as a starting point to identify the extent, corridor widths, and connectivity of riparian vegetation in the cathcment.

Fine suspended sediment in the river is well above pre-European levels (Section 4.1) indicating the increased transport of sediment from landuse activities within the catchment. Riparian areas act to trap and filter sediment and prevent its flow into the river.

3.5 FUTURE WATER QUALITY MONITORING

This chapter has demonstrated that water quality monitoring data is limited to areas of the Burrum catchment that are operated for water supply infrastructure or in the estuarine section as part of routine EPA monitoring. Further monitoring and analysis is required in the Gregory and Isis rivers.

The Mary River Catchment Coordination Committee (MRCCC) was contracted in March 2005 by the BMRG's, to develop recommendations for water quality monitoring in the Burrum River Catchment as a priority action of BMRG's NRM plan.

Priority Action Plan (PAP) 2.1 was initiated to:

- identify and describe the scope of water quality monitoring that is currently occurring within the study area;
- assess available information on physical processes and habitat condition in the Burrum River Catchment, to assist with prioritisation of water quality monitoring;
- develop a framework to aid in prioritising areas within the study area, where water quality monitoring is needed;
- make recommendations on a suitable holistic Water Quality Monitoring Program, within the study area.

This work made recommendations in ***Country to Coast – a healthy sustainable future*** Volume 5F – Priority Action Plan 2.1 Water Quality Theme Final Reports, JULY 2005 Draft 1.0. This work has been largely incorporated into this WQIP.

3.5.1 Recommendations Burrum River Catchment water quality monitoring

A multi-tiered water quality monitoring program is recommended for the Burrum River catchment. Programs will be complementary to building and enhancing scientific knowledge and nurturing, recognising and giving status to community participants e.g. Friends of the Burrum River system and other waterwatch participants.

Recommended water quality monitoring programs are:

- Water Quality Report Card Program, which includes ambient routine regular monitoring program conducted by Queensland EPA and WBWC;
- Event Monitoring Program;
- Recreational Health Monitoring Program;
- Waterwatch Program.

3.5.2 Water quality “Report Card” program

- A high-level assessment of 6 freshwater and 5 estuarine sites in the Burrum River Catchment study area for physico-chemical, biological and habitat assessment
- Including potential partners: Community (Friends of Burrum River System), Hervey Bay City Council, WBWC, EPA, DPI & F, DNRW, BMRG

The Water Quality Report Card will focus on assessing the ecosystem response to natural and human impacts and the state of riparian vegetation. The monitoring program includes several indicators of waterway health, including biological indicators and should aim to monitor in areas where there are currently gaps.

The aims of the Water Quality Report Card Program are:

1. Compare waterway health within the 4 zones proposed, to identify waterway health and trends
2. Identify causes of waterway health and trends
3. Provide information on aquatic ecosystem health on a catchment scale, to landowners, councils and the community
4. Link with existing water quality monitoring programs within the study area
5. Provide links for improved communication between community and statutory bodies
6. Provide advice and support for agency and local government projects and priorities, i.e. Mary Basin Water Resource Plan, stormwater management plans.
7. Contribute to the establishment and assessment of ‘end-of-catchment targets’, as identified in the Burnett Mary Regional Group’s Country to Coast NRM Plan.

The Water Quality Report Card Program will be split into two programs:

Freshwater Program - freshwater Waterway Health indicators recommended for assessment include:

- Fish (Native Species Richness, Native Fish Assemblage [O/E], % alien individuals)
- Nutrients (Algal Bioassay, Delta N15 analysis, TN, TP, NO_x, NH_3)
- Eco-processes (Gross Primary Production, Respiration, Delta C13 analysis)
- Physico-chemical analysis (Temperature, pH, Dissolved Oxygen, Conductivity, Turbidity / Total Suspended Solids)
- Invertebrates (Invertebrate richness, PET richness, SIGNAL score)

Riparian Zone indicators recommended for assessment of freshwater ecosystems include:

- Physical Form (Geomorphic attributes)
- Streamside Zone (Shade, erosion)

Estuarine Program - Estuarine & Coastal Waterway Health indicators recommended for assessment include:

- Total Phosphorus
- Turbidity
- Chlorophyll-a
- Dissolved Oxygen
- Total Nitrogen
- Sewage Plume Mapping (Algae Delta15N)
- Seagrass Depth Range
- Lyngbya Majuscula Monitoring (may need to be monitored in the future)
- Spatial Interpolation of Water Quality

It is recommended that the Water Quality Report Card Program be undertaken on a six monthly basis for freshwater zones, and on a monthly basis for the estuarine zones. After detailed analysis of the information collected, a water quality report card could be published, on an annual basis, to show changes to the health of the aquatic environments sampled over time. The Water Quality Report Card Program is a medium term objective requiring a set-up stage.

MRCCC 2005 used a decision matrix based on the analysis of conservation values and anthropogenic threats from various data sources in the Burrum River Catchment. Factors for calculating these values and threats included:

- Water Quality – Compliance with Draft EPA Water Quality Objective, 2005
- Compliance
- Mary Basin Water Resource Plan – Technical Advisory Panel for Burrum River[17]
- State of the Rivers Reporting[18]
- High Environmental Value (HEV) areas[19]
- Rare or significant aquatic fauna
- Endangered species[20]
- Significant sediment inputs[18]
- Point-source impacts (sewage treatment plants, septic and stormwater impacts)
- Risk from future development – Hervey Bay City Council Planning
- Landuse Considerations[21]
- Fluvial geomorphology

[17] DNRM, 2003
[18] Johnson, 1996
[19] EPA, 2006
[20] WildNet Fauna Data
[21] Landuse Mapping, Shane Pointon & Karen Newbold, DNR 1998

From the outcomes of the MRCCC prioritisation framework, five Priority One estuarine sites and six freshwater sites (three Priority One and three Priority Two) were recommended for the Burrum River Report Card Monitoring Program. This is agreed.

Reference sites for monitoring will need to be determined however the monitoring programs run by both EPA and WBWC offer a starting point for sites throughout the Burrum River and Estuary. Additional sites will need to be identified in the Gregory and Isis Rivers.

A partner would need to be identified, to develop local water quality objectives and to analyse and assess the water quality information and data collected. A partner would also need to be identified, to develop the report card assessment methodology.

3.5.3 Burrum River event monitoring program

- Event monitoring occurs at several sites within the Burrum River Catchment Study area and monitors sediment and nutrient inputs being delivered into the Burrum River Estuary and the Burrum Heads Seagrass flats.
- Potential partners: Community Waterwatch (Friends of Burrum River System), WBWC, EPA, DNRW

The event monitoring will establish baseline information regarding the sediment and nutrient supply and transportation in the Burrum River catchment, and ultimately enable the identification of sediment and nutrient sources. Ideally the data would be used to inform a model of sediment and nutrient sources and transport in the Burrum River Catchment, e.g. SedNet and ANNEX models.

An analysis of the type and location of event monitoring will need to be determined. Lenthall Dam or Burrum Weir #1 offers the best opportunity to not only collect samples but also determine discharge volumes however these sites are a considerable distance from the Burrum estuary.

Event samples have recently been collected at these locations by the Water Quality Alliance and FBRSG. The outcome of this work should be investigated to determine the feasibility of an event monitoring program, its cost/benefit for the Burrum catchment (a relatively well vegetated catchment), and the alternative option of installing and maintaining an autosampler.

3.5.4 Recreational health monitoring program

- This includes bacteriological monitoring of 7 sites within the Burrum River Catchment study area

Potential partners: WBWC, Fraser Coast Regional Council Bundaberg Regional Council, Community (Friends of Burrum River System), EPA

A Recreational Water Quality Health Monitoring Program should be initiated in publicly accessible swimming areas, such as popular river recreation areas, or beaches of the Burrum River. Beaches and swimming holes in urban areas are receiving areas for stormwater inputs. Stormwater can contain high levels of nutrients, chemicals, heavy metals and other harmful substances, such as pathogens.

In SEQ, various councils and agencies have coordinated water quality monitoring in popular recreational sites from Redcliffe to Noosa Heads, since 1994. The on-going aim of the program is to assess the suitability of popular beaches and river locations, for recreational activities such as swimming.

The locations monitored are popular places for both ‘primary’ contact and ‘secondary’ contact recreation. Harmful pathogens, including various bacteria and viruses, are generally difficult to detect or monitor. Therefore counts of faecal coliform bacteria are often used to assess microbiological water quality.

Sampling duration generally corresponds to the beginning, middle and end of the popular swimming season (October-December; January-April). Bacteriological samples should be collected each week at all sites, for six consecutive weeks in the first two periods, and for five consecutive weeks in the third. Rainfall data is required for at least 72 hours before each sampling date.

The outcome of a Recreational Health Monitoring Program is to identify sites where consistent contamination or isolated high contamination events are measured. Major primary contact sites for recreational activities, i.e. swimming sites used by humans for recreational purposes, and are located in or near urban areas.

It is recommended that a large sweep of sites are sampled initially to determine faecal coliform levels, and then prioritise monitoring for sites showing high levels of faecal coliform. An interim list of high priority sites for monitoring is based on current levels of primary contact at each site. Seven sites were identified by MRCCC 2005 in the Burrum River catchment as follows: Wongi Waterholes; Lenthall Dam; Howard; Pacific Haven; Buxton; Walkers Point and Burrum Heads.

In south-east Queensland the EPA has collaborated with local government authorities to establish recreational health monitoring. A similar partnership should be established in the Burrum River Catchment.

3.5.4.1 Community water quality monitoring (Waterwatch)

A Waterwatch Program can be an essential component of the Water Quality Report Card Program and would build on the work being done by FBRSG as part of the Water Quality Alliance.

Waterwatch has the capacity to build linkages between the scientific community, government regulators and the general community, thus creating better understanding and appreciation of the complexity of issues faced by current waterway management. Waterwatch can give early warnings of potential problems.

FBRSG currently undertake ambient water quality monitoring in the Burrum estuary and it is recommended that any further initiation of Waterwatch sites be aligned with the proposed Water Quality Report Card sites. This will allow physio-chemical data to begin to be compiled by these sites and will give the community a chance to be involved and take ownership of a Water Quality Report Card Program.

Within the Burrum River Catchment, there are several options available to implement a School-based Water Quality Education Program. Favourable consultation with Howard and Torbanlea State Schools has occurred in the past regarding such a program.

Waterwatch should include water related activities, not simply sampling water. Some of theses activities include:

- Frogwatch
- Water weeds survey
- Macroinvertebrates for freshwaters (water bug surveys)
- Short term projects such as riparian **replanting** and bank **stabilisation**
- Catchment crawls

Each catchment or drainage basin, should have its own interactive website, which lists data collected, interprets this data if appropriate, allows entry and processing of newly collected water quality monitoring data and provides a forum for communication, education and advancement of water quality management and improvement within the catchment and other NRM issues, if appropriate.

4.0 CHAPTER 4:
CURRENT POLLUTION SOURCE / MANAGEMENT ISSUES

4.1 CURRENT POLLUTANT SOURCES

A pollutant that enters a waterway does so either through direct discharge from a point source or indirectly as a diffuse source pollutant. Point source discharges include wastewater treatment plant or refinery discharge pipes, while diffuse source pollution occur via runoff or seepage.

Pollutant load information for the Burrum Catchment is limited. The Burrum catchment is located in a regional area with only a few major centres having centralised wastewater treatment. There are no licensed point source discharges that release directly into rivers of the Burrum catchment.

Diffuse source pollutants are the main sources of pollutants entering the Burrum catchment. Dissolved nutrients from poorly managed septic systems and home treatment systems can leach from the evaporation trenches or irrigation sites through the regions sandy surface soils and into ground and surface water, particularly during high rainfall periods. While horticulture in the Gregory and Isis river catchments, and grazing throughout the Burrum catchment are likely sources of dissolved and particulate nutrients, pesticides, and sediment.

4.1.1 Current Pollutant Estimates

Pollutant loads for the Burrum and Gregory rivers was modelled as part of the Ozestuaries modelling program. Table 4.1 summarises these findings by comparing current and natural nutrient yields for the Burrum and Gregory Rivers, further research is required to determine the sediment and nutrient yields from the Cherwell and Isis rivers.

Table 4.1: Ozestuaries Nutrient Yields (Geoscience Australia, 2008)

Description	BURRUM RIVER		GREGORY RIVER	
	Current Modelled Yields (tonne/yr)	Natural (Pre-European) Yield (tonne/yr)	Current Modelled Yields (tonne/yr)	Natural (Pre-European) Yield (tonne/yr)
Fine Suspended Sediment	11300	400	19100	1000
Dissolved Phosphorous	3.80	3.70	1.10	0.90
Fine Sediment Phosphorous	9.00	0.30	13.00	0.50
Dissolved Nitrogen	75.42	68.60	13.43	13.00
Fine Sediment Nitrogen	37.60	1.90	34.40	1.80

© Commonwealth of Australia (Geoscience Australia) 2005

Nutrient yields detailed in Table 4.1 indicate significantly higher current yields of suspended sediment, fine sediment phosphorous and fine sediment nitrogen than pre European times.

4.1.2 Land Use

The major land uses in the Burrum catchment include:

- **Grazing**
- **Forestry**
- **Agriculture**
- **Residential**

Figure 4.1 provides a breakdown of Burrum catchment major land use.

Figure 4.1: Burrum Catchment Landuse Breakdown

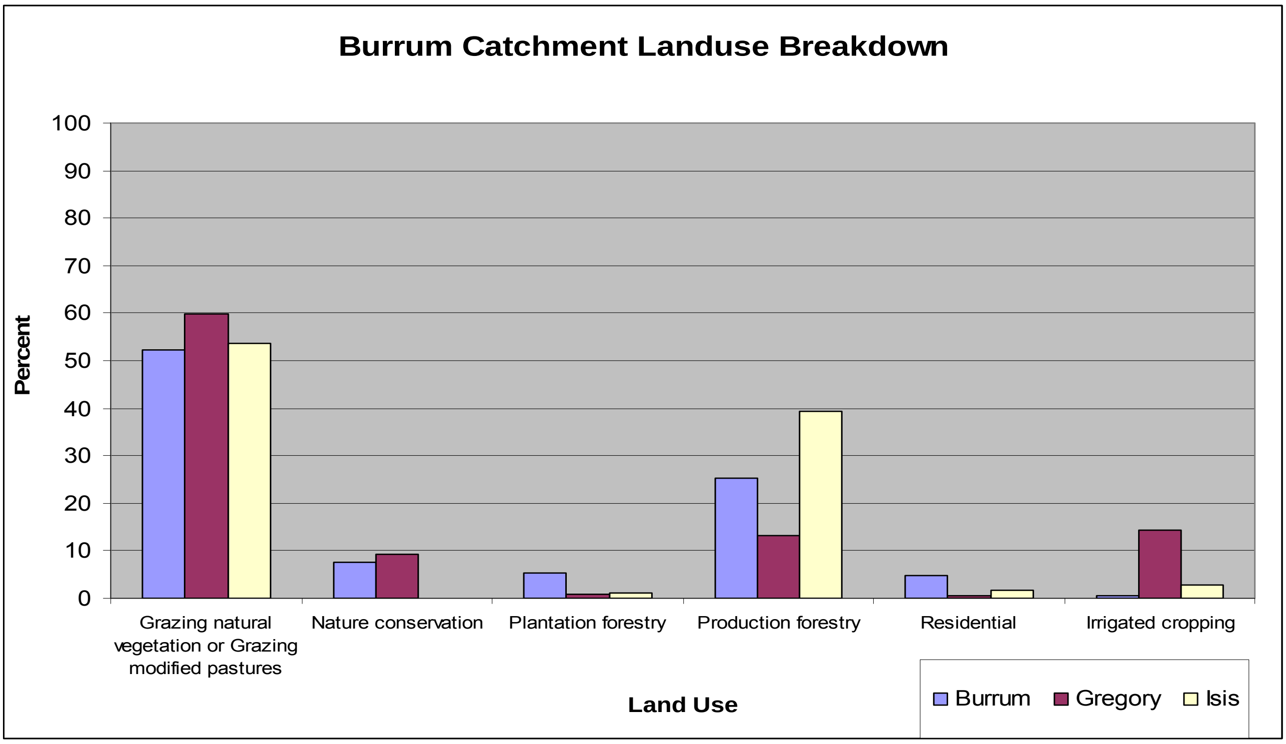
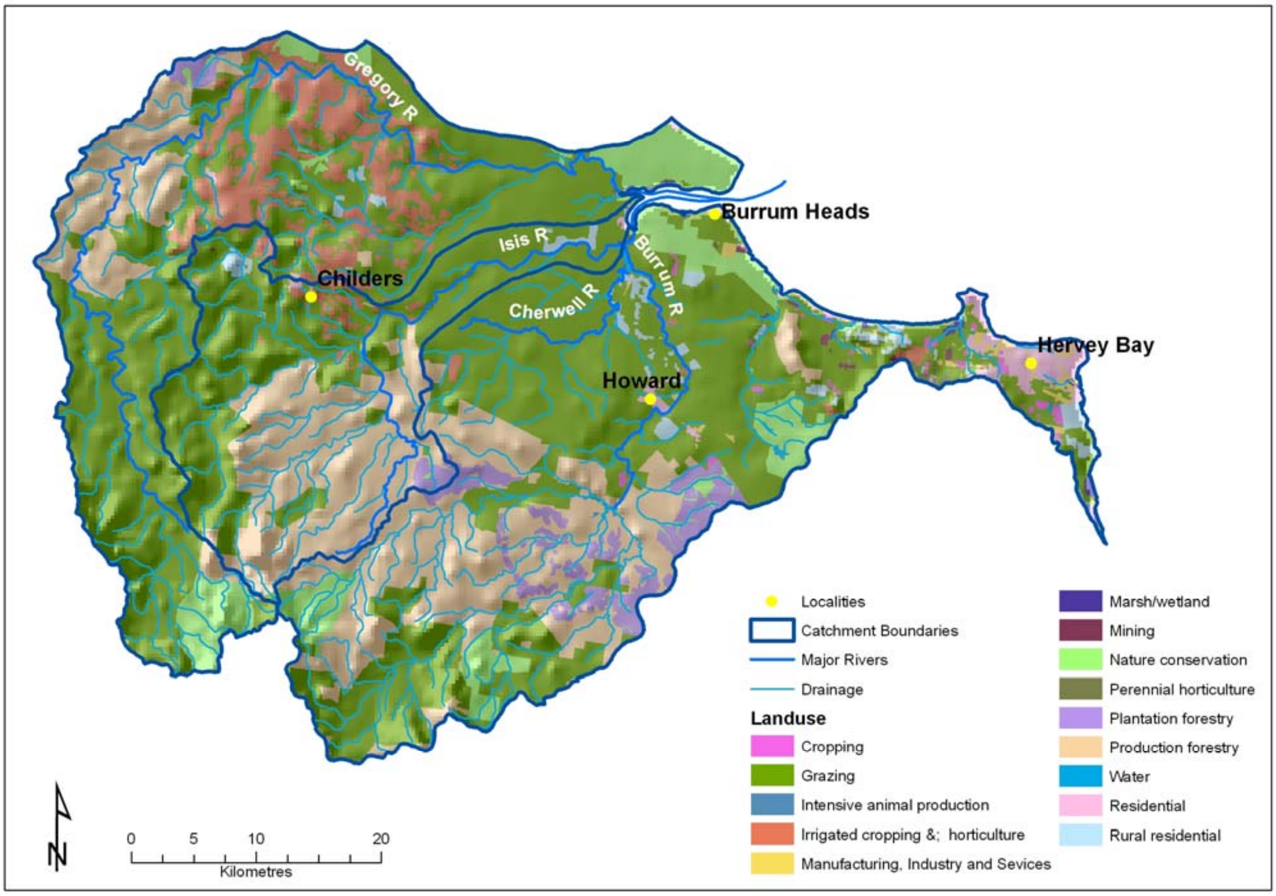


Figure 4.2 produced by BMRG provide a spatial breakdown of catchment landuse. The predominant landuse in the headwater section of the Burrum River Catchment, upstream of Lenthall Dam is production forestry with minor plantation forestry (including pine), nature conservation, and grazing. Downstream of Lenthall Dam the predominant land use is grazing, with minor rural residential, irrigated cropping, and urban development. The Cherwell River has similar landuse characteristics as the Burrum River, while the headwaters of the Isis and Gregory Rivers include both production forestry and irrigated cropping and horticulture, and the lower reaches are used mainly for grazing.

Figure 4.2: Land uses in the Burrum River Catchment and Hervey Bay



The contribution of sediment and nutrients estimated in the Ozestuaries short term modelling project does not link to the source of the pollutant. An earlier study conducted by Brodie *et al.* (2003) modelled the land use sediment and nutrient delivery to the Great Barrier Reef lagoon (Table 4.2). For the Burrum catchment grazing delivers a high proportion of the total sediment and particulate nutrients exported from the catchment, while sugar cane and forestry also contribute nutrients to the estuary.

Table 4.2: Sediment and Nutrient delivery for the Burrum Catchment (Brodie *et al,* 2003)

Burrum	Forest	Grazing	Sugar cane	Other crops	Other	Total	Export
Area (%)	36	51	10	1	2		
Total Suspended Sediment (kt/y)	15	51	14	1	1	82	82
DissInorganicN (t/y)	44	81	30	2	3	161	161
DissOrganicN (t/y)	44	74	15	1	2	136	127
PartN (t/y)	86	222	43	2	4	357	234
TotalN (t/y)	174	377	88	5	9	654	522
DissOrganicP (t/y)	3	4	1	0	0	8	8
FiterableReactiveP (t/y)	6	13	2	0	0	21	4
PartP (t/y)	16	49	10	1	1	77	62
TotalP (t/y)	25	66	13	1	1	106	74

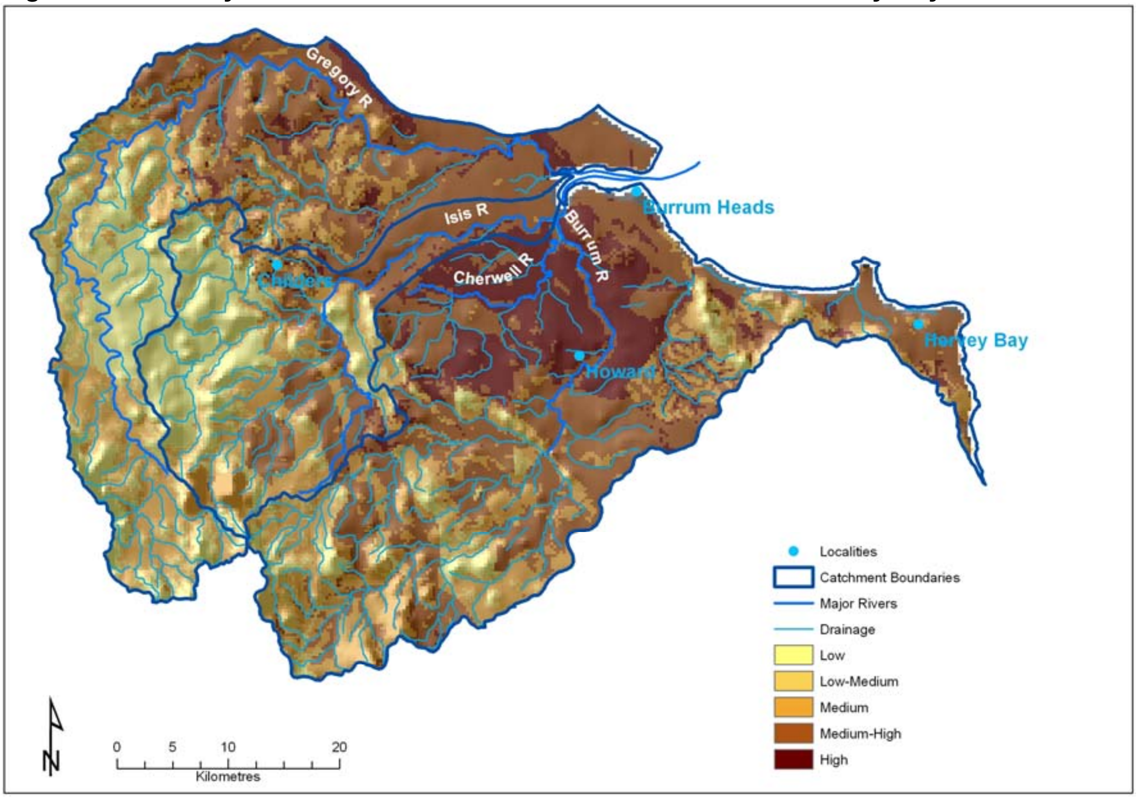
4.1.3 Salinity Hazard

Land deforested in the Burrum catchment for grazing or other purposes could create a salinity hazard. Water tables that were formerly balanced by evapo-transpiration from deep rooted trees subsequently rise. As the water table rises dissolved salts are also brought to the surface. Ground water is subsequently evaporated from the topsoil leaving behind the salts that cause dry land salinity.

Catena landscapes, where gradational soil profiles have developed down hill-slopes, can also contribute to salinity outbreaks because down-slope movement of groundwater results in seeps on lower hill-slopes and into drainages. Excessive irrigation on catena slopes that contributes to down-slope movement of groundwater can therefore contribute to salinity.

The areas with the highest risk of causing a salinity hazard in the Burrum catchment were mapped by BMRG and are detailed in Figure 4.3.

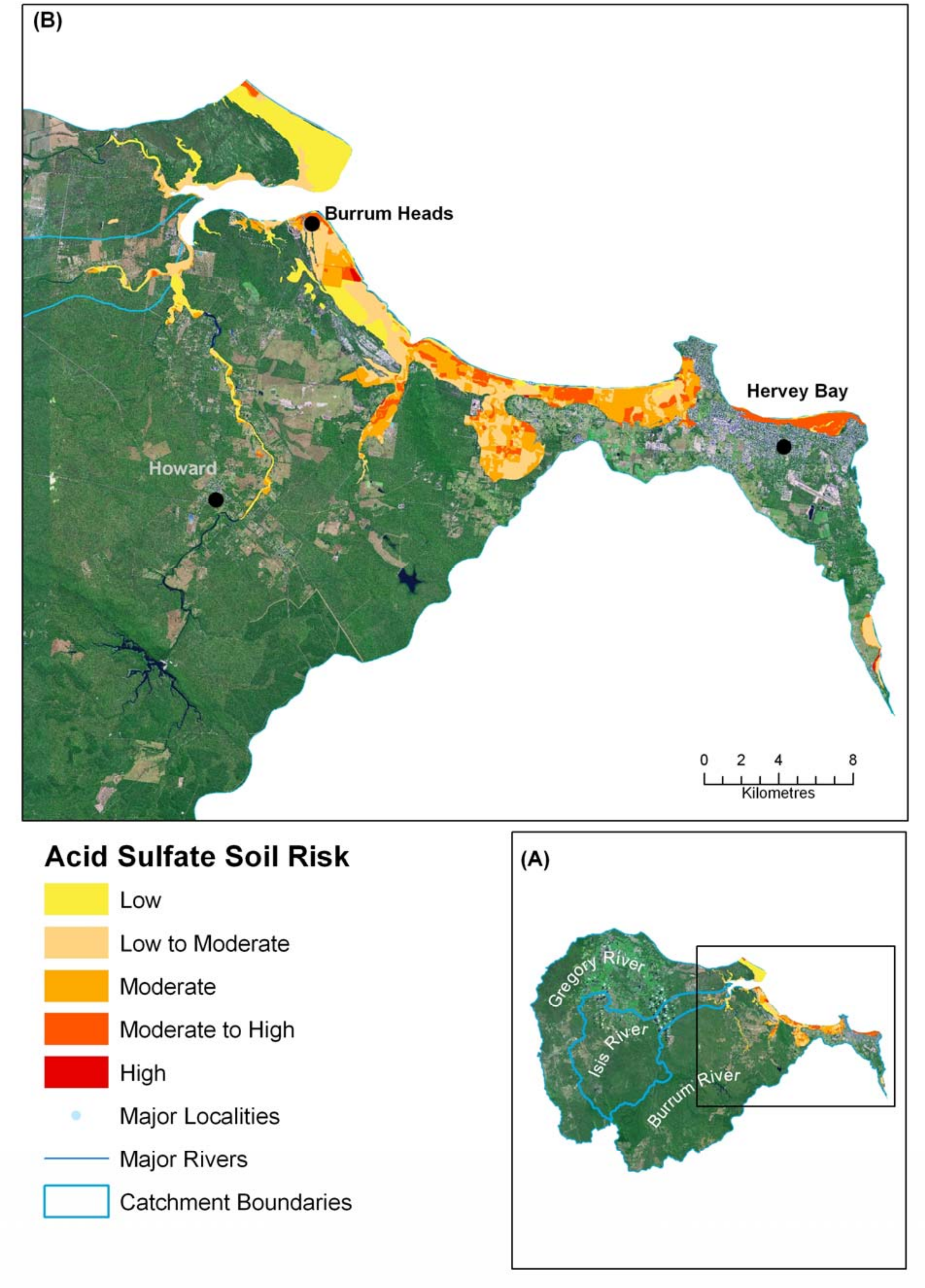
Figure 4.3: Salinity Hazard in the Burrum River Catchment and Hervey Bay



4.1.4 Acid Sulphate Soils

Given the coastal location of the Burrum catchment there are significant areas below 5m above sea level and therefore risk sites for ASS. Figure 4.4 details the location and risk of ASS in the Burrum catchment. Figure 4 was produced by BMRG using NRW data layers for digital elevation, geology, land tenure, vegetation cover and mean high water spring. These layers provided the criteria from which the risk map was produced.

Figure 4.4: Acid Sulfate Soil Risk



4.1.5 Sediment Delivery to Rivers

Landscape erosion from gullying, hillslope erosion, and riverbank erosion contributes sediment to the Burrum River, which is then deposited in reservoirs, floodplains, the estuary, or the coastal zone.

Table 4.3 provides a breakdown of the sediment budgets of the Burrum Catchment. This table demonstrates that ¾ of sediment is coming from hill slope erosion with the remainder an even mix of both gully and bank erosion.

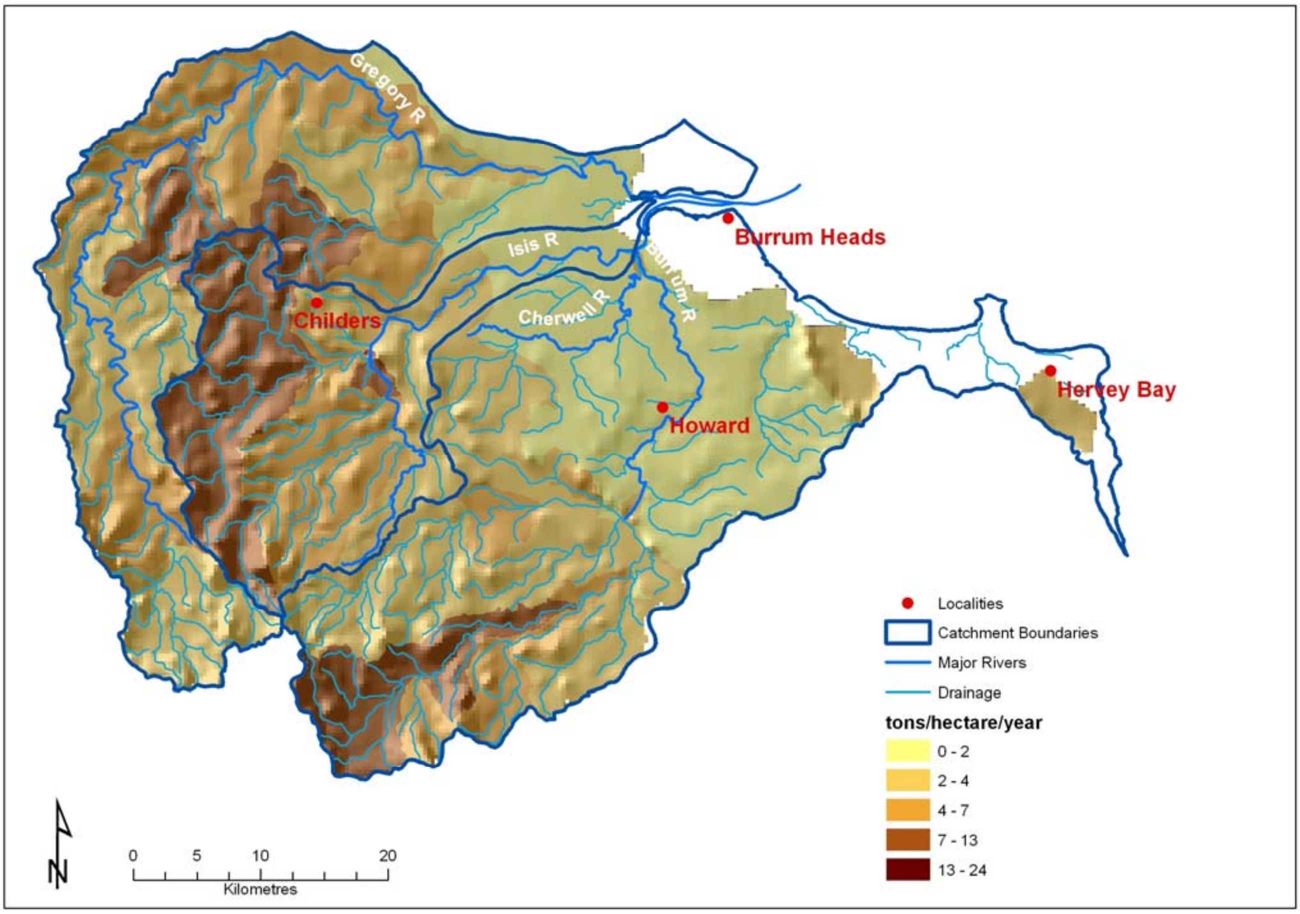
Table 4.3: Sediment Modelling – Burrum Catchment (Fentie *et al,* 2006)

Short Term Modelling – Burrum		
Inputs	**Measure**	
	Kt/yr	**%**
Gully	17	12
Bank	17	12
Hill slope	104	76
TOTAL	**138**	**100**
Outputs	**Kt/yr**	**%**
Deposition (Suspended load)		
Dam	19	14
Floodplain	8	6
Deposition (Bed load)		
Dam	2	1
Channel	0	0
Export		
Suspended	15	11
Bed load	94	68
TOTAL	**138**	**100**

SedNET modelling[22] identified parts of the Burrum catchment where the potential for long-term delivery of sediment to the river is greatest. Figure 4.5, produced by BMRG, provide a spatial analysis of sediment delivery for the Burrum catchment. The Doongul Creek system in the Burrum headwaters and the upper reaches of the Gregory and Isis Rivers, where agricultural development is dominant, has the greatest potential for sediment delivery to the Burrum River (refer Figure 4.2 & Figure 4.5). Care needs to be taken when considering the outcome of SedNET modelling, particularly related to gully inputs where assessment techniques require validation.

[22] Fentie *et al.,* 2006

Figure 4.5: Modelled delivery of sediment into the Burrum River Catchment and Hervey Bay



4.2 MANAGEMENT ISSUES

4.2.1 Point Source Pollution

4.2.1.1 Sewage Effluent

Sewage discharge to the coast contributes significant amounts of nitrogen and phosphorous to the marine environment. There are no major point source discharges into the Burrum River, however home septic systems within the catchment are a diffuse source pollutant concern. Water quality data analysed in this report indicate that fine sediment phosphorous yields from the catchment are at levels significantly higher than pre-European settlement. Further research needs to be conducted to identify the nutrient yields from the Isis and Cherwell Rivers.

Septic systems require routine maintenance and pump out to ensure they are operating effectively. To mitigate the risk of septic systems it is proposed that a database and pump out schedule be developed to ensure the ongoing maintenance of septic tanks. Additionally, information programs should be provided to households in the catchment to promote the importance of routine maintenance and maintaining septic health.

4.2.1.2 Aquaculture

Further investigations are required to determine the impact of aquaculture discharges within the catchment. Small scale aquaculture is present throughout the catchment while larger scale facilities are present in the northern catchment along the Gregory and Isis Rivers. Aquaculture is regulated as an Environmentally Relevant Action under the Environmental Protection Act (1994). Effluent discharges are regulated under an environmental licence, while best management practices and codes of practice are available including the Operational Policy for Marine Prawn Aquaculture.

4.2.2 Diffuse Source Pollution

4.2.2.1 Agriculture

The Productivity Commission (2003) suggest that diffuse sources, particularly cattle grazing and intensive agriculture (crop production), are the most significant contributors to pollutant discharges into the marine environment. In addition, natural runoff is an important source of sediment.

A number of peak Industry bodies have developed Best Management Practice (BMP) Codes of Practice (CoP), and Property Management Planning (PMP) guidelines for their members. It should be noted that some of these are still in development – for example a BMP for the use of herbicides in cane is expected to be completed by 2010. Whilst these guidelines are not particularly binding on members, they do provide a standard for practitioners of particular industries and usually form the best basis for adherence to legislative requirements, (e.g. *Codes of Practice accredited under the Environment Protection Act 1994*) and can be used as support for a defence of due diligence by an industry practitioner.

For a given industry, many possible management practices can contribute to pollutant discharges to water. There are also a range of management practices that mitigate pollutant discharges. The mix of practices actually used varies considerably between different land managers and landscape contexts. Many primary producers have demonstrated that it is both possible and viable to adopt and/or adapt practices leading to improvement in water quality in coastal rivers, streams and estuaries.

It is misleading to stereotype any industry, as uniformly adopting an approach that is good or bad. Rather, it is more useful to view each industry as having a distribution of managers, some of whom are very successful in minimising water quality impacts; others whose management skills are mixed; and a number whose practices might cause a disproportionately large share of pollutant discharges to water.

Efforts to reduce the quantity of diffuse and point source pollution through the adoption of BMPs is consistent with BMRGs RCTs WR1.2.

The catchments dominant industries (grazing, horticulture, and coastal sugar cane) generate large amounts of money for both the State and Regional economies however they also contribute large amounts of sediment, nutrients and pesticides to the states coast. Addressing this problem has become a priority of the Reef Plan.

Through the Reef Plan nutrient management zones are defined as a way to spatially identify and prioritise extension services, property management planning and natural resource management funding to improve the environmental performance of these important industries.

The Burrum catchment falls into Burnett Coastal Nutrient Management Zone, with this zone declared under the Reef Water Quality Protection Plan as a moderate risk zone. The appendices of the Reef Water Quality Protection Plan Nutrient Management Zones discussion paper defines each contributing industry and the types of initiatives they have in place to manage these pollutants. Industries that are present in the Burrum catchment and their associated strategies are detailed below.

4.2.2.2 Horticulture Industry

Horticulture is common in the southern Great Barrier Reef catchments including the Burrum and Mary. The Wide Bay region, including parts of the Burnett, Biggenden, Hervey Bay, Isis, Kolan and Maryborough have a horticulture industry worth $150 million with 9200ha under production[23]. The principal commodities for the region include Tomatoes, Capsicum and Chillis, Avocados, Zucchini, Mangoes, Rockmelons, Macadamia nuts, Potatoes, Mandarins, Snow Peas, Pineapples, and Mushrooms.

Horticulture will continue to be a major industry in the region with the DPI&F, local industry, and the Department of Education and Training recently launching the Bundaberg Horticulture Workforce Development Plan, aimed at securing the workforce and growing the industry in the region.

The horticulture industry has the following initiatives aimed at sustainable farming practices:

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[23] DPI&F, 2007

National Initiatives

- Hoticulture for Tomorrow initiative which aims to improve communication with the industry and NRM management authorities, as well as develop industry guidelines and standards for environmental assurance in Australian horticulture.
- Freshcare – is a national, on farm food safety program, based on the international HACCP standard, which includes recording all fertiliser and soil application.
- EnviroVeg – began in 2001 under the direction of the peak body for the Australian vegetable industry, the Australian Vegetable and Potato Growers Federation, as a way to address community concerns about the environmental impact of vegetable production. It is a voluntary program that aims to improve environmental performance in the industry by encouraging farmers to assess their practice against industry best standards.

Queensland Initiatives

- Growcom Farm Management System Initiative – the program is building on the existing farm management systems to include additional management elements. For example in the reef catchments the additional management elements will focus on implementing management practices that limit sediment and nutrient loss. This program includes a support service to help farmers implement change.
- Farmcare Code – code of practice for sustainable fruit and vegetable production in Queensland. This code is recognised under the Environmental Protection Act (1994) and details the environmental management section of the farm management system initiative.
- AgSIP – Sustainable Agriculture State-level Investment Programs aim to improve the sustainability of farming practice throughout the State through monitoring, benchmarking and case study sites used to address natural resource management issues.

4.2.2.3 Grazing Industry

There is limited information about the impact of the grazing industry in the Burrum catchment, although it is widely believed that grazing can indirectly contribute large amounts of sediment and particulate nutrients to waterways.

Impacts of grazing include; reducing ground cover leading to erosion; grazing in riparian areas which degrades habitat; leaching of nutrients (phosphorous) from cattle licks; fertilising pasture for beef improvement.

The beef grazing industry does not have a specific code of practice at this time.

4.2.2.4 Sugarcane

Some 95% of Australia's sugar is produced in Queensland and the majority of this production occurs in the GBR catchment, including the Burrum and Mary catchments[23]. It is estimated that over 50% of Queensland cane lands are under irrigation, while at the same time sugar is recognised as the largest user of fertiliser in the GBR catchment[23]. Recent studies have estimated that 75 per cent of the nitrogen and 35–40 per cent of the phosphorus applied annually in the coastal zone of Queensland comes from sugarcane production[24].

[24] Rayment *et al.,* 1998

A number of strategies have been employed to improve on the management and environmental performance of the sugar industry, including:

- 6 Easy Steps – Nutrient Management Package providing printed material (including regional soil specific guidelines), training and case study examples of strategies cane farmers can implement to improve environmental performance. The programs steps include:
    1. Knowing and understanding soils
    2. Understanding and managing nutrient process and losses
    3. Routine soil testing
    4. Adopting soil-specific nutrient guidelines
    5. Using leaf analysis to check on the adequacy of nutrient inputs
    6. Keeping good records and modifying nutrient inputs when and where necessary.

- Sugarcane Farm Management Systems – a voluntary program allowing farmers to manage environmental impact and improve productivity through a systematic management system.
- Future Cane – is a Queensland Government initiative to secure the long term viability of the states cane industry. The program aims to improve the adoption rate of sustainable sugarcane farming practices such as rotation cropping to improve soil health and lessen the need for fertilisation.
- Code of Practice for Sustainable Cane Growing – developed by CANEGROWERS with input from other agencies as best practice guide for cane farming and covers issues including protection of riparian vegetation, creation of artificial wetlands, methods to reduce both erosion and fertiliser application, and irrigation efficiency. Audits found that 97% of cane growers surveyed, who had read the code, believed it help to minimise environmental harm from cane production[25].
- Combining Profitability and Sustainability in Sugar (COMPASS) – builds on the code of practice by establishing a workshop process for farmers to rate their farm management against best practice, and identify ways to achieve financial, social and environmental benefits. As of May 2005 just under 30% of sugarcane farmers in Queensland had participated in COMPASS workshops[23].

[25] QFF *et al.,* 2005

4.2.2.5 Forestry

Forestry is the major landuse in the southeast corner of the Burrum catchment, particularly on the Isis and upper freshwater reach of the Burrum River. Harvesting of timber could create the risk of increased diffuse source pollution and sediment runoff if the process isn't management according to best practice. Best practice management will be needed to mitigate the impact of forestry on water quality in these areas. Environmental Impact Assessments and Environmental Management Plans should be undertaken prior to any major harvesting or replanting events.

Forestry Plantations Queensland has developed a number of strategies to achieve sustainable forestry production, including:

- Sustainability Policy - Environmental, social and economic integrity is a core value of Forestry Plantations Queensland (FPQ) and essential to its future commercial success.
- FPQ is committed to sustainable forest management and supporting industry in enhanced marketing of timber products through Australian Forestry Standard (AFS) "chain of custody" certification.
- Independent Australian Forestry Standard (AFS) Certification to endorse that FPQ plantations are environmentally, socially, culturally & economically sustainable. Certification requires meeting the following criteria:

Criterion 1:
Forest management shall be undertaken in a systematic manner that addresses the range of forest values.

Criterion 2:
Forest management shall provide for public participation and foster on-going relationships to be a good neighbour.

Criterion 3:
Forest management shall protect and maintain the biological diversity of forests, including their successive stages, across the regional landscape.

Criterion 4:
Forest management shall maintain the productive capacity of forests.

Criterion 5:
Forest management shall maintain forest ecosystem health and vitality.

Criterion 6:
Forest management shall protect soil and water resources.

Criterion 7:
Forest management shall maintain forests' contribution to carbon cycles.

Criterion 8:
Forest management shall protect and maintain, for indigenous and non-indigenous people, their natural, cultural, social, recreational, religious and spiritual values.

Criterion 9:
Forest management shall maintain and enhance long-term social and economic benefits.

4.2.2.6 Stormwater

Turbidity results failed in the upper/middle Burrum estuary south of Howard (Chapter 3). Investigations, utilising local community groups such as the FBRSG, are required to determine the impact of stormwater from peri-urban development in areas including Howard and Burrum Heads.

Sediment traps and other forms of storm water control may need to be retrofitted if this is identified as the cause. The proposed event monitoring program should focus on this site to determine the impact of stormwater flow from Howard.

4.2.2.7 Riparian Areas

Further analysis is needed to identify riparian sites within the Burrum catchment that require revegetation, particularly around the lower freshwater and estuarine reaches where urban pressure along the river is increasing. The Queensland Wetland Programme may form a starting point to determine the extent, width and connectivity of riparian vegetation in the catchment.

Areas along the Burrum catchment and in the plantation and native forest are under grazing lease. Grazing cattle currently access the water in the upper and lower freshwater reaches of the Burrum River. Cattle tracks degrade riparian vegetation leading to erosion. Off-stream watering points and fencing off riparian areas may be required to remediate heavily impacted sites.

4.2.2.8 Acid Sulphate Soils

Acid sulphate soils (ASS) have been identified in the coastal areas of the Burrum catchment, as have occurrences of red spot fish disease which have been linked to ASS.

BMRG's management action WR2.1 is committed to limiting the impact of acid sulphate soils on water resources and aquatic ecosystems by 2050. ASS Management actions suggested in table 5.1 align with WR2.1.

A receiving water model for the Burrum is required for the realistic setting of end of catchment targets. The receiving waters of Hervey Bay, along with Burrum Estuary itself, are designated High Ecological Value areas and a receiving water model is needed to determine the pollutant loads exiting the catchment. Development of this receiving model will become the first priority of the management action plan. Once the model is developed, and target loads reductions established, management actions can be analysed to determine their environmental, social and economic consequences.

Once modelling is complete the management actions proposed in Table 5.1 can be discussed through consultation and prioritised based on a cost/benefit analysis. This priority action is in line with management actions WR1A-O of BMRG's NRM plan.

4.2.3 Monitoring

Water quality monitoring requires expanding in the Burrum catchment, particularly in the freshwater reaches of the Isis and Gregory rivers, while modelling of sediment inputs from the Isis and Cherwell rivers is also required. Future monitoring has been proposed in Chapter 3 and the focus will need to be on expanding monitoring to provide a more comprehensive cover of the entire catchment.

4.2.4 Management Considerations

Information Management and accessibility is important for collaborative monitoring programs. Data will need to be able to be stored and analysed effectively to determine the progress of management action implementation and the effectiveness of those actions.

BMRG currently warehouse and analyse data and their independent role as a catchment manager is important for this requirement. A program of data storage and analysis will need to be determined and a suitable partner identified.

Financial support for water quality monitoring, reporting (report card) and community involvement (Waterwatch) should centre on a 1–2c a kilolitre catchment management water quality charge, levied by local government and deposited in a catchment management water quality maintenance account. This funding source could be known as the Burrum Catchment Charge (BCC) and should be under the control of the Water Authority, BMRG, Regional Council, or other body responsible for providing water services. Similar situations exist within the Lake Baroon Catchment, presently vested with Aquagen.

4.3 PRIORITIES

Due to the limited water quality data available for the Burrum catchment priority pollutants have been determined based on the information detailed in this chapter, including land use and the sediment and nutrient findings of Brodie *et al.* (2003). Further prioritisation of actions will need to occur during the consultation stage.

Based on the findings of Brodie (2003) the priority pollutants for the Burrum catchment include:

Pollutant	Source
Suspended sediment and particulate nutrients	Grazing and urban development sites
Dissolved nutrients	Cane and horticulture, urban residential areas such as golf courses, point source discharges
Pesticides	Cane and horticulture, urban residential areas
Acid sulphate soils	Coastal cane/horticulture, urban development

5.0 CHAPTER 5: ENVIRONMENTAL VALUES AND WATER QUALITY OBJECTIVES

5.1 ENVIRONMENTAL VALUES

Environmental Values are the beneficial uses that people receive from water bodies including aquatic ecosystem function, water for drinking, water for industry and agriculture, recreation, scenic amenity, and culture heritage.

Environmental Values (EV's) are defined in ANZECC Guidelines[26] as

> ***"the particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health and that require protection from the effects of pollution, waste discharges and deposits. Several environmental values may be designated for a specific waterbody"***

EV's for a particular water body are classified based on their actual and perceived community worth. The levels of protection for each EV have associated water quality objectives that are intended to be achieved. The Australian Water Quality Guidelines (2000) establish 3 levels of aquatic ecosystem protection into which waters may fall.

Level 1 **High ecological value** (HEV) **-** unmodified or other highly valued systems

Level 2 **Slightly/moderately disturbed -** ecosystems in which aquatic biological diversity may be adversely affected to a relatively small but measurable degree by human activity

Level 3 **Highly disturbed -** measurably degraded ecosystems of lower ecological value

The process of establishing EV's and WQO's (WQO's) is set out under the EPP (Water) under the *Environmental Protection Act 1994* and reflect the National Water Quality Management Strategy (NWQMS). According to the NWQMS and the EPP (Water), **water quality** includes the broader concept of aquatic system health, not just water chemistry.

Table 5.1 details environmental values the waters that they are applicable to.

[26] ANZECC, 2000

Table 5.1: Environmental Values (EVs) and applicable waters (EPA, 2007)

Environmental Value (EV)	Applicable to Tidal Waters	Applicable to Fresh (non tidal) waters
Protection of aquatic ecosystems (aquatic ecosystem EV) Protection of aquatic ecosystems, under 3 possible levels of protection relating to the following 3 ecosystem conditions: • High ecological value waters • Slightly to moderately disturbed waters • Highly disturbed waters (suitability for seagrass has also been specifically identified for some waters as a component of this EV)	x	x
EV's other than aquatic ecosystem EV (called human use EV's)		
Suitability for human consumers of wild or stocked fish, shellfish or crustaceans (suitability for oystering has also been specifically identified for some waters)	x	x
Suitability for primary contact recreation (e.g. swimming)	x	x
Suitability for secondary contact recreation (e.g. boating)	x	x
Suitability for visual (no contact) recreation	x	x
Protection of cultural and spiritual values, including Traditional Owner values of water	x	x
Suitability for industrial use (including manufacturing plants and power generation)	x	x
Suitability for aquaculture (e.g. red claw, barramundi)	x	x
Suitability for drinking water supplies		x
Suitability for crop irrigation		x
Suitability for stock watering		x
Suitability for farm use		x

EV's and Water Quality Objectives (WQO's) were established for the waters of the Mary Basin, by the Environmental Protection Agency, under the EPP Water Subordinate Legislation 2006 No 30, in March 2006. The Mary Basin includes the freshwaters and estuaries of the Burrum Catchment.

The EV's for the Burrum Catchment are detailed in Table 5.2.

The Burrum estuary and the waters of Hervey Bay beyond the mouth of the Burrum estuary are classified as Level 1 HEV sites (HB1, BE1). In addition to the EV classification the Burrum estuary has a fish habitat area, originally declared in 1986, covering 4409ha. Although most of the reaches above the estuary are classified Level 2 (slightly to moderately disturbed) efforts need to be directed into these upstream areas in order to protect the Level 1 estuary and marine waters beyond the estuary.

Table 5.2: Environmental Values (EVs) for waters of the Burrum, Gregory, Isis and Cherwell River Catchments (EPA, 2007)

WATER	ENVIRONMENTAL VALUES [1,2,3]													
	Aquatic ecosystems	Human Consumption	Primary Recreation	Secondary Recreation	Visual Recreation	Cultural Heritage	Industrial Use	Aquaculture	Drinking Water	Irrigation	Stock Water	Farm Supply	Oystering	Seagrass
Hervey Bay – Open costal waters	✓	✓	✓	✓	✓	✓		✓						✓
Burrum River – lower estuary / enclosed coastal	✓	✓	✓	✓	✓	✓								✓
Burrum River – estuarine waters	✓	✓	✓	✓	✓	✓								✓
Burrum River – freshwater	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
Gregory River – estuarine waters	✓	✓	✓	✓	✓	✓								
Isis River – estuarine waters	✓	✓	✓	✓	✓	✓								
Cherwell River – estuarine waters	✓	✓	✓	✓	✓	✓								
Other freshwater tributaries	✓	✓	✓	✓	✓	✓				✓	✓	✓		
Wetlands, lakes and reservoirs	✓	✓	✓	✓	✓	✓								
Ground Waters	✓								✓	✓	✓	✓		

[1] ✓ indicates the EV has been selected for protection
[2] Blank means the EV was not selected for protection
[3] Refer to section 3.2 for water quality objectives applying to the EV's in this table

5.2 WATER QUALITY OBJECTIVES

WQO's are the **measurable indicators or parameters needed to protect EV's**. They can be **physical (suspended sediment), chemical (nitrogen), biological (fish)** or **condition parameters (vegetation condition).**

Table 5.3 below provides physico-chemical WQO's to support the aquatic ecosystem EV for waters in the Burrum catchment, and estuarine waters of the Gregory, Isis and Cherwell Rivers[27]. These values are sourced from Environmental Protection (Water) Policy Basin No 137 [27].

EV's have been broken down into different reaches of the system, with some objectives applying to specific areas or water types, as indicated on Table 3.3, while others apply to more than one water type. In particular, those waters of high ecological value are identified where a higher level of protection is required and more stringent WQO's apply. Other waters fall into the slightly/moderately disturbed level of protection, for which corresponding WQO's have been derived.

Table 5.3: Water Quality Objectives for Waters in the Burrum, Gregory, Isis and Cherwell Catchments (EPA, 2007)

WATER AREA (TYPE)	EV & LEVEL of PROTECTION	WATER QUALITY OBJECTIVES
Upland freshwaters (Burrum)	Aquatic ecosystem **Slightly to moderately disturbed**	• turbidity: <25 NTU • suspended solids: <6 mg/L • chlorophyll a: <2 ug/lL • total nitrogen: <250 ug/L • oxidised N: <40 ug/L • ammonia N: <10 ug/L • organic N: <200 ug/L • total phosphorus: <30 ug/L • filterable reactive phosphorus (FRP): <15ug/L • dissolved oxygen: 90-110% saturation • pH: 6.5-8.2 • secchi depth: n/a
Freshwater lakes/reservoirs **Lenthalls Dam** **Burrum Weir No 1** **Burrum Weir No 2**	Aquatic ecosystem **Slightly to moderately disturbed**	• turbidity: 1-20 NTU n/d • suspended solids: n/d • chlorophyll a: <5 ug/lL • total nitrogen: <350 ug/L • oxidised N: <10 ug/L • ammonia N: <10 ug/L • organic N: <330 ug/L • total phosphorus: <10 ug/L • filterable reactive phosphorus (FRP): <5ug/L • dissolved oxygen: 90-110% saturation • pH: 6.5-8.0 • secchi depth: n/a

[27] EPA, 2007

Lowland freshwaters Burrum catchment, tributaries of Gregory, Isis, Cherwell	Aquatic ecosystem **Slightly to moderately disturbed**	• turbidity: <50 NTU • suspended solids: <6 mg/L • chlorophyll a: <5 ug/lL • total nitrogen: <500 ug/L • oxidised N: <60 ug/L • ammonia N: <20 ug/L • organic N: <420 ug/L • total phosphorus: <50 ug/L • filterable reactive phosphorus (FRP): <20 ug/L • dissolved oxygen: 85-110% saturation • pH: 6.5-8.0 • secchi depth: n/a
Freshwaters	Aquatic ecosystem **Slightly to moderately disturbed**	Toxicants in water, sediment and biota as per AWQG (2000) Comply with code of practice for Antifouling and In-water Hull Cleaning and Maintenance, ANZECC
Freshwater riparian areas	Aquatic ecosystem **Slightly to moderately disturbed**	Protect or restore riparian areas. Refer Table 3.4 -riparian area water quality objectives
Wetlands	Aquatic ecosystem **Slightly to moderately disturbed**	Objectives as per AWQG (2000)
MARINE & ESTUARINE WATERS		
Upper estuarine waters (Burrum, Gregory, Isis, Cherwell River) reaches and other coastal creeks where upper estuary drains into lower estuary.	Aquatic ecosystem **Slightly to moderately disturbed**	• turbidity: <25 NTU • suspended solids: <25 mg/L • chlorophyll a: <8 ug/lL • total nitrogen: <450 ug/L • oxidised N: <15 ug/L • ammonia N: <30 ug/L • organic N: <400 ug/L • total phosphorus: <30 ug/L • filterable reactive phosphorus (FRP): <10 ug/L • dissolved oxygen: 80-105% saturation • pH: 7.0-8.4 • secchi depth: >0.5m

Mid estuarine reaches of the Burrum River	Aquatic ecosystem **High ecological value**	Maintain existing water quality. The 20th,50th and 80th percentiles of existing water quality for Burrum River mid estuarine waters are: • turbidity: 2-5-8 NTU • suspended solids: 20-20-20 mg/L • chlorophyll a: 0.8-1.5-2.5 ug/lL • total nitrogen: 150-240-380 ug/L • oxidised N: 2-5-15 ug/L • ammonia N: 7-15-32 ug/L • organic N: 130-210-320ug/L • total phosphorus: 10-13-16 ug/L • filterable reactive phosphorus (FRP): 2-2-2 ug/L • dissolved oxygen: 85-95-105% saturation • pH: 8.0-8.2-8.4 • secchi depth: 1.1-1.6-2.0m
Mid estuarine waters (Burrum, Gregory, Isis, Cherwell River reaches). Estuary drains into lower estuary.	Aquatic ecosystem **Slightly to moderately disturbed**	• turbidity: <8 NTU • suspended solids: <20 mg/L • chlorophyll a: <4 ug/lL • total nitrogen: <300 ug/L • oxidised N: <10 ug/L • ammonia N: <10 ug/L • organic N: <280 ug/L • total phosphorus: <25 ug/L • filterable reactive phosphorus (FRP): <6 ug/L • dissolved oxygen: 85-105% saturation • pH: 7.0-8.4 • secchi depth: >1.0m
Lower estuarine reaches Burrum River	Aquatic ecosystem **High ecological value**	The 20th,50th and 80th percentiles of existing water quality for Burrum River lower estuarine waters are: • turbidity: 1-2-4 NTU • suspended solids: 4-9-13 mg/L • chlorophyll a: 0.6-0.8-1.3 ug/lL • total nitrogen: 110-115-160 ug/L • oxidised N: 2-2-3 ug/L • ammonia N: 2-7-10 ug/L • organic N: 100-100-150ug/L • total phosphorus: 6-10-14 ug/L • filterable reactive phosphorus (FRP): 2-2-3 ug/L • dissolved oxygen: 90-95-105% saturation • pH: 8.1-8.2-8.4 • secchi depth: 1.8-2.9-4.3m
All marine and estuarine waters (within this table)	Aquatic ecosystem **High ecological value** (level 1) **Slightly to moderately disturbed** (level 2)	Toxicants in water, sediment and biota As per AWQG (2000) Release of sewage from vessels to be in accordance with requirements of *Transport Operations (Marine Pollution) Act and Regulations, 1995* Comply with code of practice for Antifouling and In-water Hull Cleaning and Maintenance, ANZECC

Marine/estuarine waters with chosen **seagrass** EV	Aquatic ecosystem **Slightly to moderately disturbed**	The minimum WQO's needed to restore seagrass to areas where it has been lost are: • median total suspended solids: <10mg/L • median secchi depth: >1.7m • light attenuation coefficient >0.9 In areas where seagrass is intact, it is important to maintain water quality. Thus WQO's are: • maintenance of local total suspended solids, turbidity, secchi and light attenuation • local seagrass distribution and composition is maintained and measured by: - extent of seagrass - species diversity - seagrass depth limit
Marine/estuarine riparian areas	Aquatic ecosystem **Slightly to moderately disturbed**	Protect or restore riparian areas. Refer Table 3.3 -riparian area water quality objectives
Tidal canals constructed Marinas and boat harbours	Aquatic ecosystem **Slightly to moderately disturbed** (level 2)	• turbidity: <8 NTU • suspended solids: <20mg/L • chlorophyll a: <4 ug/lL • total nitrogen: <300 ug/L • oxidised N: <10 ug/L • ammonia N: <10 ug/L • organic N: <280 ug/L • total phosphorus: <25 ug/L • filterable reactive phosphorus (FRP): <6ug/L • dissolved oxygen: 85-105% saturation • pH: 7.0-8.4 • secchi depth: >1.0m

5.2.1 Water Quality Objectives - Riparian areas in the Burrum, Gregory, Isis and Cherwell River Catchments

Riparian areas play an important role in the protection of aquatic environments. The riparian WQO's fall into the aquatic ecosystem EV and as with the other WQO's have been sourced from the Environmental Protection (Water) Policy Basin No 137 (part), Environmental Protection Agency March 2007 (EPA, 2007).

The WQO's for riparian zones were developed using a multi layered approach that included:

- A table of general objectives (Table 5.4) and figures of conceptual models, which paint a picture of riparian needs and the benefits based on waterway type and differing functions of riparian areas rather than the normal approach of nominating a particular width of riparian, which is usually difficult to achieve because of current land use
- A list of technical guidelines for differing aspects of riparian management

Table 5.4: Water Quality Objectives for riparian areas in the Burrum and Cherwell River Catchments (EPA, 2007)

Water type	Ecological processes	Riparian function	
		Habitat	**Bed and bank stability**
Upland Freshwater	**Perennial** (Figure 3.3.1) Maintain /restore vegetation to achieve 70% canopy shade In streams less than 10m wide this will achieve: • moderation of temperature and dissolved oxygen extremes • organic cycling of leaf litter for nutrients and energy • transformation of diffuse nitrogen inputs	**Perennial** (Figure 3.3.1) Eradicate weeds, maintain/ restore : • instream large woody debris for fish & invertebrates • native trees, shrubs, and ground cover on the banks • tree roots to provide stable under-cut banks This also assists in maintaining biodiversity	**Perennial** (Figure 3.3.1) Maintain/restore bank vegetation to minimise erosion Maintain large woody debris for channel shape and form Manage cattle access to maintain bank stability and bank vegetation
	Ephemeral (Figure 3.3.2) as above	**Ephemeral** (Figure 3.3.2) as above	**Ephemeral** (Figure3.3. 2) Maintain or restore bed & bank vegetation to minimise erosion during wet weather flows Manage cattle access to maintain/restore bank stability and bank vegetation
	Gullies Not applicable	**Gullies** Not applicable	**Gullies** Maintain low vegetation to minimise erosion during wet weather flows

Lowland freshwater	**Perennial** (Figure 3.3.3) Maintain/restore vegetation to achieve: • shade over near bank areas • some moderation of temperature and dissolved oxygen extremes • transformation of diffuse nitrogen inputs	**Perennial** (Figure 3.3.3) Eradicate weeds and maintain/restore: • in-stream woody debris for fish & invertebrates • native trees, shrubs and ground cover on the banks • tree roots to provide stable undercut banks This also assists in maintaining biodiversity	**Perennial** (Figure 3.3.3) Maintain/restore vegetation Maintain large woody debris for channel shape and form Manage cattle access to maintain/restore bank stability and bank erosion
Wallum/ tannin stained	**Perennial** Maintain/restore vegetation to achieve: • 70% canopy shade in streams less than 10m wide • Shade over near bank areas in wider streams This will achieve: • moderation of temperature and dissolved oxygen extremes • transformation of diffuse nitrogen inputs	**Perennial** Eradicate weeds and maintain/restore: • in steam debris • native trees, shrubs and ground cover on the banks This also assists in maintaining biodiversity	**Perennial** Maintain/restore bank vegetation Manage cattle access to maintain/restore bank stability and bank vegetation
Estuarine	Maintain or restore marine plants to achieve: • shade over bank areas • moderation of temperature and dissolved oxygen extremes • organic cycling of leaf litter for nutrients and energy • transformation of diffuse nitrogen inputs	Eradicate weeds and maintain/restore: • in steam debris • marine plants, trees, shrubs and ground cover on the banks	Maintain and restore bank vegetation to minimise erosion
Coastal foreshores	Maintain or restore marine plants to achieve: • shade over bank areas • moderation of temperature and dissolved oxygen extremes • organic cycling of leaf litter for nutrients and energy • transformation of diffuse nitrogen inputs	Eradicate weeds and maintain or restore marine plants, trees, shrubs and ground cover and restore tidal regimes where appropriate	Maintain or restore shoreline vegetation (such as mangroves, salt marshes and seagrass) to minimise erosion

6.0 CHAPTER 6: ENVIRONMENTAL FLOWS

6.1 INTRODUCTION

Estuaries are semi-enclosed water bodies which open to the sea and are supplied with freshwater via rivers and streams. Freshwater inflow is one of the key factors which defines an estuary and contributes to the biological and physical attributes which make estuaries important spawning, nursery and feeding habitats for commercial and recreational fish and crustacean species.

Freshwater that flows to the ocean via estuaries, is not freshwater wasted. This was qualitatively illustrated by Halliday and Robins (2007) regarding Queensland subtropical estuaries where freshwater inflows were found to play an important role in:

- the recruitment of juvenile fish and crustaceans
- the enhancement of growth rates and subsequently both survival and abundance, of fish and crustaceans
- providing the essential elements driving change in the salinity state of the estuary and the cyclinity of demersal assemblages

Freshwater flow affects estuarine fauna on daily, monthly, yearly and decadal scales and is intrinsically linked with fishery productivity and coastal economies.

6.1.1 Changes to freshwater flows

Abstraction of water from most of Queensland coastal rivers, south of Cooktown, has been necessary for the development of land based activities such as:

- Agriculture
- Aquaculture
- Industry
- Urban Development

Only a few coastal rivers are without water infrastructure, which usually acts as barrier preventing upstream movement of aquatic species. Water abstraction has already modified the timing, quantity and quality of freshwater flows sufficiently to place the sustainability of estuaries at risk. There is currently limited documentation and research available on the extent of flow modification and likely effects on the long term productivity and biodiversity of Queensland's estuaries. In spite of this, there is an increasing public awareness of the need to manage freshwater flows, to ensure the sustainability of downstream estuarine, coastal and marine environments.

Freshwater is a limited resource and with time, there has been an increasing allocation-related competition between water users.

Freshwater resources are currently managed under State law and until recently, the management process involved balancing the needs of traditional rural and urban needs, without consideration of water flows to the environment.

This lack of recognition changed in 1994, when the Coalition of Australian Governments (COAG) signed the Water Reform Agreement and as part of the process recognised the environment as a legitimate water user.

The Water Reform Agreement restricts trading rights associated with water allocations, unless water is allocated to the environment. These allocations, referred to as 'environmental flows', are aimed at protecting the health of natural ecosystems, while providing security to water users.

The COAG Agreement also specifies, that the determination of environmental flows must be undertaken, in a structured transparent manner.

Water management in Queensland is under the jurisdiction of The Department of Natural Resources and Water, and is controlled legislatively via the Water Act and subsequent Water Resource Plans (WRPs), which are determined on a drainage basin basis. In terms of the Burrum Estuary, the Burrum and Cherwell Rivers form part of the Mary WRP, whilst the Gregory and Isis Rivers and their catchments, belong to the Burnett WRP.

The process of developing WRP's involves consideration of scientific advice and includes community and stakeholder consultation.

The challenge for humans, as users of both water and estuarine resources, is to understand the complex role of freshwater in estuaries, and to manage freshwater in an ecologically sustainable way. Without freshwater flowing into the ocean, there would be no estuaries, nor estuarine dependent fish and crustaceans, which support both commercial and indigenous fisheries.

Flow

Freshwater flow (which equates to river flow and rainfall) data, can be gauged or estimated using models.

Gauged flow is often available for locations upstream of estuarine reach.

Estimated flow can be modelled for points within the estuarine reach, e.g. end of system.

Ideally gauged and estimated flow should include all sources of water input, (i.e. runoff) and extraction and any discrepancies to this should be constant.

Correlating flow with estuarine fisheries landings assumes that there is some relationship between freshwater flow and fisheries production. The consistency of the relationship over increasing volumes, rates and durations of freshwater flow, will depend on the hydrology (i.e. tidal and mixing regime) and the geomorphology of the estuary.

6.1.2 Review of current knowledge relating to flow

Relationships between catch of estuarine, or near coastal fishery species and freshwater flow (or rainfall as a proxy indicator of freshwater flow), are collated by Halliday and Robins (2007), for 20 tropical or subtropical species. Some of these 20 species of relevance to the Burrum River and its estuary are:

- Banana prawns *Penaeus merguinesis* [28]
- Barramundi *Lates calcarifer* [29]
- Black bream *Acanthopagrus butcheri* [30]

[28] Vance *et al.,* 1985; Evans *et al.,* 1997; Vance *et al.,* 1998; Staples & Vance, 1986, 1987
[29] Sawynok, 1998
[30] Walker *et al.,* 1998

Additionally Lonergan and Bunn (1999) correlate for SE Queensland:

- Summer flows with catches of mud crabs; king prawns; tiger prawns; bay prawns and flathead
- Total annual flows with catches of school prawns; greasy prawns; tiger prawns; mullet and flathead

Lonergan and Bunn (1999) also show winter flows to significantly correlate with mullet and school prawns catches and that 25% of the variability in annual fish catches correlate with flow, after accounting for year differences.

Suggested causal mechanisms for the observed relationship between fin fish catches and freshwater flow include:

- Changes to the catchability [31]
- Changes to cohort or year class strength during the first year of life [32]
- Changes to food availability via productivity changes, resulting from flow borne nutrients [33]

The proposed mechanisms for the connection between estuarine fishery species and freshwater flow include (after Halliday and Robins, 2007):

- Trophic linkages, via changes to primary or secondary production that result from the addition of nutrients
- Changes in distribution, as a consequence of altered (expanded, reduced or connected) habitats
- Changes in population dynamics, such as recruitment, growth, survival and abundance

These papers demonstrate a correlation with freshwater flow and the dynamics of aquatic environments, however the impacts of flow events are generally one or more steps removed from the direct changes in physical parameters, as shown in Table 6. (Drinkwater, 1986; Alber, 2002; Kimmerer, 2002).

[31] Lonergan & Bunn, 1999
[32] Quinones & Montes, 2001
[33] Aleem, 1972; Salen-Picard *et al*., 2002

Table 6.1: Conceptual framework of the order of effects relationship between freshwater inflow and ecological processes (Robins *et al.,* 2007; Hart and Finelli, 1999; and Alber, 2002

Freshwater Inflow	Primary Effects (Physical Conditions)	Secondary Effects (Estuarine Resources)	Tertiary Effects (Estuarine Resources)
Quantity	Water temperature	**Primary production** • Trophic response of primary producers	**Secondary production** Trophic response of secondary producers
Timing	Salinity gradient		
Quality	**Dissolved material** • Nutrient content • Dissolved oxygen • Contaminant load	**Changes to habitats** • Expansion • Reduction • Connection	**Movement of species Into changed habitats** • Changed distribution
	Particulate material • Contaminant load • Turbidity • Sediment	**Movement of animals** In response to physical conditions • Adults or larvae • Immigration or emigration	**Changes in** • Growth and survival of individuals • Population abundance and biomass • Assemblage composition
	Changed geomorphology		

Also in the literature, there are several papers which consider the theoretical relationship between flow and production. Most papers report positive correlations between catch and flow, for both finfish and crustaceans. There is however, a need to better understand the causal mechanisms of the relationships between flow and fisheries production. Correlation and modelling can assist in assessing these relationships, but cannot make up for a lack of data or system understanding. Understanding causal mechanisms will allow greater certainty in answering questions in regards to: how, when and what duration freshwater is needed to flow into estuaries, in order to sustain fishery populations.

In summary, as far as fisheries are concerned, environmental flows affect the:

- **Catchability** of a particular species
- **Recruitment** of a species that are stimulated by, or require freshwater flows
- **Growth rates** of estuarine species
- **Connectivity of habitats**

Any monitoring of the consequences of environmental flow allocations to estuaries, should be based on explicit aspects of the biology or life history of a number of estuarine species, so that a range of measurers are collected and used for assessment.

6.2 THE BURRUM SITUATION REGARDING ENVIRONMENTAL FLOWS

The Burrum River contains water supply infrastructure used to supply the City of Hervey Bay. Brizga *et al.* (2002) acknowledges that the Burrum River has already been altered from its natural state, as a result of the presence and operation of existing water infrastructure and will continue to undergo further changes, as long term adjustments to existing water resource development and other human impacts continue. They anticipate that further changes will occur as a consequence of the 2m raising of Lenthall Dam in 2007.

Key water resource management issues for the Burrum Catchment identified by Brizga *et al.* (2002) were:

- The Burrum River is impounded by Lenthall Dam (Weir No.3) and 2 weirs (Burrum No. 2 and Burrum No.1), all 3 of which form a contiguous sequence of pondages.
- Lenthall Dam has a multilevel offtake
- The river between Lenthall Dam and Weir No 1, (which is situated at the tidal limit) has been converted to a series of weir pondages. Thus, low flow management in non tidal reaches below Lenthall Dam is not an issue, as ambient water levels are strongly influenced by weir operation. Further research is required to clarify the role of low flows in estuarine ecosystems. Although low flows are likely to be of significance for water quality, the provision of brackish water habitat at the head of an estuary is likely to provide immigration cues for mobile biota, ultimately awaiting large environmental flows. This is the basis for recommendations of compensatory releases from Burrum Weir No.1 to maintain quasi-natural flow inputs to the estuary.
- Fish passage is disrupted by Lenthall Dam and the 2 weirs, preventing the maintenance of natural populations of diadromous fish species in the Burrum River or tributaries above Burrum Weir No 1. It has been judged impractical to restore connectivity of fish passage throughout the Burrum catchment because of the height of Lenthall Dam and the feasibility of an appropriate fish passage device.

Installation of a fishway at Burrum Weir No 2 has also be adjudged not worthwhile, because of its closeness to Lenthall Dam and as it would only provide access to a few local tributaries. A working vertical slot fishway has been proposed for Burrum Weir No.1, to allow movement of diadromous species between freshwater and estuarine environments.

Brizga *et al.* (2002) identified the following changes which have occurred as result of or reduced environmental flows:

- **Geomorphology** - geomorphological processes have been disrupted by the water supply infrastructure, including sedimentation of the lower estuary. Contributory factors include: natural climatic variability, engineering works at the river mouth, bank erosion and the encroachment of peri-urban development along the banks of the Burrum. Sediment transport except during major flood events has been dramatically altered. The 2m raising of Lenthall Dam further reduces the 1.5 year ARI daily flow from 66% of pre-development to 50%.

- **Long term water quality -** water quality has undergone significant changes due to water infrastructure development, changes to the flow regime, and land use impacts, particularly along the banks of the Burrum River. Water quality changes to freshwater environments include: fluctuations in dissolved oxygen, changes in turbidity regimes; clearer water than in the past, resulting from lower flow conditions; increased likelihood of stratification; accumulation of organic materials; macrophyte growth and resulting effect on water quality; fluctuations in temperature resulting form impoundment and resulting effects on water releases and receiving waters; greater risk of algal blooms, due to increased water residence time within pondages. The water quality changes in estuarine waters include; reduced sediment delivery, changes in salinity as a result of reduced freshwater flow, permanent high turbidity because of reduced flushing flow and subsequent resuspension by tides and boat traffic, and changes to the tidal prism (as described in s2.9.2).

- **Nutrient delivery to the estuary -** water supply infrastructure and land use change adjacent to the river have reduced delivery of nutrients, sediment, organic materials and freshwater to the estuary. This to some extent has been offset by land uses changes in the estuarine reaches, such as increasing urban development, which has increased erosion and the release of nutrients directly to the estuary.

- **Wet season flow -** water infrastructure holds back wet season flows which would otherwise travel unimpeded down to the estuary. As described in s6.1.2, these flows are essential cues for migration, emigration, spawning of fish and other aquatic animals. Wet season flow is likely to be mitigated to an extent, by the introduction of environmental flows releases to be made under Water Resource Plan operating licences.

- **Instream habitats & associated biota** – the Burrum river habitat has been impacted by the dam and weir infrastructure, which has changed the natural hydrology of the river from a mix of riffles, sandy glides, pools and cascades to large elongate pools. These hydrological changes alter the river habitat and the associated biota that live there.

- **Salinity structure of the estuary -** The staged development of water infrastructure on the Burrum River has resulted in incremental reductions on the flow of freshwater down the river, extending the periods of no flow. The impacts of reduced flow below the Weirs have included increased salinity at the head of the estuary, (where tidal influence is at its lowest) and reduction in the extent of brackish water zone.

  Freshwater input is critical to the salinity regime within an estuary, particularly near the head of the estuary where the volume of water exchange is least within a tidal cycle. Extension of duration of low flow periods is likely to have changed salinity levels below Burrum Weir No 1 from a freshwater/brackish regime to a brackish/saltwater on today[34].

- **Lateral and longitudinal connectivity -** Overbank flooding is limited to certain upper and lower reaches. Water supply infrastructure limits the natural flow of water to the floodplains.

  Water supply infrastructure has fragmented longitudinal conductivity along the Burrum River, although the Cherwell, Gregory and Isis rivers are relatively unimpeded. There is presently a newly BMRG funded biopass project which is investigating this topic. It is being lead by Queensland DPI & F and is developing a strategy for the Burnett Mary region. The project is drawing upon the experience from areas such as the Mackay Whitsundays and NSW.

[34] Brizga *et al*, 2002

- **Riparian zones** – functional riparian zones exist along the Burrum River, although land use changes are impacting riparian areas.

- **Native plants and animals -** The Burrum River still contains significant areas of remnant riparian vegetation, although local impacts include: clearings, weed invasion, weir impoundments and changes to the flow regime.

- **Aquatic macrophyte** communities are likely to have changed in abundance and species composition, as a result of the water infrastructure. *The current species mix of plants and animals today is typical of low-flow and still water habitats*[34].

- **Seagrasses** and mangroves are a feature of the lower estuary. Locals believe that seagrasses are in good condition and that mangroves have increased as a result of increased sedimentation as a result of decreased flows and bank slumping and the subsequent presence of a more marine environment.

- **Invertebrate and plankton communities** within the Burrum's upper reaches have changed, as a result of weir pondages and loss of tidal influences. Changes also have occurred within lower reaches of the Burrum, as a result of changes in flow, sediment, nutrient and organic matter inputs, resulting from the presence of dams and weirs.

- **Fish populations** within the Burrum have changed significantly from their natural state, as a result of the reduced connectivity caused by water infrastructure, changes to water quality, stocking programs, bank erosion and fishing.

  Other vertebrate species (frogs, reptiles, mammals and birds) are also likely to have been affected by changes resulting in: altered flow regimes, particularly those which are aquatic, semi-aquatic or closely associated with water[34].

- **Ecological processes** – previously discussed changes in flow regime have impacted ecological processes that include flow events that are cues for spawning.

6.3 ENVIRONMENTAL FLOW ALLOCATIONS

In Queensland, Water Resource plans (WRP's), which are secondary legislation to the *Queensland Water Act 2000* include a subsection on 'ecological outcomes'. WRP's also stipulate:

- environmental flow objectives
- water allocation security objectives
- performance indicators of water allocations

The allocation of environmental flows has focussed on the needs of freshwater ecosystems, despite flows to the estuary being extensively modified on a frequent basis. This situation has been a continued frustration to estuary based stakeholders, particularly professional and recreational fishers. The applicability of environmental flows determined for freshwater ecosystems to the estuary is both unknown and untested, e.g. first post winter flows are thought to trigger spawning in freshwater fish, but no estuarine fish species is thought to spawn as a consequence of freshwater flow per se[35]. Freshwater flows may trigger estuarine fish species to move downstream, with spawning cues related to other environmental parameters, such as day-length and lunar phase[2] Increasing the understanding of the role of freshwater in estuaries will assist in having the needs of estuaries and their stakeholders properly considered, during water management processes.

Wide Bay Water Corporation, as operator of the water supply infrastructure, engaged Brizga *et al* (2002a) to investigate the impact of a 2m raising of Lenthall Dam, on the geology and ecology of the downstream environment. The purpose of the investigation was to outline the environmental flow strategy for the Burrum River, that would achieve no/minor impact of development on the downstream environment of the Burrum River. The method used in this analysis was to initially rate the geomorphological and ecological impact of flow changes on the different reaches of the system and to rate these, based on whether there was likely to be no/minor impact, or major/significant impact.

Key flow indicators were identified for the Burrum River, based on general principles from the scientific literature and relevant local information, including:

- total flow volumes
- annual variability
- seasonality
- zero flows
- low flows
- high flows

[35] Halliday & Robins, 2007

A benchmarking approach, using the Pioneer WRP assessment models, was used as the basis for the Burrum environmental flow analysis[34]. The results of this investigation found that major/very major impacts occurred on the following conditions[34]:

1. 1.5 year ARI daily flow decreased at Lenthall Dam tailwater and Burrum Weir No. 1 tailwater
2. The proportion of low flow days increased below Burrum Weir No. 1
3. The number of dry spells increased below Burrum Weir No. 1 and at the end of the system

To mitigate these impacts, WBWC engaged Sunwater Engineering Services to develop a Flow Management Plan that would improve on these conditions. The flow management outcomes were then to be incorporated into the operating licence for the supply scheme. The flow management strategies identified included: the passing of a post winter flow event and the establishment of a low flow release via the proposed fishway at Burrum Weir No. 1[36].

The recommendations of the Sunwater (2002) report were negotiated with the NR&W, with the following environmental flow conditions incorporated into the Interim Resource Operation Licence Wide Bay Water Corporation Supply Scheme:

- Releases from Lenthall Dam must achieve flows of 10ML/day through the fishway from September to April inclusive, when Lenthall Dam water level is at EL24.0m AHD or higher.
- On the occasion of the first inflow to the storage area of Lenthall Dam, between 1 October and 30 April, that reaches 3000ML/day or greater, releases must be made from Lenthall Dam, equivalent to the inflow and depending on the level of the dam at the time.

These licence requirements are in accordance with the Sunwater (2002) flow management plan and should mitigate the major geomorphological and ecological risks identified by Brizga *et al* (2002a) from the raising of Lenthall Dam.

Similar environmental flow licence requirements are to be included in the Resource Operation Licence that will come out of the Mary WRP. These flow conditions limit further impact to the environment from the raising of Lenthall Dam. The Gregory and Isis rivers, which are relatively un-impounded, lessen the impact of flow regime change on the Burrum estuary[34].

[36] Sunwater, 2002

6.4 THE BRISBANE ENVIRONMENTAL FLOW CONVENTION

This declaration presents summary findings and a global action agenda that addresses the urgent need to protect rivers globally, as proclaimed at the 10th International River*symposium* and Environmental Flows Conference, held in Brisbane, Australia, on 3-6 September 2007.

The conference was attended by more than 750 scientists, economists, engineers, resource managers and policy makers from 50 nations. Key findings included:

- Freshwater ecosystems are the foundation of our social, cultural, and economic well-being.
- Freshwater ecosystems are seriously impaired and continue to degrade at alarming rates.
- Water flowing to the sea is *not* wasted.
- Flow alteration imperils freshwater and estuarine ecosystems.
- *Environmental flow management* provides the water flows needed to sustain freshwater and estuarine ecosystems in coexistence with agriculture, industry, and cities.
- Climate change intensifies the urgency.
- Progress has been made, but much more attention is needed.

The full declaration can be downloaded from the river symposium website **www.riversymposium.com**

Freshwater ecosystems are the foundation of our social, cultural, and economic well-being. Healthy freshwater ecosystems – rivers, lakes, floodplains, wetlands, and estuaries – provide clean water, food, fibre, energy and many other benefits that support economies and livelihoods around the world. They are essential to human health and well-being.

Freshwater ecosystems are seriously impaired and continue to degrade at alarming rates. Aquatic species are declining more rapidly than terrestrial and marine species. As freshwater ecosystems degrade, human communities lose important social, cultural, and economic benefits; estuaries lose productivity; invasive plants and animals flourish; and the natural resilience of rivers, lakes, wetlands, and estuaries weakens. The severe cumulative impact is global in scope.

Water flowing to the sea is *not* wasted. Fresh water that flows into the ocean nourishes estuaries, which provide abundant food supplies, buffer infrastructure against storms and tidal surges, and dilute and evacuate pollutants.

Flow alteration imperils freshwater and estuarine ecosystems. These ecosystems have evolved with, and depend upon, naturally variable flows of high-quality fresh water. Greater attention to environmental flow needs must be exercised when attempting to manage floods; supply water to cities, farms, and industries; generate power; and facilitate navigation, recreation, and drainage.

Environmental flow management provides the water flows needed to sustain freshwater and estuarine ecosystems in coexistence with agriculture, industry, and cities. The goal of environmental flow management is to restore and maintain the socially valued benefits of healthy, resilient freshwater ecosystems through participatory decision making informed by sound science. Ground-water and floodplain management are integral to environmental flow management.

Climate change intensifies the urgency. Sound environmental flow management hedges against potentially serious and irreversible damage to freshwater ecosystems from climate change impacts by maintaining and enhancing ecosystem resiliency.

Progress has been made, but much more attention is needed. Several governments have instituted innovative water policies that explicitly recognise environmental flow needs. Environmental flow needs are increasingly being considered in water infrastructure development and are being maintained or restored, through releases of water from dams, limitations on ground-water and surface-water diversions, and management of land-use practices. Even so, the progress made to date falls far short of the global effort needed to sustain healthy freshwater ecosystems and the economies, livelihoods, and human well-being that depend upon them.

1 *Environmental flows* describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.

7.0 CHAPTER 7: RESOURCE CONDITION AND MANAGEMENT ACTION TARGET SETTING

7.1 INTRODUCTION

We will never transcend our need for good quality (clean) water, it is constant and critical.

Water Quality Improvement Plans (WQIPs) aim to achieve target reductions in pollutant discharges to receiving waters from the surrounding catchment.

A key aspect of the development of WQIPs is the setting of **water quality targets, (concentration and load based)** for end of catchments and receiving waters. These water quality targets should be binding and accepted by the community on the understanding that a suite of management actions will be required from many sectors to achieve the target. Management Action Targets describe the onground works (or associated capacity building) that is needed to meet the WQ targets.

The Reef Water Quality Partnership Regional Implementation Group (RIG), agreed to a common approach to the setting of water quality targets in the GBR area in October 2006. This approach is outlined below.

Catchment load based targets should be based on best available understanding of:

1. Environmental values and the link between end of catchment loads and the receiving water quality and ecosystem health objectives
2. Current pollutant loads and estimates of pre- European loads
3. Achievable objectives based on modelling outcomes of management action scenarios and stakeholder consultation

Although the Burrum Catchment is considered outside of the GBR zone a consistent approach to water quality improvement was deemed critical and therefore this report aims to follow the same approach.

Catchment models estimate end of catchment water quality and loads from point sources, land uses and management actions within the catchment. **Models of transport and transformation** of pollutants, i.e. nutrients, sediments and chemicals (pesticides) in receiving waters can link changes in load at the end of the catchment, to water quality outcomes in estuaries and coastal waters. **Ecosystem models** can link water quality to ecosystem health indicator and catchment models. Thus, **receiving water quality models** and **catchment models** together, can perform the essential function of linking management action to water quality (and ecological outcomes) in coastal waters. Development of these models and evaluation of management action scenarios is the highest priority management action detailed in this section.

7.2 WATER QUALITY TARGET SETTING, BURRUM CATCHMENT

WQ Targets for the Burrum & Mary Catchments are based on water quality objectives for these catchments, published in the Environmental Protection (Water) Policy 1997: Burrum, Gregory, Isis, Cherwell and Elliott Rivers Environmental Values and Water Quality Objectives Basin No. 137[27].

Pollutant reduction targets, which are required to bring water quality results that are currently above the water quality targets, will be proposed once a receiving water model for the Burrum catchment has been established and management actions modelled using SedNet. The receiving water modelling process allows management scenarios to be analysed based on environmental, social and economic impacts, thereby informing decision making before resources have been allocated. The setting of definitive pollutant emission targets is also limited by the degree of water quality data that exists for the Burrum catchment. As an example, pollutant yield (sediment and nutrients) detailed in Chapter 4, are only available for the Burrum and Gregory rivers, with no data available for the Isis and Cherwell Rivers. This approach to the water quality improvement planning process for the Burrum Catchment allows consistency with the other plans being developed.

The Productivity Commission (2003) suggested an alternative approach that targets inputs and practices, which land managers can readily change and which are correlated with pollution emissions. This approach is likely to be particularly relevant for the implementation of on-ground Best Management Practice and Industry Codes of Practice to achieve load reductions from diffuse sources.

To achieve positive outcomes from target setting, targets need to be developed in a spirit of open and transparent dialogue with landholders. Individual catchments comprise a wide diversity of land uses, soil types, topography and climate, thus requiring target setting and management opportunities to be tailored to the particular catchment.

Targets need to be SMART (**S**pecific, **M**easurable, **A**chievable, **R**elevant and **T**imed) as suggested by McDonald and Roberts (2004) and offer a promising approach for application in catchments. SedNet/ANNEX is a useful tool for addressing SMART target setting, because it provides an objective, transparent means to assess the relevant changes that accrue from proposed management actions, by providing:

- a framework to assemble catchment information and local knowledge
- the ability to extrapolate available catchment and climate datasets, both spatially and temporally
- a framework to engage in dialogue with the community, on key catchment processes and behaviour
- a conceptual model and understanding of catchment processes and behaviour

Some key components of any target setting approach are:

- ***Ownership and partnership*** **-** everyone (including landholders, governments, regional bodies, industries, etc) need to agree on the target setting process
- ***Delivery*** **-** everyone needs to deliver their part, this may be as a partnership, or it may be achieved through coordinated, but individual deliveries

- ***Review*** - review of targets is essential, particularly as new information becomes available. It also must be undertaken in a timely manner. The review helps improve the accuracy of the model, manage expectations and prioritise future actions
- **Consequences** of non-delivery of targets need to be determined and barriers that constrain implementation, regularly discussed and addressed

SedNet under the Short Term Modelling Project was used to model the impact of specific management practices that might lead to an improvement in water quality. Increasing vegetation (ground) cover in grazing lands, particularly in low intensity large-scale grazing lands, was the most effective method to reduce sediment loads where as implementation of best practice for fertiliser application was the most effective strategy for reducing dissolved nutrient loads.

These management practices offer potentially measurable targets, such as increased ground cover and riparian vegetation and modification of fertiliser application.

In summary **water quality target setting** is possible using an adaptive management framework, which promotes an open and transparent approach and involves both stakeholders and the wider community. This approach should utilise improved management practice, various types and developments of models and an effective monitoring regime to identify the changes in water quality with time.

The targets and actions that follow have been established based on the findings of this report and as a basis from which to build on during the consultation phase.

7.2.1 Aspirational Targets

The aspirational targets for water resources in the Burnett Mary region, as defined in Country to Coast – A healthy sustainable future, are:

- To manage and protect water resources to ensure long term water quality throughout the region by 2050.
- Water Resources and associated ecosystems are protected from the impacts of acid sulphate by 2050.
- Water Resources are used in an efficient, equitable and sustainable manner by 2050.
- Groundwater is sustainably managed for long term environmental, production and social values by 2050.
- Riparian Zones are sustainably maintained and/or rehabilitated and erosion process is maintained at natural levels by 2050.

In addition to these regional aspiration targets the following aspiration targets specific to the Burrum catchment are proposed:

- by 2050 water quality in slightly to moderately disturbed areas of the Burrum catchment should be improved on current levels.
- water quality and ecological integrity in high ecological value areas of the Burrum catchment are maintained.

7.2.2 Resource Condition Targets

Resource condition targets for the Burnett Mary region, which covers the Burrum Catchment, are defined in ***Country to Coast – A Healthy Sustainable Future***. The RCTs are reviewed and amended to remove indicative and redundant.

The most up to date RCTs that are relevant to this Water Quality Improvement Plan are below[8]:

WR1.1	End of Basin Targets are established by July 2008, and periodically reviewed to include new information. Water Quality Improvement Plans (WQIPs) are implemented throughout the region to halt or reverse decline in water quality parameters by 2015.
WR1.2	Concentrated and diffuse source loads are consistent with regional Environmental Values and Water Quality Objectives by 2020, and region-wide standards and Best Management Practices are widely used in ERA license reviews.
WR2.1	Acid Sulphate Soils are managed appropriately and Acid Sulphate Soil related outbreaks are eliminated by 2015.
WR4.1	Economically and ecologically important groundwater provinces in the region are maintained or improved by 2025.
FB3.2	The ecological function, condition and extent of Wetlands and riparian zones of the top 20 prioritised wetlands in each catchment will be restored and maintained by 2025.
CMD1.3	Impacts on coastal and marine resources from discharge loads from point sources and urban stormwater are reduced by 100Ha of urban development managed under WSUD (or an equivalent system upgrade) by 2025.

7.2.3 Management Actions

Table 7.1 summarises the strategies and activities needed to implement management actions. Time frames and responsibility are listed for each management action.

Note: The list of management actions in Table 7.1 will need to be reviewed, updated and prioritised once priority actions 1-3 are complete. At this time load reduction targets will have been established and management actions modelled against the targets. The process to model and select management actions required to achieve target reductions will include consultation.

Table 7.1: Draft Management Actions for Implementation

Activity No.	Management Action Targets	Lead Agency	Collaborating Agencies	Corresponding BMRG RCT or MAT
1. Priority Actions				
1.1	Develop receiving model for the Burrum Catchment, which includes Burrum, Cherwell, Gregory and Isis Rivers.	BMRG	CSIRO	WR1.1
1.2	Model sediment and nutrient loads and against improved land management to establish load reduction targets.	BMRG	NRW	WR1.1, WR1.1.2
1.3	Conduct costs analysis of management actions and update Table 5.1	BMRG	NRW, EPA	WR1.1
2. Point Source				
2.1	Nutrient/sediment yield determined for the Isis River	BMRG	NRW, EPA	WR1.2
2.2	Septic systems – establish database with pump out schedule to ensure septics are maintained.	Regional Councils		WR1.2
2.3	Implement extension program to promote septic system health and maintenance.	Regional Councils	BMRG	WR1.2
2.4	Aquaculture – investigate the nutrient loads from the aquaculture industry in the catchment	BMRG	DPI&F	WR1.2
3. Diffuse Source				
3.1	Continue to encourage the adoption of Code of Practice and Best Management Practice in horticulture, forestry and grazing activities within the catchment	BMRG, DPI&F	NRW, CRC, CSIRO, Universities	LR2.1 LR1.1.3
3.2	Identify priority CoP and BMP and implement extension programme including training and demonstration sites to maximise adoption	BMRG, DPI&F		WR1.2, LR1.1.3
3.3	Develop and implement a Grazing Management Strategy for the Fraser Coast Region.	DPI&F	BMRG, CRC, CSIRO	WR1.2/WR5.1 LR1.2, LR1.1.3
3.4	Manage forest harvesting according to Australian Forestry Standard	FPQ, NRW		WR1.2
3.5	Stormwater – investigate the impact of stormwater from Howard & Burrum Heads.	BMRG	Community monitoring groups Regional Councils	WR1.2, CMD1.3
3.6	Riparian areas – investigate the extent and quality of riparian vegetation in the Burrum Catchment (utilising data from Queensland Wetlands Programme). Establish a list of priority sites requiring remediation	BMRG	EPA	WR5.1

3.7	Remediate riparian vegetation in identified 'hot spot' areas.	BMRG, Regional Councils		WR5.1
3.8	Acid Sulphate Soils – regional management and mitigation strategies developed.	BMRG	NRW, DPI&F	WR2.1, WR2.1.2
3.9	Acid Sulphate Soils – identify and remediate a site impacted by ASS.	BMRG, Regional Council		WR2.1, WR2.1.3
3.10	Environmental flows implemented to maintain/improve water quality in the catchment.	Regional Council/Water Providers	NRW	WR3.2
4. Monitoring				
4.1	Prepare data storage and analysis procedures for collection, storage and analysis of monitoring data.	BMRG		WR1.1.6
4.2	Continue to support community water quality monitoring network and investigate the feasibility of additional monitoring programs including Water quality report card program, Event Monitoring Program, Recreational Health Monitoring Program, Waterwatch Program.	BMRG		WR1.1 WR1.1.6
5. Financial Security				
5.1	Investigate feasibility of 1-2c environmental levy to contribute to cost of ongoing management actions	Regional Council's	Regional Council	

8.0 CHAPTER 8: MONITORING, RESEARCH, EVALUATION AND REVIEW

8.1 INTRODUCTION

Monitoring and research will be used to quantify the effectiveness of the management actions described in Chapter 7 as well as obtain better estimates of pollutant loads and improve models. Once the effectiveness of management actions is understood the plan can be updated or modified to broaden effective management actions or revisit actions that were not effective.

Water quality monitoring programs identified in Chapter 3 will play a key role in monitoring the effectiveness of this plan against targets and water quality objectives. The program's currently conducted by the EPA and WBWC, which were used to assess the condition of the catchment in this report, will provide direct comparisons over time and as this plan is implemented.

Additional monitoring and reporting programs are required to effectively monitor the results of this plan. The following sections details additional monitoring activities that could be used to compliment the existing programs.

8.2 KNOWLEDGE REQUIREMENTS

A receiving model for the Burrum is required, for the realistic setting of target loads within the Burrum estuary and to monitor implications and effects of changing management strategies.

Receiving models for the whole of the Great Sandy Strait, (including the Burrum), are required to better understand the dynamics of this important ecosystem, and this knowledge gap has been put up as a priority management action. This would probably need the involvement of one of more of the major partners, such as CSIRO.

Further research is required to clarify the role of low flows in estuarine ecosystems and particularly their involvement in production of bait fish and other invertebrates, upon which fish feed. These species are required to attract and retain larger predatory fish species, to the lower reaches of the estuary, upon which recreational anglers and the local economies they support in part rely.

The river between Lenthall Dam and Burrum Weir No 1, which is situated at the tidal limit, has been converted into 2 weir pondages. Water quality sampling suggests that the water quality both within Lenthall Dam and these pondages meets all guideline requirements. This, however, is not the case between last Burrum Weir number 1 and the Cherwell River and the Cherwell and the River Mouth, for the water quality for these reaches is rated as good in terms of recreation, moderate in terms of the aquatic ecosystem, but poor in terms of dinking water and primary industry water quality standards. It is likely that low flows from non tidal reaches below Lenthall Dam have a degree of responsibility for poor water quality.

Also, the provision of brackish water habitat, at the head of an estuary, is necessary to provide immigration cues for mobile biota, ultimately awaiting large environmental flows. With time and drought conditions, estuarine waters, at tidal limits, become more marine and with lack of water movement water, quality deteriorates. In normal rainfall years and subsequent to the raising of Lenthall Dam in 2006/2007, compensatory releases from Burrum Weir No.1 and Lenthall Dam itself, are required to maintain quasi-natural flow inputs to the estuary, (known as environmental flows).

8.3 EVALUATION AND REPORTING

Evaluation and reporting is critical to assessing adaptive management and enabling progressive improvements in effectiveness of management actions taken.

Results need to be integrated, synthesised and translated into applied and transformed into applied knowledge to enable end user action both for strategic planning and implementation at a range of scales, especially regional and end users (governments, regional NRM bodies, industry groups, local government and managers).

Effective data and information sharing are vital to ensure and underpin the collaborative approach.

Reporting is required to allow a diverse and definitive evidence approach to the education outcomes resulting from monitoring, investigations, test trialling, modelling and assessment.

The entire process is interactive and needs to be refined with time, however reporting/adaptive management of the plan will be consistent with BMRG's reporting program for Country to Coast – a healthy sustainable future.

ANNUAL REVIEWS
Annual performance reviews reporting implementation progress are proposed to be completed by BMRG with key stakeholders including State Government and Industry groups invited to attend.

PHASE 2 IMPLEMENTATION
After the completion of priority management actions and the establishment of pollution targets the plan will need to be adapted/updated in light of new findings.

This process will involve consultation and a review and cost analysis of management actions. The next version of the Burrum Catchment WQIP will be drafted and ready for implementation.

8.4 PUBLIC CONSULTATION PROCESS

The first stage of consultation/review to finalise the Burrum Catchment WQIP requires meetings with both science and stakeholder groups to evaluate the science that contributed to the report, review priority pollutants, establish load reduction targets, and finalise management action targets.

The suggested approach for the second stage of consultation, to expose this Draft Burrum Water Quality Improvement Plan to a larger proportion of key Stakeholders and the public, is to conduct a catchment crawl information day. This includes, as well as, a catchment crawl down the catchment from Lenthall Dam to Burrum Heads an information session, which formally presents the plan to stakeholders and seeks input as to stakeholders wishes/advice regarding further presentation of the plan and timelines to the groups they represent.

After a time period has elapsed, further presentations have occurred to stakeholder groups as requested following the catchment crawl and submissions and comments from stakeholders have been considered a further workshop(s) will be convened to finalise the plan, probably in April/May. The finalised plan is scheduled for June 2008.

The targeted stakeholders for the catchment Crawl Information Day are suggested as:

- Burnett Mary Regional Group for Natural Resource Management
- Wide Bay Water Corporation
- Wide Bay Burnett Regional Co-ordinating Group
- Queensland Department of Natural Resources and Water
- Queensland Department of Environment
- Queensland Department of Primary Industries and Fisheries
- The Coastal Water Quality Alliance
- BMRG Traditional Owner Working Group
- Friends of the Burrum River System
- Wildlife Preservation Society, Hervey Bay Branch
- Wide Bay Burnett Conservation Council
- Fraser Coast Sunfish
- Fraser Coast representatives of the Regional Seafood Association
- Fraser Coast Regional Council
- Bundaberg Regional Council
- Local Graziers
- Howard School
- Burrum Heads Chamber of Commerce
- Irrigation Water Users
- Other Burrum stakeholders as identified

Stakeholders organisations will be formally contacted in writing and invited to send up to 2 representatives to the Catchment Crawl/Burrum WQIP draft release day. The letter will explain that in the first instance only 2 representatives can be accommodated but a presentation of the plan to the stakeholder group can be arranged after the crawl event.

Background notes including a draft copy of the Burrum WQIP will be provided to all stakeholders who attend.

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The Burrum Catchment Water Quality Improvement Plan covers the Burrum, Cherwell, Gregory and Isis River catchments, which discharge via the Burrum estuary to Hervey Bay.

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