PAP 2.1/2.2 Burnett Basin Regional Community Water Quality Networks and Rivercare

Centre for
Environmental
MANAGEMENT

Faculty of Arts, Health and Sciences
Central Queensland University
Gladstone Q 4680

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Salinity & Water
AUSTRALIA

Mary
Regional Group
for Natural Resource Management Inc

Natural
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Chapter 1 Executive Summary

PAP 2.1 Component A: Current local and state government water quality monitoring networks

State government water monitoring in the Burnett Basin is undertaken by the EPA, DNRM, BOM, AIMS, Sunwater and BPA. The major water monitors are EPA and DNRM, with their programs monitoring a significant number of sites and parameters across the basin. The EPA programme includes sub-surface (0.2 metre water depth) multi-parameter ambient water quality testing. Parameters that are measured include: nutrients (total nitrogen, ammonia, oxidized nitrogen, organic nitrogen, total phosphorus, dissolved phosphorus) micro-algal growth (chlorophyll a), water clarity (turbidity, secchi depth and temperature), oxygen (saturated and dissolved), pH, salinity and conductivity. New initiatives proposed are related to tracking changes in catchments through to the Great Barrier Reef, focusing on capture of condition and trend data relative to drivers and vectors. There is also EPA licence condition point source compliance monitoring at various industries and businesses including Bundaberg Sugar, various caravan parks and prawn farms that release water into the Burnett catchment. Typically, dissolved oxygen, pH, salinity and nutrients are included within the monitoring requirements. However, there are incidences of flood release from various industries that do not require monitoring or authorization. Whilst DNRM has undertaken an extensive time-series monitoring programme in the past, data collection stations have dramatically reduced in number since 2001. The major gaps within EPA/DNRM monitoring programs are related to upper basin coverage, selection of appropriate parameters to detect impact or condition and trend, spatial allocation in relation to hotspots and collection of reference data (to assist in defining water quality objectives). The lack of appropriately selected water quality parameters in the upper section of the catchment has resulted in a general lack of knowledge with respect to erosion and soil loss, oxygenation of the water column, eutrophication and algal blooms. There is a conspicuous lack of testing for contamination or toxins especially for herbicides, pesticides and cyanobacterial toxins. There is a lack of EPA and DNRM monitoring sites along the coastal fringe of the catchment with associated lack of knowledge pertaining to land based influences and their impacts on estuarine and marine environments. Event monitoring, water column depth profiling, biological monitoring and testing for hydrogen sulfide and ammonium nitrogen are also absent.

The Resource Operations Licence (ROL) requirement for the monitoring in relation to water storages in the Burnett Basin is the most extensive monitoring plan within the catchment. Water quality sites monitored by the ROL holder (Sunwater) are located upstream, within and immediately downstream of weirs and storages. Parameters include temperature, DO, pH, EC, TN, TP, manganese, hydrogen sulphide and turbidity with water column depth profiling of the first four parameters within storages. Cyanobacteria are also monitored according to national protocols. Given the importance of such information to public health there is a substantial gap in the actual human health risk reduction that should result from such monitoring. Precise results are held as commercial in confidence and are not widely or readily available from the licence holder.

The identified gaps in state government based monitoring contribute to a general lack of coherent systems (integrated and logistical approach) for detecting the base causes of fish deaths and other system degradation together with ensuring the widespread availability of critical data (Sunwater commercial in-confidence). There appears to be a general lack of profiling of stratified water columns (by government) and detection of critical changes in the structure of the biota (e.g. proportion of volume of water column that may be anoxic at overturn or toxic algal blooms). Combined with the lack of system testing for other contamination or toxins (herbicides, pesticides etc), the paucity of spatial and temporal physico/chemical data for the inland regions and the lack of quality systems, evidence of the ability of the current state government monitoring networks to predict or even to detect serious problems is considered nominal. This lack of knowledge and associated management can result in severe biological (impacts on aquatic biodiversity, stock and agriculture) and human health risks.

The Australian Government Bureau of Meteorology controls an extensive climate-monitoring programme with a total of 16 weather stations throughout the Burnett Mary Basin Region recording various parameters in addition to average rainfall. In addition, the Australian Institute of Marine Science (AIMS) monitors time-series surface water temperatures in the Woongarra Marine Park. The Bundaberg Port Authority has an extensive bi-monthly monitoring programme with 20 bores monitored for conductivity, salinity, water depth, pH and various metals in addition to sediment analysis in the town reach, benthic macroinvertebrate and seagrass surveys in the sea dumping area.

Local government monitoring is undertaken within 17 local Shire Councils. Although most shire councils undertake minimal water monitoring (potable water supplies and/or sewage treatment plants), several have comprehensive programs where data are thought to be of value. Other councils are expanding their current monitoring efforts, including development of broader water monitoring programs. The future of Shire Councils in NRM may be changing (some councils are more active in many community driven NRM programs) and this change is thought to reflect a greater understanding of the requirements of regional communities in environmental issues (support and guidance is necessary for ongoing and successful programs). This developing trend is also thought to reflect a greater local responsibility relating to anthropogenic changes and their effects on natural systems.

Unfortunately, most local governments and shires do not undertake ambient monitoring programs other than their own compliance monitoring for raw (prior to treatment) and treated water (potable and effluent release). Monitoring programs undertaken by councils are frequently incomplete or inappropriate, as the majority of councils do not test for the full suite of parameters recommended by the Australian Drinking Water guidelines to determine contamination and/or potential health dangers (Australian Government, 2004). Key areas where testing could be implemented or improved are contaminant and toxin testing; groundwater and salinity testing; selection of important diagnostic parameters; monitoring and reporting for cyanobacteria and oxidized nitrogen; incorporation of quality assurance techniques; testing of depth profiles; qualified analysis of results and communication and dissemination of key results. The greatest asset is the widespread interest of local government and the desire to work and assist each other in attaining the most sustainable outcomes in terms of natural resource management.

PAP 2.1 Component B: Current community-based water quality monitoring networks.

The numerous functional and static Landcare and catchment care groups within the region were assessed individually based upon a dialogue between CQU employees and representatives/members of community groups and local councils. Although all pertinent data may not have been made available, there is evidence of a substantial network with skills and interests that can be dramatically improved in terms of functionality. There is also a significant school led involvement in catchment care. Unfortunately, of the existing community groups, only two have the current technical capacity to undertake a full scope of water quality monitoring, although still limited and not fully quality assured. In addition, few NRM groups own or have access to water monitoring equipment or have the necessary training to operate it. There is also a lack of equipped offices, managerial and administrative personnel. For future monitoring, the quality of data required will determine what equipment the groups will need. If this equipment were available, training would be necessary for its effective use.

All groups contacted through this study have indicated their readiness to contribute to a basin-wide water quality monitoring network. If properly resourced, trained and guided to enter the investment phase, they believe in their ability to re-ignite interest in local NRM and water issues throughout their respective region. Collaboration from experts within the community and the development of a technical nodes structure (and communication/data integration model) to facilitate community education and dispersal of knowledge by providing central locations is, therefore, recommended to build a NRM skill base. In view of the size and importance of the task ahead, the willingness of individual groups to cooperate with their Shire Councils, other NRM groups and various other stakeholders is unprecedented.

There are two current marine/coastal community water monitoring projects, one of which is active. These are the particularly active Woongarra Marine Park Monitoring and Education Project (WMPMEP) and the Baffle Creek Catchment Management Group/Rosedale School (including Waterwatch and other programs). WMPMEP, with a project officer, funding, high technical standards and some QA measures is ideally placed to become a technical node/NRM centre for a Water Monitoring Network. This group has gathered substantial water quality and ecological data, which are currently being entered into databases (ACCESS – at the WMPEMP office) from hardcopy field data sheets to assist future analysis efforts. Any data collected so far by BCCMG remains in hardcopy form within schools (as programs were often curriculum based), or with group committee members.

There are three current freshwater community water monitoring projects. These are BCCA south subcatchment (through Waterwatch), Three Moon Salinity Group and BCCMG (through Waterwatch). Of these, BCCA south/Waterwatch enters data from hardcopy filed data sheets into databases EXCEL), all of which are housed within the Waterwatch Office (at Wondai). Data collected through other programs remain in hardcopy form within schools or with group committee members.

It is recommended that development and implementation of technical nodes, an integrated water quality monitoring network and resourcing/engagement of BCCA sub-catchment groups be used to provide a solid foundation for expansion of current community water monitoring within the NRM networks of the Burnett River Basin. The primary objectives of the technical nodes include the implementation of technical field initiatives, project design to address local and regional priorities, data management, quality assurance systems and training and a report-back mechanism a the community level. The water monitoring networks will provide the environment for knowledge transfer, data storage and reporting. The essential requirements of a technical node (NRM centre) strategy would be permanent fully equipped office space, operational training regimes and provision and ongoing maintenance of water monitoring equipment.

PAP 2.1 Component C: Gaps, Issues and Action plans

This section provides an assessment of "hotspots" or issues per subcatchment based upon the Funding Plan (BMRG 2003); the State of the region study (LRAM, 2004); the Reef Water Quality Protection Plan (State of Queensland and Commonwealth of Australia, 20030; previous regional assessments (Queensland Government, 1999; NLWRA, 2000, Ozestuaries); metadata review provided by NRM (NRM, 2004); community derived catchment information (Waterwatch, Catchment Care) and anecdotal accounts. Recent studies have identified exports of nitrogen and phosphorus from the Burnett catchment to equate to 11% and 13% of total nitrogen and phosphorus loads to the Great Barrier Reef (Furnas, 2002). The Reef Water Quality Protection Plan identified the Burnett Basin as the second highest risk catchment analysed, containing identified biophysical, social and developmental risks together with a risk to marine industries. Notwithstanding, ecological relevance and good conservational value was noted in many areas.

The majority of studies for the region provide audit information with regard to either EIS requirements (project specific) or give regional assessments (catchment wide) and are not geared towards detection of change in river communities in relation to environmental variables or for detection of hotspots within systems. Given the insufficient data collection for most tributaries of the Burnett (Boonara Ck, Stuart R, Cadarga Ck, Boyne R, Bayulla Ck, Three Moon Ck, Nogo R, St John Ck, Reid Ck etc), the full detection and evidence of local issues relating to point and diffuse sources was beyond the scope of most regional assessments and hence, this report. However, where available, specific information relating to local issues is discussed.

Key problem issues identified in various catchments were sediment and nutrient runoff (Kolan, Burnett, Elliott, Stuart and Boyne river systems), deteriorating water quality in surface waters (Kolan and Burnett catchments) and aquifers (north Burnett region, suspected Elliott and inland regions), decreased river flow (Burnett River catchment) and increased water extraction (Elliott River, Burnett River systems), increased salinity (Three Moon catchment, middle of Barambah Creek subcatchment), potential for contamination by agricultural chemicals (Elliott, Isis and Gregory river catchments,

Barker-Barambah subcatchments) and increased incidence of fish kills (Burnett River), water weed invasion and blue-green algal blooms (Stuart and Boyne River systems, impoundments, lower Burnett River). A reduced and/or degraded riparian zone was also noted as a key issue, as was the lack of identified reference reaches (to enable comparison and template for rehabilitation efforts). The major issues for marine and estuarine regions were the lack of coastal water quality monitoring in general and in relation to vulnerable marine communities and decreased water quality at river mouths. Loss of prior monitoring programmes, trained personnel and specialised infrastructure should be systematically addressed through development of long-term projects (appropriately resourced and linked – recommended project outlines are included in this section) and action plans (to enable immediate gap filling through on ground activity).

There is an obvious need for increased activity and organisation of community groups together with engagement of local industry in water quality monitoring within the catchment. Long term monitoring of contaminants, nutrients and their pathways could be used to determine condition and trend. The quantification and control of sediment and sediment-bound nutrient export together with maximisation of riparian zone throughout the Burnett Basin should be of high priority as these may enable water quality improvement and reduction in the biomass of cyanobacterial blooms. Landscape salinisation problems have been identified with the main gap the lack of monitoring of areas of high salinity hazard. Selection and future preservation and protection of reference sites should be undertaken in freshwater, estuarine and marine sections of the Burnett River system. Biological monitoring of coastal mangroves, seagrasses, saltmarshes and corals in conjunction with water quality monitoring should also be included. Improved data analysis, reporting and wider communication is recommended; such a system would also enable rapid response to deterioration in ecosystem health. Continuation of formal education programs is recommended for the positive benefits of inspiring catchment activity and dispersing knowledge. The CEM has also put forth a strategy for the establishment of technical nodes within the Burnett Basin (chapter 3) in order to facilitate the effective delivery of on ground projects within river subcatchments.

PAP 2.2 Component C: River Reach Plans

Under new regional arrangements (discussed in Chapter 1), the BMRG is responsible for implementing Australian Government initiatives such as Rivercare and Waterwatch. The Rivercare initiative is for improving the condition of Australia's water resources (including rivers, streams, wetlands and groundwater) resulting in improved water quality and environmental condition. This includes freshwater environments as well as estuarine and coastal waters and is being achieved by supporting actions that reduce the nutrients, sediments and other pollutants that reach waterways and groundwater, including the use of clean wastewater and stormwater systems and improved water efficiency and re-use.

Within PAP 2.1 it was identified that a major gap within the current Burnett water monitoring networks was the lack of subcatchment or reach level planning to address issues with on-ground activity. Objectives within catchment management strategies (or NRM plans) do not often relate to specific places, equipment and people. Subcatchment or reach level action/rehabilitation plans significantly improve the progression and translation of general objectives (of an NRM plan/catchment management strategy) in a prioritised and strategic manner to on-ground actions. Based on this, a major requirement for Burnett subcatchments was identified as the need for dedicated rehabilitation/action plans for each of the subcatchments. Chapter 6 provides support to the nominated approach to rivercare (through geomorphic reach classifications) and advises of an approach (and guiding documents) for successful rehabilitation/action planning.

It is often helpful to river management to divide a river into contiguous zones or reaches (river management units – RMU's) and to develop separate management (rehabilitation or action) plans for each reach. This enables characterisation of each stretch of river, and assists in interpretation of physical and ecological changes along the river continuum. Although approaches to the division of waterways are varied, a geomorphic approach is recommended as a basis for the Burnett Catchment as this approach has yielded appropriate and relevant information for management planning elsewhere.

Considering the sensitivity (or capacity) of river reaches due to different geomorphic contexts is particularly recommended for effective long-term rehabilitation plans.

Within the geomorphic approach there are varying methods of classification, based on those parameters that are used to define sections of the stream. It is recommended that future Rivercare studies in the Burnett Basin use reach classifications according to the "Geomorphic Assessment of Reaches (GAR) – Burnett River and major tributaries" as the basis for developing rehabilitation/action plans. The Burnett GAR classification scheme is recommended for several reasons. Primarily, this study represents the most comprehensive geomorphic river work undertaken within the catchment to date. Further, DNRM envisages the Burnett GAR reach classification will be used extensively for future projects in the Burnett Basin, with several new projects already adopting its use to assist in representative site selection (AquBAMM and SIP WQ05) – therefore the GAR is recommended to allow comparisons between future projects. Management planning (including rehabilitation/action plans) should be regarded as a continuous process and plans should grow and change as information becomes available. In the event that an updated geomorphic classification was determined for the catchment, sites and data would be reassigned and re analysed according to the new scheme.

Within the general method of RMU's as described above, it is recommended that Rivercare planning and implementation stages (i.e. for preparing strategic actions) follow the general planning approach detailed in current literature relating to river restoration/ rehabilitation. Examples include the conceptual framework of Stream Rehabilitation Essentials, detailed steps within the rehabilitation manual for Australian Streams and principals from the River Restoration Framework. Adoption of the steps and principles defined in these works (such as planning and risk assessment procedures) would ensure prioritisation at catchment and reach scales to make certain that resultant actions are strategically well designed. The role of the planning stages of a rehabilitation plan is critical, particularly initial steps of developing a template of the stream and identifying natural assets, degraded assets and problems/issues within a reach. Without the thorough completion of this inventory, the subsequent prioritisation process would be confounded. Ultimately, undertaking a broadscale inventory of river reaches would ensure that all appropriate information has been gathered (including GPS locations) and would also corroborate anecdotal accounts.

Several projects currently gaining resource information (under the National Action Plan) may be well placed to both inform rehabilitation plans and advise the prioritisation process. Of these the most likely to provide reach level information are SIP WQ03 with regard to the relative contributions of subcatchments to total sediment loads in the Burnett River and WQ05 with regard to degraded riparian or hotspots within riparian zones. Possible contributions of other projects are discussed further in Chapter 6.

Chapter 2 Background to PAP 2.1/2.2 and report overview

Queensland's implementation of The National Action Plan for Salinity and Water Quality (NAPSWQ) has resulted in new regional natural resource planning arrangements across the state. NRM bodies (funded under the NAPSWQ and NHT Extension) are now responsible for achieving 'healthy regional arrangements' in Queensland by coordinating views of regional communities and preparing NRM plans (which incorporate natural resource plans (water, vegetation etc)) and targets, and by filling planning and management gaps. This arrangement encourages governments and regional communities to work together to prevent, stabilise or reverse dryland salinity and to improve water quality in Queensland.

The Burnett Mary Regional Group for Natural Resource Management Inc (BMRG) is the NRM body for the Burnett Mary regions and their mission is to "plan, promote and invest to achieve ecological diversity, conservation and sustainable production throughout the Burnett-Mary region".

The BMRG has identified community-led water quantity monitoring initiatives as a priority action for the region. The Centre for Environmental Management, Central Queensland University was commissioned by BMRG to undertake various components of the work relating to the Water Quality and Rivercare Priority Action Plans (PAP's) for the region (Components A, B and C for PAP2.1 and Component C for PAP 2.2). This is report documents information arising from PAP 2.1 and 2.2: Burnett Basin Regional Community Water Quality Networks and Rivercare.

The intention of the water quality PAP is to

- identify the location and current status of existing water quality data sets and programs,
- build upon the existing community based water quality monitoring networks that currently exist throughout the region,
- build capacity within the community with regard to water quality issues and monitoring techniques,
- ensure good coverage of water quality monitoring while remaining cognizant that the community must be inextricably involved.

The PAP 2.1 project consisted of three major components, while PAP 2.2 included one component.

1. Component A of PAP 2.1 (Chapter 3 of this report) produces a preliminary overview of current local and state agency water quality monitoring programs. These involved assessments of site cover, parameters and monitoring frequency within local and state monitoring programs and a description of current gaps in water quality monitoring.
2. Component B (Chapter 4) provides an evaluation of current community based monitoring networks and develops strategies for holistic and strategic community based water quality monitoring. This included undertaking an inventory and evaluation study to analyse and document community-based water quality monitoring systems for the basin. The final part of component B was to implement a suitable QA system for community groups – this activity is still in progress.
3. Component C (Chapter 5) uses existing data (regional assessments, site data etc) and information gathered in the two previous components (present government coverage - gaps, overlap and hotspots, community capacity - human resources and monetary requirements and QA), to identify current gaps and issues that require addressing within subcatchments. This included developing strategies and projects for integrated community monitoring and identifying on ground actions to address regional issues at a local scale.

4. The intention of Component C Rivercare PAP (PAP 2.2 – Chapter 6) for the Burnett Catchment was initially to scope rehabilitation plan requirements for the Burnett, Kolan and Baffle river systems. Upon commencement of the project, however, it became obvious that there was a need for an advised approach to the rivercare and river reach classifications (as varied approaches have taken in the past). Direction from project managers was for PAP 2.2 to take a literature review approach to provide this advice.

Report structure follows components described above, with each component represented as a chapter. Initial chapters provide Introduction and description of the report and its contents (Chapter 1), and an Executive Summary relating the primary findings of each component (Chapter 2). Remaining chapters represent various PAP components described above (Chapters 3-6).

Chapter 3 Component A: Local and state water monitoring networks

3.1 State government monitoring

3.1.1 Environmental Protection Agency (EPA) - ambient

The Environmental Protection Agency (EPA) implements an Environmental Protection (water) Policy (EPP) aiming to protect Queensland's water environment. The policy involves:

- identifying environmental values for Queensland waters,
- deciding water quality objectives to enhance and protect those environmental values,
- making consistent and equitable decisions about Queensland waters that promotes efficient use of resources and best practice environmental management, and
- involving the community (including indigenous communities) through consultation and education and promoting community responsibility.

The EPA has undertaken a Queensland statewide Ambient Water Quality Monitoring Program for many years, with the purpose of assessing water quality at sites monitored. The data collected provides:

- a broad information base for state of environment reports,
- a basis for assessing trend and compliance with guidelines,
- broad ranging information on the spatial and temporal variability of Queensland waters;
- a basis for developing reference values or guidelines for Queensland waters,
- raw data to provide to a range of client groups, and
- quality assurance for Waterwatch and catchment groups

Within this program the EPA has monitored ambient monthly water quality at a number of sites in the Burnett Mary Basin (current EPA sites are shown in Figure 1). Water quality is assessed by measurement of a variety of parameters at a water depth of 0.2 metres at each site. Parameters that are measured vary for each site and generally include: nutrients (total nitrogen, ammonia, oxidized nitrogen, organic nitrogen, total phosphorus, dissolved phosphorus) micro-algal growth (chlorophyll a), water clarity (turbidity, secchi depth and temperature), oxygen (saturated and dissolved), pH, salinity and conductivity.

Recently, there have been initiatives to upgrade this monitoring system. This is due to changed information needs; there is now a requirement for knowledge of tracked changes in water quality through catchments to the Great Barrier Reef (pressure from the Reef Water Quality Protection Plan (RWQPP - The State of Queensland and Commonwealth of Australian, 2004) and Sustainable Rivers Audit), for better mapping of landuse change and for models to predict the future situation in water resource management (Hunter, H., pers. com., 2004). Therefore, the current scope and cover of the EPA Water Quality Program is presently being reassessed and a new Queensland Government monitoring program will be initiated focusing capture of condition and trend data relative to drivers and vectors. Monitoring of loads (at a finer scale than just subcatchment) will be part of this program (there is Smartstate funding for three years for this). This may occur through installment of refrigerated/automated samplers and data loggers.

This state perspective has nominated five catchments (Burdekin, Fitzroy, Burnett etc). Within the Burnett five subcatchments have been chosen (Boyne, Auburn, Barker/Barambah, Upper, Mid and Lower Burnett), where plans will be fully developed by the end of March 2005. The initiation of this program may contribute to the filling of water-monitoring gaps (within the five subcatchments) that have been recognised by this project (discussed in Section 3.2.19 Gaps Analysis).

Appendix 1 lists the water monitoring sites and associated parameters undertaken by the EPA and DNR within the Burnett Basin. For the purpose of this assessment, sites that were discontinued prior to 2002 are not listed here. Figure 1 shows the current water quality sites and parameters within the Burnett basin including EPA and NRM.

The EPA is also responsible for monitoring of man-made or natural systems following adverse effects (fish kills etc). This monitoring is discussed under section 3.2.2 Bundaberg City Council Community Monitoring Program number four, as Bundaberg Council is usually the first response in these cases.

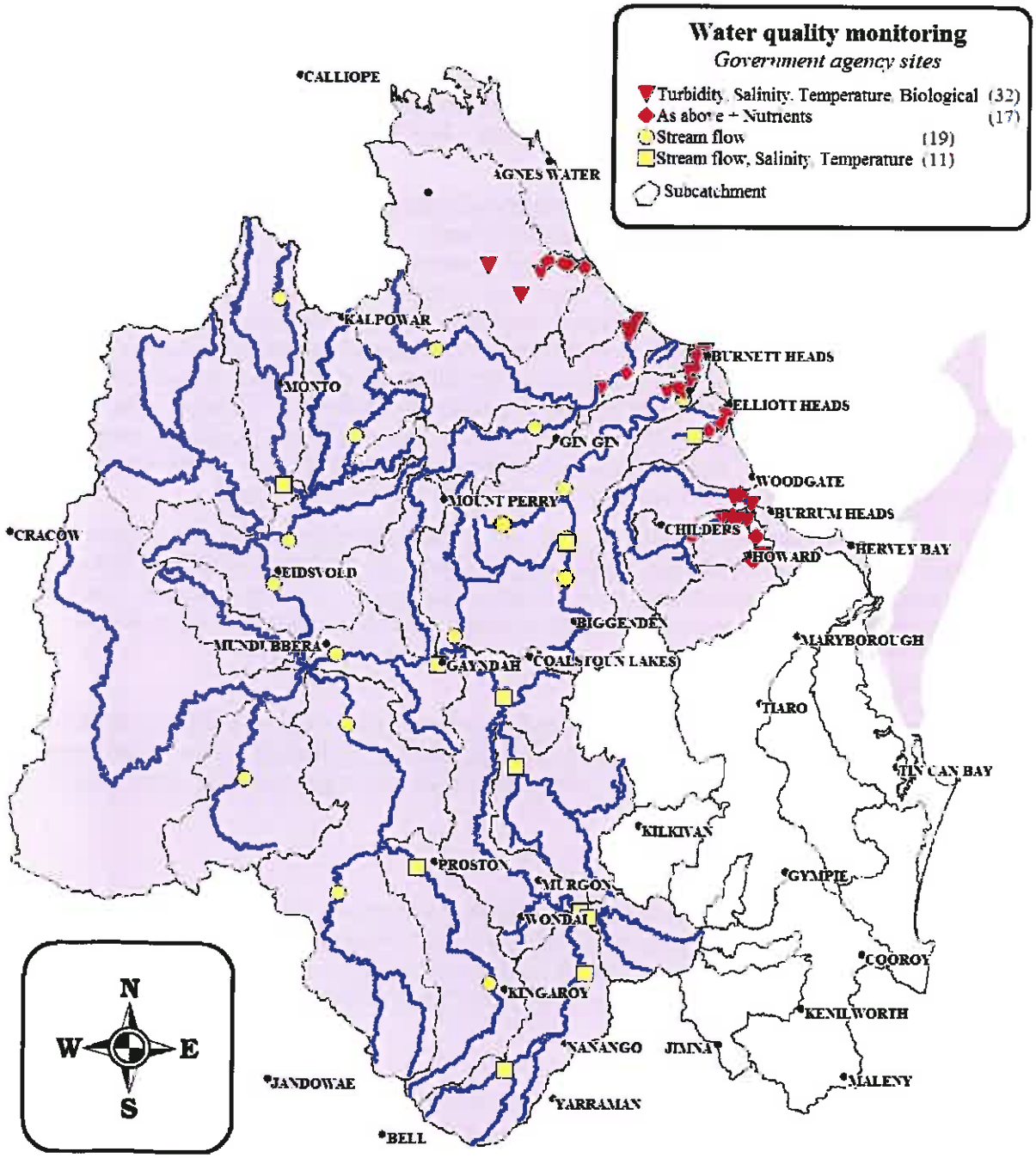

Figure 1: Current water quality sites and associated parameters across the Burnett Basin for EPA and NRM programs. The colour of sites represents the custodian; dark sites are EPA and grey sites are NRM.

3.1.2 EPA - Point source compliance monitoring

The following industries and businesses (Bundaberg Sugar, Bundaberg and the Oaks Caravan Parks, and Bundaberg, Queensland and Gazaford Prawn Farms) are authorised to release into the Burnett Basin catchments following various levels of treatment. However, point source monitoring must be undertaken as a license condition, as determined by the Environmental Protection Agency.

The compliance monitoring described below was provided via the Burnett Basin Metadata (NRM, 2004[b]). One limitation of the point source metadata is the lack of information on other licensed sites in the catchments that, although not authorised to release to the environment on an ongoing basis, may release during a flood event (uncontrollable beyond certain size flood events). An example of this may be a sediment collection dam at a quarry etc, which gets inundated with rising floodwaters. It may be designed to cope with a 1 in 50 yr flood event, but will not cope with a 1 in 70 or 100 year event. These releases however, would not be normal "baseline" releases to the environment, and would be occurring with significant dilution (NRM, 2004[b]). However, they may contribute substantially to loads within flooded flows.

A further and critical limitation of the Burnett Metadata is the collation by Ecomaps of point source releases (the collator searched under Burnett Catchment only). It is possible that there are industries authorised to release to the environment in neighboring catchments (mostly to the west), which then flow into the Burnett. An example is the Barambah Catchment (an industry may release to the Barambah catchment, the Barambah catchment may then flow into the Burnett Catchment before reaching the sea). Ecomaps incorrectly have catchment boundaries "landlocked", which is obviously not the case. Therefore the metadata does not give the full array of industries authorised to release into the Burnett Catchment. EPA was unable to provide the full scope of information required (relating to the gaps mentioned above) for this report, due to time constraints (Karle, M., pers. comm., 2004). The usefulness of the Metadata was also reduced due to the lack of information regarding specific point source locations (GPS would allow mapping for visual assessments).

Some of the current limitations of both the point source metadata (incompleteness) and the current data request system (time constraints cause delays) should be alleviated with the creation and implementation of "The Queensland Point Source Database" - a new system containing comprehensive information on point sources with an interface for data submission and generation.

Bundaberg Sugar

During the crushing season, Bundaberg Sugar conducts monthly point source monitoring at Millaquin Mill's discharge site, which releases water to a short tributary of Burnett River. The following parameters are measured: BOD, suspended solids, pH, dissolved oxygen, salinity, water temperature and carbohydrate content.

Bundaberg Caravan Park

Bundaberg Caravan Park hires an environmental consultant to perform point source monitoring at the discharge site, which drains via a gully into McCoys Creek. It involves daily measurements of the quantity of water being discharged. In addition, a quarterly analysis of BOD, suspended solids, pH, nitrogen, phosphorus, dissolved oxygen, free chlorine and faecal coliforms is carried out.

Oaks Caravan Park

A point source monitoring program is implemented at the discharge point of Oaks Caravan Park, Burnett Heads. Monitoring is conducted before treated effluent leaves the final treatment phase, as the outlet is an ocean outfall. Consultants measure the volume of water released daily; and every three months, levels of BOD suspended solids, pH, total nitrogen, total phosphorus, dissolved oxygen, free chlorine and faecal coliforms are recorded.

Bundaberg Prawn Farm

The Bundaberg Prawn farm conducts point source and ambient monitoring in the Burnett Basin. Point source monitoring of water quality is undertaken at the discharge site, which flows from the farm's settling pond into the Burrum River. Several parameters are measured monthly, including suspended solids, pH, dissolved oxygen, total nitrogen, total phosphorus and chlorophyll a. Ambient monitoring is undertaken at the farms discretion.

Queensland Prawn Farm

The Queensland Prawn Farm currently performs point source and ambient monitoring programs. Point source monitoring includes discharge monitoring at the settling water pond where environmental consultants measure levels of total phosphorus, total nitrogen, dissolved oxygen, pH, suspended solids, chlorophyll a and BOD. These parameters are tested in February, March, April, May, August and November of every year. Ambient monitoring is undertaken at the farms discretion.

Gazaford Prawn Farm

In conjunction with the Environmental Protection Agency, the Gazaford Prawn Farm conducts point source and ambient monitoring throughout various times of the year. Point source monitoring is carried out at the farm's settling pond and measures pH and dissolved oxygen daily while discharging. It also records monthly levels of suspended solids, total phosphorus, total nitrogen and chlorophyll a while discharging. Ambient monitoring is undertaken at the farms discretion.

3.1.3 Department of Natural Resources and Mines

The Queensland Department of Natural Resources and Mines (acronyms include QDNR&M, DNRM, NRM, DNR) is committed to "maintaining a high quality of life for current and future generations by ensuring the sustainable management and use of one of Queensland's most precious resources – water" (DNR&M, 2004). To do so, DNR&M:

- formulates policies, plans and evaluation systems to optimise access to and use of the State's water and riverine quarry materials,
- continually monitors and assesses water quality and quantity, and
- develops water resource plans (WRPs) to determine current and future water demands and allocation priorities

Water quality monitoring by DNR&M in the Burnett Mary Basin dates back to as early as 1909. Since then, the department has undertaken an extensive time series monitoring program at over 114 sites (many of which are now redundant) in the Burnett basin including Baffle Creek, Kolan River, Burnett River, Three Moon Creek, Barker Creek, Barambah Creek, Boyne River and more. Automated data loggers undertake sampling at regular intervals recording water level and the quantity of water discharged. Surface or near surface water temperature, conductivity and pH are also assessed in the Burnett River (four sites), Sheep Station Creek (one site), Three Moon Creek (one site), Barambah Creek (five sites), Baker Creek (two sites), Boonara Creek (one site), Stuart River (one site) and Auburn River (one site). One site at Burnett River records turbidity.

Within the Burnett Basin, NRM data collection stations (besides those on the main trunk of the Burnett River itself) have dramatically decreased in number since 2001 (Appendix 1). For example, no gauging sites are currently active in the Baffle system, only one in the Kolan system (reduced from 5 in 2002), one in the Three Moon system (reduced from 4 in 2002), four in the Central Burnett region (reduced from 8 in 2002), no sites presently active in the Isis or Gregory rivers and only one in the Elliott. The decrease of sites in the upland creeks (Barambah Creek reduced from ten sites in 2002 to four in 2004) is particularly concerning, as some of these areas are recognised water quality hotspots and/or town water supplies within subcatchments.

Appendix 1 lists the water monitoring sites and associated parameters undertaken by the EPA and DNR within the Burnett Basin. Sites that were discontinued prior to 2002 were not included. Figure 1 shows the current DNRM and EPA water quality sites and associated parameters within the Burnett Basin.

3.1.4 Australian Government Bureau of Meteorology

The Australian Governments Bureau of Meteorology (BOM) provides meteorological, hydrological and oceanographic services in support of Australia's national needs and international obligations (Australian Government BOM, 2004). The Bureau has several aims, including:

- *Climate record-* To meet the needs of future generations for reliable homogeneous climatological data,
- *Scientific understanding-* To advance the science of meteorology and develop an integrated comprehensive description and scientific understanding of Australia's weather and climate,
- *Community welfare-* To contribute effectively to:
  - reduction of the social and economic impact of natural disasters;
  economic development and prosperity of primary, secondary and tertiary industry,
  - safety of life and property,
  - national security,
  - preservation and enhancement of the quality of the environment,
  - community health, recreation and quality of life, and
  - efficient planning, management and operation of Government and community affairs,
  through the development and provision of meteorological and related services,
- *International cooperation-*. To meet Australia's international obligations and advance Australia's interests in and through international meteorology.

The BOM controls an extensive climate-monitoring program to support the above aims. Rainfall averages from the monitoring program are used to observe the quantity of water that is entering the Burnett Basin. Rainfall is recorded daily however; the averages are presented on a monthly basis. A total of 16 weather stations record average rainfall for the Burnett Mary Basin Region, these are listed in Table 2.

Table 1: current weather stations recording average rainfall for Burnett/Mary Basin Region

Site	Location	Site	Location
40428	Brians Pastures	40100	Imbil Forestry
39014	Bulburin Forestry	39057	Kalpower Forestry
39128	Bundaberg Aero	040112	Kingaroy Prince
39015	Bundaberg Post	039059	Lady Elliot Island
39018	Bustard Head	040126	Maryborough
39025	Childers Post Office	039104	Monto Post Office
39039	Gayndah Post Office	040158	Nanango Wills ST
40093	Gympie	039171	Nerayen Res Stn

3.1.5 Australian Institute of Marine Science

Australian Institute of Marine Science (AIMS) "collects and analyses data to improve public understanding of the marine world and to find science-based management practices that ensure long-term sustainable use and development of marine resources" (AIMS, 2004). In particular, AIMS carries out research projects on rivers, which entail field and modeling studies of natural processes and human induced changes in flushing and sedimentation of estuaries.

AIMS monitors water temperature at Woongarra Marine Park, off Bundaberg by collecting time-series surface temperature measurements. Temperature is recorded daily at two sites near the mouth of the Burnett River. Variability in sea temperature has been related to corresponding changes in richness and abundance of resident ecological communities, and exploring these relationships can assist in determining drivers within ecosystem dynamics. AIMS works in collaboration with the Woongarra Marine Park Monitoring and Education Project (WMPMEP) in developing appropriate methodology and defensible data collection procedures within their monitoring projects.

3.1.6 Sunwater

The Resource Operations Plan for the Burnett Basin, released in May 2003, lists an array of monitoring requirements for compliance by both State Government (NRM) and the Resource Operations License (ROL) holder (Sunwater) relating to storage reserves, which are described below (NRM, 2003).

State Government monitoring

Water quantity/quality sites monitored by state government are part of NRM's Statewide Ambient Water-monitoring Program (Table 2). Requirements for monitoring include water quantity and quality (continuous time series flow and height) and surface measurements of parameters including temperature, dissolved oxygen, pH, electrical conductivity, total nitrogen, total phosphorus, and turbidity), natural ecosystem monitoring and groundwater monitoring.

Requirements for natural ecosystem /water quality monitoring are for temp, pH, EC and DO to be measured each time ecosystem sites are visited (sites presented in Table 3) (NRM, 2003). Other monitoring (geomorphology, riparian assessment, aquatic vegetation, aquatic habitat, macroinvertebrates, fish and estuarine monitoring (water quality and mangroves) is required at selected intervals (frequency of monitoring for parameters are presented in Table 3).

Table 2: Sites for ROP state monitoring requirements for Water Quantity and Quality for the Burnett Basin (undertaken as part of the NRM ongoing ambient water quality program).

Stream	Location	Stream flow	Water quality	Site Identifier
Auburn River	Glenwood No 2	X	X	GS 136305A
Burnett River	Figtree Creek	X	X	GS 136007A
Burnett River	Mount Lawless	X		GS 136002D
Burnett River	Gayndah Flume	X	X	GS 136017B
Burnett River	Jones Weir Headwater	X		GS 136094A
Burnett River	Jones Weir Tailwater	X		GS 136004A
Burnett River	Eidsvold	X	X	GS 136106A
Burnett River	Ceratodus	X		GS 136103B
Cadarga Creek	Briovinia Station	X		GS 136306A
Degilbo Creek	Coringa	X		GS 136011A
Eastern Creek	Lands End	X		GS 136118A
GinGin Creek	Dam Site	X	X	GS 135004A
Kolan River	Springfield	X	X	GS 135002A
Reids Creek	Dam Site	X	X	GS 136006A

Table 3: River reach sites for ROP state monitoring requirements for Ecosystem Monitoring for the Burnett Basin (including water quality - undertaken as part of the NRM ongoing ambient water quality program).

River reach locations	Geomorphic field survey	Geomorphic assessment	Riparian Assessment	Aquatic vegetation	Water quality	Aquatic habitat	Macroinvertebrates	Fish	Mangroves
Burnett River		X							
Yarrol (AMTD 380.8km)	X		X	X		X	X	X	
Eidsvold (AMTD 291.1km)	X		X	X	X	X	X	X	
Mundubbera (AMTD 240km)	X		X	X	X	X	X	X	
Gayndah (AMTD 203km)	X		X	X	X	X	X	X	
Figtree Creek (AMTD 119km)	X		X	X	X	X	X	X	
Ned Churchward Weir tailwater (AMTD 74.1km)	X		X	X	X	X	X	X	
Burnett Estuary (AMTD 0,4.8,8.5,11.4,14.7,17.4,20.3,23.5km)					X				X
Kolan River		X							
Springfield (AMTD 135km)	X		X	X	X	X	X	X	
Bucca Weir tailwater (AMTD 38km)	X		X	X	X	X	X	X	
Kolan estuary (AMTD 0,20.,5.3,8.1,12km)					X				X
Auburn River		X							
Glenwood (AMTD 37.9km)	X		X	X	X	X	X	X	
Frequency (season and years)	spring 1,4&8	1 & 8	spring 1,4&8	spring autumn	spring autumn	spring autumn	monthly	annually	spring 1,4&8

ROL requirements

Monitoring requirements include water quantity (continuous time series flow, height and inflow data), quality (monthly) and cyanobacteria testing. Sunwater has conducted this monitoring since 2002 (several of these sites were previously NRM stations - Campbell, C., pers. comm., 2005).

Water quantity sites by the ROL holder are located at headwaters (upstream), tailwaters (downstream) and within storages. The requirements for flow, height and inflow vary for each site and are presented in Table 4. Water Quality sites are also located upstream, within and immediately downstream of weirs and storages. Monitoring includes monthly surface or depth-profile measurements of temperature, DO, pH, EC, TN, TP, manganese, hydrogen sulphide and turbidity (Table 5). These sites are limited to general location descriptions (no GPS).

Depth profiles for temperature, dissolved oxygen, pH and electrical conductivity are required at intervals of 1m above the thermocline, 0.5m through the thermocline, and 2m below the thermocline. Smaller intervals are to be used if the storage is shallow or if dissolved oxygen or pH readings are changing rapidly.

Each storage pond must be monitored for cyanobacteria on a regular basis in accordance with the ARMCANZ draft National Protocol for the *Monitoring of Cyanobacteria and their toxins in Surface Water*. Cells are reported in mm^3/L cell bio volume of each species of cyanobacteria as per requirements.

Table 4: Sites for ROP Resource Operations License (ROL) monitoring requirements for Water Quality and Quantity for the Burnett Basin (undertaken by Sunwater).

Stream	Location	Height and flow	Height	Daily inflow	Site Identifier
Nogo River	Wuruma Dam			X	dam
Nogo River	Wuruma Dam headwater		X		GS 136113A
Nogo River	Wuruma Dam tailwater	X			GS 136109B
Burnett River	John Goleby Weir			X	weir
Burnett River	John Goleby Weir headwater		X		GS 136120A
Burnett River	Claude Wharton Weir			X	weir
Burnett River	Claude Wharton Weir headwater		X		GS 136003C
Burnett River	Jones Weir			X	weir
Kolan River	Bucca Weir			X	weir
Kolan River	Bucca Weir headwater		X		GS 135008A
Kolan River	Bucca Weir tailwater	X			TBA
Kolan River	Fred Haigh Dam			X	dam
Kolan River	Fred Haigh Dam headwater		X		GS 135009A
Kolan River	Fred Haigh Dam tailwater	X			GS 135012A
Kolan River	Kolan Barrage			X	barrage
Kolan River	Kolan River Barrage (Gooburrum Pump station)		X		GS 135010B
Burnett River	Ned Churchward Weir			X	weir
Burnett River	Ned Churchward Weir headwater		X		GS 136023A
Burnett River	Ned Churchward Weir tailwater	X			TBA
Burnett River	Ben Anderson Barrage			X	barrrage
Burnett River	Ben Anderson Barrage (Woongarra pump station)		X		GS 136020A
Sheepstation Creek	Sheepstation Creek	X			GS 136018A

X = monitoring is undertaken at this station.

Table 5: Sites for ROP ROL monitoring requirements for water quality for the Burnett Basin (undertaken by Sunwater).

Parameter	Storage inflow	In Storage	Storage Outflow
Temperature	X	PROFILE	X
Dissolved Oxygen	X	PROFILE	X
pH	X	PROFILE	X
Electrical conductivity	X	PROFILE	X
Total Nitrogen	X	X	X
Total Phosphorus	X	X	X
Manganese	X	X	X
Hydrogen Sulphide	NR	NR	X
Turbidity	NR	X	NR

Sunwater data are not immediately available through NRM due to commercial in confidence and there is an (apparently lengthy) application approval process (through NRM as custodians) for the acquisition of this data (Campbell, C., NRM, pers. comm., 2004). Due to custodial arrangements and lack of direct access to Sunwater, authors were unsuccessful in gaining evidence of quality assurance in data collection systems by Sunwater.

Section note: CEM, CQU approached Sunwater during the course of this PAP to discuss concerns relating to the availability of Sunwater's water quality and related data (information arising from this data will be useful to advise management). Negotiations are currently underway for provision of this data to BMRG.

3.1.7 Bundaberg Port Authority

Groundwater

The Bundaberg Port Authority has undertaken water quality monitoring on 28 of their underground bores since 1996. Approximately every second month, the Port Authority monitors 20 surrounding bores for conductivity, pH, salinity and various metals (copper, iron, aluminum, arsenic, cadmium, chromium, zinc, lead, selenium, nickel). North of the Port Authority, eight underground bores are tested for water depth, RL water, conductivity, pH, copper, iron, aluminum, arsenic, cadmium, chromium, zinc, lead, selenium, and nickel.

Ecological

The Bundaberg Port Authority undertakes an environmental monitoring program (marine flora and fauna) to meet their license requirements. Specific details of this monitoring plan (GPS sampling locations, number of sites etc) were not been disclosed to this project as the Bundaberg Port Authority is awaiting program details from consultants (this information will be made available ASAP to PAP2.1 and BMRG). The monitoring includes:

1. Sampling and analysis plan – this monitoring program is designed to meet EPA requirements to measure the chemical qualities of the top half to one meter of sediment in selected sites up to the town reach.

2. Benthic macroinvertebrate and seagrass surveys - this program is designed to assess changes in infauna and seagrass cover in the sea dumping area.

3.1.8 Gaps analysis

Past reviews

As stated in the State of the Region review (LRAM, 2004), reviews of existing state agency (DNR, EPA) datasets have been undertaken in the past. These reviews include

1. Testing the waters study (Queensland Government 1999) (to determine accuracy, temporal cover and methods);
2. National Land and Water Resources Audit (NLWRA, 2000, NLWRA, 2002) (to determine representative sites);
3. Various water resource-planning exercises for Mary Burnett.

These reviews identified the following gaps and deficiencies in the datasets:

- Lack of content (parameters) at some sites and therefore inconsistency;
- Limited temporal replication at some sites (sites have been discontinued, others have minimal history);
- Changes in the analysis methodology (technology related – EPA has had major revision of methods in 2004 as well as changes in earlier years);
- Combination of the above causing lack of effectiveness of the network;
- Monitoring sites relating to diffuse or point sources are depauperate at some locations and in general spatial coverage appears inadequate in showing the major cumulative downstream effects on water quality (nutrients, sediment and salinity) (LRAM, 2004).

Despite the inefficiencies of agency monitoring networks, said data has provided some evidence of localised water quality problems/hotspots, which are detailed in Chapter 5: Gaps/Issues review of the Burnett Basin.

Further review of government monitoring

A number of other gaps were found within this study concerning both the spatial allocation of existing monitoring sites in relation to water quality hotspots and use of the appropriate parameters to detect impact or condition and trend. They include:

- A decrease in DNR sites across the Burnett system since 2000 resulting in upper areas which are depauperate in both gauging and appropriate water quality measurements (this is mainly due to the EPA covering lower reaches only) e.g.:
    - Three Moon Creek now only has one site (parts of this subcatchment are noted for salinity intrusion problems).
    - The Stuart River has no water quality parameters currently measured besides temperature and electrical conductivity (big gap in view of WQ issues here).
    - No gauging sites are presently active in the Gregory or Isis Rivers
    - Sites in the Barker/Barambah River systems were reduced from 12 to four since 2002
- Lack of appropriately selected water quality parameters by government (DNRM) in the upper sections resulting in a general:
    - Lack of knowledge of erosion and soil loss (as no measurements for light penetration, turbidity or suspended solids
    - Lack of knowledge regarding oxygenation of the water (dissolved oxygen measurements or percent oxygen)
    - Lack of knowledge regarding nutrient enrichment and eutrophication (nutrient measurements – Nitrogen and phosphorus and their derivative species and Chlorophyll *a*)
    - Lack of knowledge regarding state of alkalinity of water bodies (pH – this parameter also serves as an indicator acidification or contamination).
- There is a complete lack of monitoring sites along the coastal fringe of the catchment (both DNRM and EPA) resulting in a lack of knowledge of land-based influences (such as those mentioned above) and hence the effects of those influences on estuarine and marine environments.
- Conspicuous lack of testing for contamination or toxins in both EPA and DNR programs including:
    - Lack of testing for herbicides or pesticides within ambient water quality programs- there is no current mechanism to detect contamination or pathways.
    - Lack of testing for blue-green algae (either cell counts or toxins).
- Lack of appropriately designed water quality programs by government including:
    - Lack of event monitoring in EPA data collection programs – only ambient monitoring is conducted and therefore no knowledge is acquired regarding flood loadings.
    - Lack of any depth profile monitoring by EPA, DNRM, particularly with regard to fish kills\system degradation.
    - Lack of testing for hydrogen sulfide and ammonia nitrogen (NH_3-N) at degradation (fish kill) sites to appropriately determine cause.
    - Lack of depth profile monitoring in rivers by Sunwater.

Depth profiles are important to determine stratification and the proportion of the water column that is anoxic. The proportion of hypolimnion (percent of the waterway that is anoxic detected through

oxygen and temperature measurements) will determine the extent of the fish kills at overturn and ammonia (produced in anoxic conditions) often funds toxic algal blooms, therefore, knowledge of these compounds in the water column is critical for predicting water quality outcomes. Generally, stratification is associated with large and static water bodies such as dams or lakes, however, in times of low rainfall and reduced flow, pooled or impounded sections of rivers may also stratify (Bormans and Condie, 1998).

- Lack of gauging sites (DNR monitoring) to assess level and flow in the Baffle Creek area – monitoring of the last active site in Baffle Creek was stopped stop in 2003 - perhaps due to implementation of the moratorium of understanding for no further water resource development in the Baffle Basin (NRM, 2004[a]). (Please note that areas within the Baffle have been identified as suitable reference locations based on current EPA reference criteria).
- Lack of confidence in sufficient implementation of quality assurance procedures by DNR (particularly with regard to data logger water quality measurements - for example pH probes should be cleaned regularly within the deployment time and usually are not (Negus, P. pers. com., 2004) – hence:
    - Reduced confidence in water quality measurements by DNRM
- Lack of confidence in certain EPA measurements - for example unfiltered soluble nutrient data prior to 2004 may be in error by an order of magnitude and should not be used (refer to Appendix 3: Data quality statement by EPA, for explanation of this).
- Lack of biological monitoring in conjunction with physico/chemical monitoring (macroinvertebrates, indicator species, higher vertebrates (fish and water birds) etc).
- Suspected lack of systems to ensure consistent data collection methods - for example data collection for fish kills, point sources and the Ambient Water Quality Monitoring Program (EPA) are undertaken by distinct parties (Bundaberg Council, consultants and/or industry and EPA). Therefore, methods as well as Quality Assurance systems may vary considerable.
- There seems to be evidence of lack of integrated training and quality assurance within the entire system.
- Lack of integration of Sunwater data. The change of custody of several quantity and quality stations/sites from DNR to Sunwater with the commencement of the resource operations plan (placing onus of some sites on the ROL holder) has reduced NRM datasets significantly.

  Water quality data collected by Sunwater is thought to be of value for local and regional assessments (particularly sites upstream of impoundments and sites with NRM history) and would enhance existing data sets for DNR/EPA. This data is now protected by commercial in confidence. This data protection negates the usefulness of any of this data and negotiations are currently underway for access to Sunwater data.
- Lack of integration of EPA collected data - the point source and fish kill data does not appear to be utilised other than for compliance assessments. This data could contribute substantially to local and regional assessments.

Any of the gaps recognised above contribute to the general lack of coherent systems (integrated and logistical approach) for detecting the base causes of fish deaths and other system degradation together with ensuring the widespread availability of critical data (Sunwater commercial in-confidence). There appears to be a general lack of profiling of stratified water columns (by government) and detection of critical changes in the structure of the biota (e.g. proportion of volume of water column that may be anoxic at overturn or toxic algal blooms). Combined with the lack of system testing for other contamination or toxins (herbicides, pesticides etc), the paucity of spatial and temporal physico/chemical data for the inland regions and the lack of quality systems, the ability of the current state government monitoring networks to predict or even to detect serious problems is considered nominal.

3.2 Local government monitoring

The following 18 local councils/shires are required to perform compliance water monitoring for potable water and for water discharge sites (primarily from waste water treatment plants) to meet Environmental Protection Agency licence requirements. The suite of general parameters measured in raw source water by most shire councils (within potable water supply schemes) is shown in Table 6 and deviations from this list are noted within each respective council section. All councils within the Burnett Basin were contacted (some multiple times) with requests for water monitoring information (including sites and parameters), however some information on specific parameters tested by some councils is still outstanding due to time constraints.

Aside from regulatory monitoring, Bundaberg and Burnett Shires undertake additional environmental and ecosystem monitoring, some of which relates directly to water quality and is considered valuable.

Table 6: The suite of parameters generally tested for within raw water for potable water supplies in the Burnett Catchment.

General	Cations	Anions	Other Dissolved Element
Conductivity (µS/cm)	Sodium	Bicarbonate	Iron
pH at 21 ° C	Potassium	Carbonate	Manganese
Total hardness (mg/L CaCO3)	Calcium	Hydroxide	Zinc
Temp. Hardness (mg/L CaCO3)	Mangesium	Chloride	Aluminium
Alkalinity (mg/L CaCO3)	Hydrogen	Fluoride	Boron
Residual Alkalinity (meq/L)		Nitrate	Copper
Silica (mg/L)		Sulphate	
Total Dissolved Ions (mg/L)			
Total Dissolved Solids (mg/L)			
True Colour (Hazen)			
Turbidity (NTU)			
Total Suspended Solids (mg/L)			
pH (calc for CaCO3)			
Saturation Index			
Mole Ratio			
Sodium Adsorpt Ratio			
Figure of Merit Ratio			

3.2.1 Miriam Vale Shire Council

The Miriam Vale Shire Council conducts monthly water monitoring within the Agnes Water Sewerage Scheme and the towns potable water supplies.

Within the town's potable water monitoring program, Miriam Vale Council monitors additional parameters (shown in Table 7) to the general suite monitored by most water supply schemes (refer to Table 6). Of the additional parameters monitored, the most notable and relevant are arsenic and phosphate (discussed in Section 3.2.19).

Table 7: Additional parameters monitored within Miriam Vale Shire Council's potable water scheme.

Parameter	
Temperature	Alkalinity to pH 4.5
Suspended Solids	Free Carbon Dioxide
Filterable reside	Langeier Index
Calcium Hardness	Ionic strength
Magnesium hardness	Ammonia
Silica	Organic matter
Nitrite	Arsenic
Phosphate	

The Sewerage Treatment Scheme involves water quality monitoring of creeks (three sites), treated effluent (re used for irrigation – samples taken in the irrigation area or lagoon (L3, L4) outlets), soils (eight sites), storm water (eight sites) and groundwater (eight sites). Details of parameters measured at these sites are available in Table 8. The Deepwater Creek water quality monitoring program is part of a one year macroinvertebrate study within Deepwater National Park and two samples of macroinvertebrates are planned in 2004-5 (dry and wet season) as part of Stage 2 of the study.

Creek sites are located upstream, adjacent and downstream to sewerage treatment plant in Deepwater Creek (3.5km buffer zone from plant to creek. Treated effluent sites include the irrigation area and/or the lagoon outlets (L3, L4). Storm water monitoring is conducted at lots 20 (three sites), 21 (three sites) and in Deepwater National Park (two sites), as are groundwater sites. Parameters and frequency of monitoring for these programs are presented in Table 8.

Table 8: Parameters and frequency of monitoring for creeks, effluent water for irrigation, stormwater and groundwater by Miriam Vale Council as part of the Agnes Water Sewerage Scheme.

Parameter	Units	Frequency			
		Creeks	Irrigaton	Stormwater	Groundwater
pH	units	1-2*m	1	6	6
Electrical conductivity	uS/cm	MV	1	6	6
Suspended Solids	mg/L	1-2*m	1	6	NR
Turbidity	FBU	1-2*m	NR	NR	NR
Total dissolved salts	mg/L	NR	1	6	6
Total calcium	mg/L	NR	6	6	6
Total Chloride	mg/L	NR	NR	6	6
Total alkalinity (as $CaCO_3$)	mg/L	NR	NR	6	NR
Total aluminium	mg/L	NR	NR	6	NR
Total arsenic	mg/L	NR	NR	6	NR
Total nitrogen (as N)	mg/L	3	3	6	6
Total magnesium	mg/L	NR	6	6	6
Total mercury	mg/L	NR	NR	6	NR
Total phosphorus (as P)	mg/L	NR	NR	6	6
Total potassium	mg/L	NR	6	6	6
Total sodium	mg/L	NR	6	6	6
Phosphate		NR	3	NR	NR
Dissolved oxygen	mg/L	1-2*m	1	6	NR
Total phosphorus (as P)	mg/L	3	3	NR	NR
Copper		NR	24	NR	NR
Non-ionic surfactants	mg/L	NR	1	NR	NR
Ionic surfactants	mg/L	NR	1	NR	NR
Chlorophyll 'a'	ug/L	3	1	NR	NR
Sodium Absorbtion Ration	mg/L	NR	6	6	6
Sulphate		NR	NR	NR	6
BOD5		NR	1	NR	NR
Faecal coliforms	org/100ml	3	1	6	NR

Notes: * - every one month during wet season, two months in dry season
MV - not required but taken for Miriam Vale Shire records,
NR - Not required

3.2.2 Bundaberg City Council

Community health monitoring

Under the Bundaberg City Council's Community Health Plan, the Council strives "to provide a sufficient & sustainable water supply for long term economic growth and to raise public awareness of the need for water conservation" (Bundaberg City Council, 2004). This policy is employed through a number of strategies, including:

- Promote Waterwise in Bundaberg City in partnership with other agencies and the community,
- Promote the use of rain water tanks,
- Promote municipal water re-use,
- Develop information dissemination system which includes a centralised information point for all water quantity/quality issues,
- Advocate for increased water infrastructure for Bundaberg District,
- Promote biological control of weeds in the Burnett River,
- Ensure that environmental flows that allow for regular flushing are considered in the water resource plan,
- Ongoing education and enforcement of Environmental Protection legislation,
- Investigate practical options to provide gross pollutant screening,
- Investigate education program to mark environmental warning on stormwater outlets/catchpits,
- Educating builders regarding discharge from building sites e.g. Exposed aggregate,
- Maintain ongoing monitoring of water quality in Burnett River,
- Regular feedback to industry and community of results from environmental water quality monitoring.

Water for Bundaberg City is sourced primarily from the Burnett River, with some bore supplement in dryer periods. Council undertakes several monitoring programs to comply with its Community Health Plan and other current Health Regulations for potable water supplies. These programs include:

1. Point source monitoring of discharge points of three locations- North Wastewater Treatment Plant, East Wastewater Treatment Plant and Millbank Wastewater Treatment Plant. Monitoring involves weekly measures of pH and dissolved oxygen, fortnightly measures of BOD, suspended solids and feacal coliforms and monthly testing of total nitrogen and total phosphorus levels.

2. Monitoring of intake water from the Burnett River at the Box Road Water Treatment Plant as per compliance standards and recommended guidelines for drinking water (pysico/chemical analysis as per Table 6, herbicides and pesticides, cyanobacteria etc). Several parameters measured here are thought to be of particular use to advise water managers of contamination and toxins in source water (pesticides, herbicides, blue-green algae).

3. Monitoring of the town's potable water supply at selected locations at least twice monthly. Water is tested for coliforms, *E.coli* and chlorine concentration.

4. Monitoring of a natural or manmade water system after an adverse event (e.g. fishkill monitoring). Council has an arrangement with Maryborough EPA office to respond to fish kills in the small area, which is Bundaberg City Council. This response is a general one and the investigation and holding of records is conducted through the EPA office in Maryborough. Water quality parameters (DO, pH, conductivity and temperature) are taken to determine cause of kill (usually low DO from urban stormwater flush – for example into Baldwin Swamp) and data is passed to EPA, where is used for reporting purposes and then passed to the Environmental Technical Services Section of EPA for storage or consideration for use in future regional assessments.

5. Monitoring of Councils sewer system to ensure that a premises is complying with the Trade Waste Policy. The objective of the policy is to minimize the entry to the sewerage system of all substances that cannot be effectively treated, and to ensure Bundaberg City Council

protects works, assets and receiving waters from harmful trade waste substances (Bundaberg City Council, 2002). Council performs inspections and monitors Trade Waste Generator's premises annually however; it is the Trade Waste Generators responsibility to ensure that both the quality and quantity of waste discharged are in accordance with Council's standards. Samples that are collected are tested for specific parameter levels (water temperature, discharge rate, suspended solids, pH, BOD, COD, dissolved solids etc) in the discharge.

Environmental monitoring – new initiatives

Several new initiatives of the Bundaberg City Council are presently in design phase, and include

- the development of Storm water Quality Monitoring Program for each of the creeks in Bundaberg City.

  'The testing will involve hand sampling of ambient standing waters on a regular basis (e.g. seasonal) and hopefully automated sampling of first flush storm water runoff water at strategic locations within each catchment. The number of locations for automated testing will depend on the amount of future development in a catchment and cost' (Follett, M. Bundaberg City Council. pers. comm., 2004).

- an aquifer recharge project in a new suburban development;
- implementation of a Mangrove Management Plan.

'This plan involves the trimming / hedging of mangroves as well as removal in certain areas. One of the plan's objectives is to involve tertiary education facilities in the maintenance program and the investigation of the effects of mangrove trimming, hedging and removal on the surrounding ecosystems' (Mark Follett, Environmental engineer, Bundaberg City Council).

Personnel developing these new projects (primarily Mark Follett, Environmental engineer) have indicated a willingness to meet Quality Assurance standards presently being investigated within NRM and this PAP, as well as enthusiasm for community involvement in projects. Council is also willing to look at training provision and assistance to community monitoring.

Section note: In view of the above, the Bundaberg City Council is well placed to become established as a technical node within the Water Monitoring Network (discussed in the report for Component 2).

3.2.3 Burnett Shire Council

Protecting and enhancing the Burnett Shire's water, air, flora, fauna, and other natural resources is a priority within this council. Burnett Shire Council undertakes several water quality monitoring programs described below.

1. Point source monitoring is undertaken at the Bargara Wastewater Treatment Plant to meet with the standards set by the Environmental Protection Act Licence. It undertakes measures of pH and dissolved oxygen daily and monthly monitoring of BOD, suspended solids, feacal coliforms, total nitrogen, total phosphorus and free residual chlorine.

2. Monitoring of raw potable water supplies is undertaken daily at the water treatment plant for a suite of general parameters (temperature, pH, conductivity, total dissolved solids, turbidity, colour, alkalinity iron and chlorine) and monthly for general parameters listed above as well as calcium, magnesium, total hardness, nitrite, nitrate, aluminum, copper, chloride, sulphate and salinity.

   Pesticides and herbicides are not tested for on a regular basis, although measurements are taken on an average on once per year. The water treatment plant initiates cell counts for blue green algae if the algae are found to be present in the Burnett River. If cell counts at the water treatment plant reach alert levels, a sample of treated water is sent to a commercial laboratory for a toxin analysis to ensure treated water is toxin free.

3. An outfall-monitoring program is carried out at Nielson Park, Bargara. Point source monitoring is undertaken at seven sites surrounding the outfall pipe at Nielson Park. This program started in 1995 and has been monitored annually up until 1999 where it has been monitored twice yearly. At each site, water samples are collect and analysed for biological, physical and chemical variables. Biological variables that are tested include feacal coliforms and chlorophyll a. The physical variables analysed to indicate water clarity are turbidity and suspended solids. Nitrogen, phosphorus and pH are the chemical variables that are monitored.

4. In combination with the above point source program at Nielson Park, a monitoring program of benthic communities in marine areas adjacent to the outfall pipe of the park is carried out. This program began in 1995 with 2 transects operational however, since then, the project has expanded into 24 transects within 6 sites (3 impact and 3 control sites). In each site, transects of the sea floor are filmed and benthic groups are recorded. These groups include non-living (abiotic) substrate such as sand, rubble silt and rock- hard coral, soft coral, macro algae, calcareous algae and sponge. An additional benthic group is recorded and includes ascidians, crinoids and groups of organisms that occur infrequently. The program incorporates monitoring of water temperature, recorded every 30 minutes at one impact site and one control site. The biological monitoring component of this work is considered particularly important in view of the general lack of this type of monitoring within the Burnett marine region.

The Burnett Shire Council is a major sponsor of Woongarra Marine Park Education and Monitoring Project (WMPEMP) and supports the aims and objectives of this community group.

3.2.4 Kolan Shire Council

Kolan Shire Council's mission is to "provide and maintain an environment that enables the achievement of goals for the community" (Kolan Shire Council, 2004).

Town water is drawn from a channel sourced from the Fred Haigh Dam. Water testing prior to treatment occurs weekly at Kolan Council's water treatment plant for general water quality parameters including pH, temperature, conductivity etc (full list not provided). Sunwater provides additional water-testing results to Kolan Shire Council from their monitoring of Fred Haigh Dam (as per their Resource Operations License requirements). This includes monthly water quantity and quality testing (parameters specified in section 3.1.6) as well as testing for cyanobacteria. If cyanobacteria blooms are present, Sunwater alerts the Kolan Shire Council, whom then initiates their own blue-green algae monitoring (cell counts).

The Council undertakes point source monitoring at the Kolan Sewerage Treatment Plant's discharge site with weekly monitoring of BOD, suspended solids, dissolved oxygen and pH. Feacal coliforms are tested for monthly and total nitrogen and phosphorus are measured quarterly.

3.2.5 Monto Shire Council

The Monto Shire Council conducts monthly water monitoring of the towns potable water supply - bore water sourced from the Three Moon aquifer (parameters presented in Table 6). No other water monitoring is conducted, primarily due to the lack of surface water in this region.

The Eidsvold Shire shares an environmental health officer with Monto Shire Council.

3.2.6 Eidsvold Shire Council

The Eidsvold Shire Council conducts monthly water monitoring of the towns potable water supplies. Water is pumped from the Burnett river to a bore, which supplies the town (parameters supplied in Table 6). No other water monitoring is conducted.

The Eidsvold Shire shares an environmental health officer with Monto Shire Council.

3.2.7 Mundubbera Shire Council

The Mundubbera Shire Council conducts monthly water monitoring of the towns potable water supplies (ground supply form a bore in the river bed) only (parameters not supplied but from discussion are similar to the list in Table 6).

The Mundubbera Shire shares an Environmental Health Officer with the Perry and Gayndah Shire Councils. Mundubbera Council is unaware of any community groups that might contribute to water monitoring in the shire.

3.2.8 Perry Shire Council

The Perry Shire Council conducts monthly water monitoring of the town's potable water supplies (bore supply) only (parameters not supplied).

The Perry Council has not been informed of community groups that might be involved in water monitoring within the shire.

3.2.9 Biggenden Shire Council

The Biggenden Shire Council conducts water monitoring of the towns potable water supplies only (parameters and sites not supplied).

No additional water quality monitoring is carried out in the Biggenden Shire. The Council has not been informed of community groups that might be involved in water monitoring within the shire.

3.2.10 Kilkivan Shire Council

The Kilkivan Shire Council conducts water monitoring of the towns potable water supplies (parameters listed in Table 6). The monitoring is conducted on untreated water from a number of bores within the township. Besides the usual parameters measured (Table 6) Kilkivan Shire Council also test for herbicides (atrazine, diuron, triazine) and pesticides (organochlorines and organophosphates).

No additional water quality monitoring is carried out in the Kilkivan Shire. The Council has not been informed of community groups that might be involved in water monitoring within the shire.

3.2.11 Nanango Shire Council

Nanango Shire Council conducts water monitoring of the towns potable water supplies and point source monitoring within the towns sewerage outfall scheme. Town water is bored sourced and parameters measured in raw water supplies (prior to treatment) are provided in Table 6.

Sewerage outfall monitoring is undertaken monthly for suspended solids, BOD, feacal coliforms and free residual chlorine.

3.2.12 Isis Shire Council

The Isis Shire Council undertakes water quality monitoring of their town water supplies (sourced from the Gregory River) and within their sewerage-monitoring scheme. Specific parameters measured within raw town water are specified within Table 6. Monthly testing is also undertaken for coliforms on a monthly basis.

The Council conducts monthly point source water monitoring at the Isis Sewerage Treatment Plant's discharge site. Monitoring involves the measurements of dissolved oxygen, pH, total suspended solids, BOD, feacal coliforms and free residual chlorine.

3.2.13 Gayndah Shire Council

The Gayndah Shire Council conducts monthly water monitoring of the towns potable water supplies (groundwater supply from a bore in the river bed) only (parameters and sites not supplied).

The Gayndah Shire Council also conducts a point source monitoring program for the discharge point of its Final Settling Pond. The program assesses pH and dissolved oxygen daily, while BOD, suspended solids, and feacal coliforms and dissolved salts are measured monthly. Monitoring at the site also occurs bi annually, for records of total nitrogen and total phosphorus.

Gayndah Shire Council has contributed to the development of this PAP. Shire Council members have been active in contributing via the project Reference Group and through community meetings. At community meetings, a Project Officer was considered priority for the Gayndah area to engage all sectors of the community effectively and to start on ground activities.

Section note: Council is currently negotiating with BCCA south and BMRG for a central office location for NRM. This could assist CEM's strategy for the establishment of technical nodes in strategic sectors of the Basin – one of these areas having been identified as Gayndah. Judith Renshaw (Gayndah Shire Council) has discussed the need for a conceptual model to understand the large positive spin off from having a central NRM office.

3.2.14 Murgon Shire Council

The Murgon Shire Council conducts water monitoring of the town's potable water supplies (parameters listed in Table 6) and sewerage treatment scheme. Murgon Shire Council carries out no further water quality monitoring and Council is unaware of any community groups that might contribute to water monitoring within the shire.

Monthly monitoring is undertaken for coliforms and *E.coli* at the Water Treatment Plant, Gore St Pump Station, the Pulse, Hospital and Goodchild Drive. Three of these sites (Water Treatment Plant, Cemetery and the Sale Yards) are also assessed for chemical parameters such as pH, conductivity and a range of cations and anions on a two-three monthly basis (full list in Table 6).

3.2.15 Wondai Shire Council

Wondai Shire Council conducts water monitoring of the towns potable water supplies in accordance with world health guidelines for drinking water (parameters not supplied). No additional water quality monitoring is carried out in the Wondai Shire. Council reported inactivity among the previously active community groups in the Shire (reasons unknown but suspected lack of funding) and expressed concern with respect to this situation.

3.2.16 Cherbourg Community Council

The Cherbourg Community Council undertakes water monitoring of the towns potable water supplies. This includes at least weekly testing for pH, Chlorine and Alum at the water treatment plant. Additional water samples are regularly taken and sent to a health laboratory for analysis of *E. coli* and feacal coliforms. Occasionally, water samples are sent to an external laboratory for a full chemical analysis (list as per Table 6). No testing is undertaken for cyanobacteria, pesticides or herbicides.

3.2.17 Kingaroy Shire Council

Kingaroy Shire Council has a number of NRM planning, water and sewerage and environmental health service initiatives in place and a full time NRM officer (Leanne Peterson). The Shire has, in recent years, successfully implemented an ongoing (continuation) Natural Heritage Project. The highly strategic project titled 'Implementation of the Kingaroy Shire Remnant Vegetation Management Strategy' and its associated steering committee, achieved several outcomes (listed in Table 8)

Table 9: Strategic outcomes from implementation of the Kingaroy Shire Remnant Vegetation Management Strategy (NHT project).

Output	Description
Winner of the 2002 Queensland Arbor Day Award	Kingaroy Council had received two prizes I the 2002 Queensland Arbor Day Awards, with wins in the local government and regional categories. Councils project was deemed the best in southern Queensland, ahead of 13 other entrees.
Runner up for the Local Government Land Care Award	Kingaroy Council was runner up.
Kingaroy Bottlebrush Community Nursery	Expansion of this nursery to provide local indigenous seedlings free of charge to rural property owners undertaking strategic Natural Resource Management Activities.
Community revegetation activities	Three activities were undertaken at priority sites though out the shire to address issues such as habitat restoration, corridor enhancement, water quality and erosion control.
Kingaroy Significant Environmental Area Signage Program	Implementation of this activity to raise awareness of areas of environmental significance, which exist in the shire.
Land for Wildlife Program	Continuation of this program with a total of 21,644.2 ha of land currently mapped and protected in Kingaroy Shire
Wooroolin Wetland Biodiversity Project	Support by council for the implementation of this project.

The Kingaroy Shires environmental levy contributes to the development and implementation of highly strategic NRM and environmental programs such as those detailed above. The levy also partially funds the Natural Resource Management Officer who coordinates implementation of these projects and deals with NRM issues. The council is a partner in Kingaroy Landcare and supports the Landcare group in acquisition of funds for on ground activities. Council also assists independent landowners in acquiring Envirofund money for rehabilitation. Other collaborative project partners include the SGAP (Society for Growing Australian Plants, Kingaroy Branch), to whom council has provided both on ground and in kind support and commitment within collaborative projects (Revegetation of a damaged area within an endangered habitat; series of three information booklets of Illustrated Guides to Dry Rainforests of Mt Wooroolin, Gayndah and Coalstoun Lakes). These projects are providing opportunity for the wider community to be more involved in environmental issues.

The Water Engineers department within council undertakes a limited amount of monitoring, however, the sites and parameters measured were not made available.

New Initiatives

The Kingaroy council is presently attempting to expand their level of NRM activity and is looking for additional money and support to facilitate this forward movement. There are a number of projects

they are attempting to fund either separately or in conjunction with ongoing projects to enable value adding to these existing programs.

One project currently under negotiation is the investigation of groundwater and conductivity levels. This project will help assess where salinity is entering the river system and focuses two main areas – (1) the urban area of Kingaroy and (2) the Crawford district (with a variety of subcatchment activities including grazing, forestry, cropping etc). Sites will be placed along the Stuart River down to the Gordonbroke Dam.

The Greencorps team - collaborative across five councils (Nanango, Wondai, Cherbourg, Monto and Kingaroy) and CTCU are applying for funding for rehabilitation of Gordonbroke foreshore. This includes tree and vegetation planting and sites for assessment.

Council is also in the process of acquiring another NRM/pest management officer to assist in the implementation of projects and provide extra resource capacity. This officer will be assisting with mapping of class 1and 2 pests and then environmental weeds. Much of this work will be centered on creeks and rivers, and it has been suggested that aligning these activities with other programs may allow the collection of extra data and information (has been suggested the NRM officer could collect other parameters etc while they are at the site).

Council is also aiming to put more effort towards instream monitoring in the future.

Where Kingaroy Council projects may link with PAP priorities

Several impending council projects present valuable opportunities in their respective objectives for contribution to filling gaps and covering hotspots recognised in this PAP. For example, Kingaroy Shire Council recently acquired Envirofund money for a landowner at the top of the Stuart River (under the Bunya mountains) to fence off 6km of riverfront to assist in preventing erosion. Projects like this play an important role in contributing to cover/monitoring of hotspots (priority areas). Parallel water quality projects enable assessment of the effects and benefits of the project on the water quality in the adjacent river.

The council groundwater and salinity project could provide some form of gap filling for knowledge of drivers of salt outbreaks (inland plains are noted as hazard areas). Greencorps projects could assist in gathering phys/chemical data if the respective project scope was expanded. The employment of two NRM officers at council and the strong partnership with Landcare could provide additional human resource capacity, given development of the appropriate partnerships and/or expansion of current and future projects.

3.2.18 Gaps analysis – local government.

Most local governments and shires do not undertake ambient monitoring programs other than their own compliance monitoring for raw (prior to treatment) and treated water (potable and effluent release). Further, current monitoring programs undertaken by councils are frequently incomplete, as the majority of councils do not test for the full suite of parameters recommended by the Australian Drinking Water guidelines to determine contamination and/or potential health dangers (Australian Government, 2004). Some points of contention include:

- Lack of testing for contamination by pesticide and herbicides in bore or river water
    - Bundaberg, Kilkivan and Burnett City/Shire Councils were the only councils who provided information regarding the regular monitoring of pesticides and herbicides. In view of the extensive agriculture and hence potential sources of contamination within inland and coastal subcatchments and the high proportion of towns and shires that use bore water as their primary or secondary water source, the apparent current lack of regular testing by councils is significant.
- Lack of evidence of appropriate choice of compounds to measure

- Most councils did not include arsenic in their suite of parameters to be tested (exceptions were Kilkivan Shire Council, Miriam Vale Shire Council and Bundaberg City Council). Arsenic occurs naturally in some sediments and arsenic poisoning due to exposure to natural or anthropogenic arsenic has been reported throughout the world (Jacarya, 2000). A study of Darwin's surface water exports found the main contribution of arsenic to be from undisturbed land (390kg/yr) as opposed to rural (140kg/yr), industrial (130kg/yr) or urban (70kg/yr) (Northern Territory Government, 2000). (Note: there is a possibility that ambient local levels do not require monitoring (perhaps determined through early studies); however this information was not made available.)
- Lack of testing by Nanango Shire Council for any form of oxidized nitrogen. This includes nitrite nitrogen, (usually produced from ammonia) and nitrate nitrogen, which can be toxic to infants at reasonably high concentrations – hence nitrates should be monitored for (with contamination noted at >10mg/L (LWRRDC, 1999) and recommended guidelines of 50mg/L (Australian Government, 2004)). Very high nitrate concentrations (200-300mg-NO_3/L) have been recorded in rural groundwater supplies and intensification of farming practices has lead to increasing proportions of nitrate in waters, particularly groundwater (Australian Government, 2004). Further, past studies have noted contamination of groundwater (>10mg/L) by nitrate to the north of Bundaberg and around Moore Park areas (believed to be related to fertiliser and septic use - Queensland Government, 1999) and this could apply to inland areas also. Testing for nitrogenous compounds should form an essential part of any raw drinking water analysis within the Burnett Catchment.
- Lack of testing for Mercury by most shire councils. Mercury was used in fungicides for sugar cane over the last 100 years and monitoring for this compound is recommended quarterly or event based (Australian Government, 2004). The large areas of land used for sugar cane across the Burnett Basin should dictate the diligent monitoring of this heavy metal by water managers.

- Lack of monitoring for blue green algae (cyanobacteria) by most shire councils who use rivers as their primary or secondary water supply. Where councils do monitor for cyanobacteria, testing programs are considered inadequate in both their monitoring frequency and their ability to detect algae toxins and instigate action promptly enough. Testing for taste/odour and toxin-producing organisms and characteristics affecting their growth is recommended weekly to monthly (Australian Government, 2004).
- Lack of monitoring of organic contaminants (recommended monthly if persistent and/or event based).
- Lack of monitoring for radionuclides (recommended every five years for surface water and every two years for groundwater and more often if a guideline is exceeded).
- Lack of water column depth profile monitoring in rivers for (minimally) temperature, dissolved oxygen, pH, electrical conductivity.
- Failure to measure fluoride in raw water or treated water release. Several inland creeks and rivers in Queensland have naturally high fluoride levels and councils should determine natural local levels in raw water. Further, if natural levels are high, additional input of fluoride to the system (through wastewater) may cause concentrations in the receiving water to exceed recommended guidelines (Note: as for arsenic, councils may have initially tested for this parameter and found low levels, hence there would be no requirement to monitor – this sort of information was not available). Fluoride was often added at up to 1 mg/L to protect against dental cavities (concentrations of > 1.5 mg/L can cause dental fluorosis and concentrations > 4 mg/L can cause skeletal fluorosis).
- No information relating to quality assurance (QA) procedures was made available.

Any of the gaps documented above create the real potential for significant short or long-term human and environmental health risks to go undetected. The lack of testing by the majority of water managers for contamination and toxins in drinking water is a key area for future management.

In view of the wide distribution of highly toxic species of cyanobacteria (blue-green algae), including *Cylindrospermopsis raciborskii* across the Burnett catchment (Fabbro, L., pers. comm., 2005; Mc Gregor, and Fabbro, 2000) and the prevalence of low flow conditions, the potential for toxic blue-green algae blooms to occur at certain times of the year is extremely high. *Cylindrospermopsis raciborskii* has been responsible for significant toxicity episodes in Australian reservoirs and recreational waters, including outbreaks of severe hepatoenterities and renal damage (Mc Gregor, and Fabbro, 2000; Ohtani and Runnegar, 1992; Hayman, 1992). Water managers sourcing water from dams or from pooled sections of rivers in times of low flow, should conscientiously undertake testing for both algal cell counts and/or toxins. The lack of substantiating data by water samplers also reduces the value of current programs. It would be beneficial for local sample collectors to make observations when collecting samples from rivers. Photographs are particularly relevant to note aspects such as floating plant masses or algal scums, colour of the water (toxic blooms are often a particular colour – e.g. red), bird life or invertebrates around the waters edge (snails etc). There was a notable lack of knowledge regarding blue-green algae toxicity issues, which related to inland rather than coastal councils.

Similarly, given the large agricultural and intensive irrigation areas (many adjacent to waterways) within the catchment, the risk associated with contamination of ground and river water by agricultural chemicals (herbicides and pesticides) and/or nutrient is generally very high. Major pathways for entry of pesticides to waterways include spray drift, runoff from rainfall following pesticide application including aquifer recharge by vertical infiltration and tailwater discharge (Arthington *et al,* 2002; Williams *et al*, date unknown). Within this study, coastal councils were found to be more vigilant in testing for agricultural contamination than inland councils. The majority of inland councils do not undertake any testing for contamination, regardless of the proportion of land contiguous to their water supplies that is used for deep irrigation /agricultural purposes. It is recommended that a wide range of pesticides and herbicides be monitored within town water supply systems.

Despite the paucity of many council testing programs (for raw water), some of the data collected over the years has the potential to be useful to water managers. River or storage data should be assessed in a local and regional context to determine relationships between variables and potential system drivers such as volume and flow of water and nutrients. Similarly, ongoing bore testing provides temporal information on water quality of aquifers; electrical conductivity measurements in particular provide crucial information where groundwater analysis is minimal and saline influence is a recognised or potential problem. Town water testing of bores also provides regular measurements of turbidity that, for the majority of towns within the catchment, appear to react quickly to flow conditions (this is not surprising as several are short bores sunk in the middle of river beds) – exceptions are Nanango, Eidsvold and Monto where varying turbidity is not an issue. There is a maximum turbidity level in place, at which water treatment plants have to be shut down. Investigation of "shut down events" may provide information regarding frequency and duration of high turbidity events within the inland Burnett.

Further, several existing council monitoring programs are recognised as providing valuable data. The monitoring by Burnett Shire, adjacent to and surrounding the outfall at Bagarra, is an important source of marine biological data in a region with minimal ongoing coastal estuarine or marine monitoring programs. The high standard of collection and QA (programs developed in collaboration with AIMS and undertaken at a high level - either AIMS trained staff or Centre for Environmental Management staff) attached to this project increases its value. The scope of the Agnes Water Sewerage Scheme (Miriam Vale Council) is considered significant in view of the lack of information and the expanding population in this region, particularly the water quality monitoring in Deepwater Creek. This monitoring is attached to a macroinvertebrate study in Deepwater National Park, increasing its value.

The Australian Drinking Water Guidelines describe the process for developing monitoring programs for drinking water. Cost-effective monitoring programs should focus on key characteristics, local knowledge and experience of these characteristics and their variability. In many cases primary and secondary sites can be used – for example if several tributaries contain similar characteristics, managers may monitor one or two key downstream locations as primary sites and measure other sites less regularly (as secondary sites i.e. every third time) (Australian Government, 2004).

While discussing the above section with councils of the Burnett Basin it was obvious that respective NRM interests of local government generally extend far beyond water quality monitoring, with councils/shires expressing a desire work with local NRM and catchment groups and to offer assistance in the way of in kind support (many councilors are active members of catchment and Landcare groups). This study found that some councils are in a period of rapid growth and development with respect to NRM issues and projects, and given this, the above summaries of current catchment activity by councils have proved timely in providing some insight into the possible future role of local government within NRM.

3.3 Industrial monitoring notes

There was representation from a wide range of industries throughout the week of community meetings across the Burnett Basin (first week of November, 2004). Other information relating to industrial monitoring was made available through EPA (point source information and discussion with staff) and PAP2.1/2.2 Reference Group Members. It appears that a moderate amount of environmental and water quality monitoring within the catchment is undertaken by local industrial sectors. While many of these programs are for license compliance reasons, others are self-initiated or beyond compliance requisites (and therefore unknown).

At this point industry is noted as a highly potential contributor to the development and functioning of a community based Water Quality Network within the Burnett basin. Discussion within community meetings included possibilities of links between community groups and local industry for support and access to laboratories and equipment. Generally, industry representatives responded favorably to suggestions of collaboration. For example Barambah Olive Estate Pty Ltd near Murgon (owned by Dennis Bishop) monitors water quality and quantity and have indicated they would be happy to undertake this monitoring in collaboration with local NRM groups. Other links already exist between industry and catchment groups in some areas.

Unfortunately, a full investigation of private industrial water monitoring within the Burnett systems was beyond the scope of the present study. Gaps and duplicity were assessed for government and community monitoring, but industrial sites and parameters were not included in this assessment and, therefore, the overall contribution on a basin-wide level remains unknown. For example the Olive Grove mentioned above may be WQ data gap filler but the data is not available to be included in regional or local assessments etc.

It is evident that there is currently no integrated approach between industrial and 'other' water monitoring within the Burnett. Some industries have formed links with NRM groups but not to the degree of sharing sites and data to ensure appropriate cover within respective regions. The practice of autonomous industries is not conductive to effective waterway management that (especially in large systems) relies on sharing of information to ensure appropriate cover and optimal resource use. Industries that were contacted through this study are presented in Appendix 2.

3.3.1 Point source monitoring by industry

Client confidentiality in point source monitoring (for EPA license compliance) may have significant implications for the inclusion of these industries/data as contributors to a monitoring network. The likelihood of industries operating under point source release licenses to share data to such a network will depend on individual circumstances; some industries have expressed concern about finger

pointing and repercussions of data being made available to a wider audience. These issues raise potential conflict between ecological and economic interests of industry and may require overarching integration of vision and objectives in bring this information to common use. Further, environmental consultants undertake data collection for many of these industries; in these cases the industry will have limited resources to offer on ground. Data collected through point source monitoring would be particularly useful in a study examining the receiving environment.

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Chapter 4 Component B: Current community-based water quality monitoring networks

4.1 Current community water quality monitoring

This section documents the existing catchment groups who monitor water quality within the fresh and saltwater reaches of the Burnett Basin. It also includes community groups (mainly Landcare) who do not currently monitor water quality but either (1) undertake substantial rivercare activities or (2) have the capacity or interest to monitor water quality in the future. The undertaking of an evaluation and inventory of the functioning of these community groups was considered essential to fully understand the groups' capacity (human resources, technical, economic, quality assurance (QA) systems) to function within an integrated water quality monitoring strategy through on ground actions. For this reason sub-catchment groups (within larger organisations) have been assessed individually. Further input to this report was from a series of community meetings held around the Basin. Attendance by all respective organisations/community/industry members at meetings and NRM contacts within this project are listed in Appendix 2, whereas community groups only are listed in Table 10.

Please note that information put forth within Section 4.1.1 "Inland community water monitoring groups" is based on dialogue between CQU employees and representatives/members of community groups, local shire councils and government and may not, therefore, be completely reflective of each group's current situation (group capacity was found to be a subjective topic even within groups).

4.1.1 Inland community water monitoring groups

A list of all respective community water monitoring (or active NRM) groups who were contacted within this project either independently or through community meetings is given below (Table 10). While the Wide Bay Burnett Conservation Council is not a "community group" as such, this organisation undertakes environmental research in the Wide Bay Burnett coastal region (often in conjunction with community volunteers) and is, therefore, included in the following section. Discussions with individual members of community groups via meetings, phone calls and emails provided the information necessary for the section below. Section 4 provides a summary table of the information described below.

The CQU PAP project has sparked cooperation between Landcare and Catchment Care groups as well as with councils. There is general support from groups towards working together, supporting each other and pooling resources.

Table 10: A list of the community NRM groups contacted through the course of PAP 2.1/2.2.

Organisation	
Burnett Catchment Care Association (BCCA) - North subcatchment	Landcare - Kolan
Burnett Catchment Care Association (BCCA) - Central subcatchment	Landcare- Gayndah
Burnett Catchment Care Association (BCCA) - South subcatchment	Landcare - Mundubbera
Burnett Catchment Care Association (BCCA) - East subcatchment	Landcare- Kingaroy
Burnett Catchment Care Association (BCCA) - Committee	Landcare - South East/Tansey
Burnett Catchment Care Association (BCCA) - Waterwatch	Landcare - Nanango and District
Woongarra Marine Park Montiorng and Education Project	Landcare - Eidsvold
Baffle Creek Catchment Management Group	Landcare - Baffle Creek and District
Lowmead Indigenous NRM Group	Landcare - Agnes Water
Cherbourg Indigenous NRM Group	Landcare - Smalls Creek
Three Moon Salinity Group	Landcare - Bundaberg and District Urban
Wide-Bay Burnett Conservation Council	Landcare - Isis
Landcare - Monto	Landcare - Proston
Landcare - Wondai	

North Burnett Subcatchment

Monto Landcare: Monto Landcare serves the Monto/Eidsvold area. This group has been active in the area in the past and has formed collaborations and local partnerships to provide funding of catchment projects. They do not undertake water quality monitoring at present and do not own water quality equipment (therefore no QA systems are noted) or possess water quality data. Past rivercare projects have included Integrated Management in the North and Central Burnett (NHT 1999) and weed control projects for catsclaw, lantana and mother of millions within riparian zones. Data sets to date are in hard copy form and reside with group members or secretary.

BCCA North: A water catchment group with no current on ground activity, water monitoring equipment or data, and reduced human resources (therefore no QA systems are noted). This group has implemented NHT-funded projects in the past (Restoration of native riparian vegetation in the upper Burnett - NHT-1999/2002) with assistance from the Burnett Catchment Care association. Datasets collected remain in hard copy form with group members or secretary.

The Burnett Catchment Care Association (BCCA) is the overarching structure under which the BCCA Subcatchment groups operate. The Committee of the BCCA (comprised of representative form EPA, DNRM, DPI and local government and members of subcatchment BCCA groups) is presently reduced, due to Department of Mines and Energy, Natural Resources, Primary Industries and Forestry and the Environmental Protection Agency no longer endorsing their officers to attend BCCA meetings. The role of this group in the future is further explored within section 5.3 of this report.

The BCCA has long standing contacts and support from locals, government and industry. This group was responsible for developing the Burnett Catchment Management Strategy in an attempt to address catchment scale issues. Some previous initiatives of the BCCA are outlined in Table 11. This organisation is experiencing some lack of activity at present, compared to previous years, arising from lack of a home base (and ongoing funding). Projects within the Burnett Basin that fall under the BCCA general committee include Natural Resource Information on Burnett River Riparian Lands (NHT 1999/01), on ground implementation of the Burnett Catchment Strategic Plan (NHT 1999/01), and the Burnett Valley Resources Inventory for the Burnett Catchment (NHT 1999/2000).

Table 11: Joint initiatives of the Burnett Catchment Care Association (past case studies)

Initiative of	Project title
BCCA, Kingaroy Landcare Group/ Waterwatch Australia and NHT	Small's Creek Lancare Group - The river walk.
BCCA, Kingaroy Landcare Group/ Waterwatch Australia and NHT	Community sponsorship for Kingaroy Landcare group
BCCA, DNRM, Queensland Fruit and Vegetable Growers, and NHT	Burnett Growers Profits from Watering Wisely
BCCA, Monto Shire Council and NHT	Restoration of native riparian vegetation in the upper Burnett
BCCA South Subcatchment Group, Wondai and Kingaroy Shire Councils, DOW Agriscience Landcare/ICM grants and DNRM	Tree Pear Trial Site

BMRG Office pending: One field officer for Monto region (Dean Power) is currently housed with council and is producing positive momentum and assisting to form links in the region.

Three Moon Salinity Group: This group has been active for several years and consists of about 18 farming families. The group has minimal equipment for water quality monitoring (at one time this group owned salinity meters) and any equipment that is owned may not be in good condition. They have good momentum and possible human resources for on ground projects. The group strongly advocated pro-active NRM communities where volunteers play an essential part.

Although unfunded at present, the group is working with the local Monto school (and Agricultural Science teacher) to educate students on NRM and water issues. They have formed links in the past with the local shire as well as with certain industry sectors (Burnett Water and BP). Data is onto field data sheets and stored in hard copy form with group members or secretary.

Kolan Shire Landcare: This group is not currently active in water monitoring activities and does not own water monitoring equipment (therefore no QA systems are noted) or possess water quality data. However, they have indicated some willingness to extend their current activities to include water monitoring given appropriate funding and technical support, and if the projects fit with their current direction. Kolan Landcare is recognised for owning and running a sizable native plant nursery, which contributes substantially to local projects, and is seen as a potential support resource for possible future rivercare projects. Past projects by this group include Black Gulley Habitat Revegetation project (NHT2000/01). Any data gathered by this group (with respect to revegetation projects) is in hard copy form and held by group members.

Central Burnett Subcatchment

Gayndah Landcare: Gayndah Landcare does not currently monitor water quality and does not own water quality equipment (therefore no QA systems are noted) or possess water quality data. However, this group has a strong interest in water quality issues and well as Landcare and Rivercare. Gayndah Landcare recently engaged someone (Bert Bamberg) to reignite water monitoring through the central area (Water Quality Engagement Project), which involved initial training days with schools, farmers, councilors and industry. This was a collaborative project between Gayndah Landcare, BCCA central and Mundubbera Landcare. Technical skill for monitoring is minimal at present, however there are people on ground with the capacity to be trained.

Gayndah Landcare have contributed to and participated in basin rivercare projects, namely the Burnett River re-vegetation project (NHT 1999/03), and they recently initiated and hosted a Water Quality and River Health Seminar (2004). The group is currently involved in the Gayndah Tree Clearing Project - a collaborative project between Gayndah Landcare, Conservation Volunteers Australia, the BCCA and Gayndah Shire Council. The mainstay of data collected is archived in hardcopy form and held with group members and/or Gayndah Shire Council.

Mundubbera Landcare: This group is not active in water quality monitoring and possesses no water monitoring equipment (therefore no QA noted) or water quality data. They do, however, have a vested interest in water quality issues and gave written support to Gayndah Landcare and BCCA Central to lead the Water Quality Engagement Project (discussed above), and several members have attended initial training days for this project.

Schools affiliated with Mundubbera Landcare are very keen to be involved with water quality projects and have the capacity to run projects through their science departments. There are people on ground within this group who could undertake monitoring. At present the group is focusing on building support to increase general capacity in-group (training, equipment etc).

BCCA central subcatchment: BCCA central does not undertake any water quality monitoring and possess no water monitoring equipment (therefore no QA was noted) or water quality data. However this group has been an active participant in rivercare projects and is currently involved the Gayndah Tree Clearing Project - a collaborative project between Gayndah Landcare, Conservation Volunteers Australia, the BCCA and Gayndah Shire Council. BCCA Central recently undertook a collaborative project (with Gayndah Landcare and Mundubbera Landcare – discussed above) to employ someone to reignite water monitoring in the central catchment, which has involved initial training days with farmers, schools, industry and councilors. Data collected by this group remains in hard copy form.

Further, the BCCA framework itself consists of appropriate structure for project management, with the umbrella organisation (the BCCA Committee), and members of subcatchment BCCA groups (as discussed in section 4.1.1 North Burnett – BCCA North).

Smalls Creek Landcare Group: This Landcare group was developed to support long term work by landowners for control of weeds in the area. This group is very active on ground with rosters to ensure equal participation in work. The group is primarily recognised for their "river walks" which are supported by BCCA, Kingaroy Landcare Group, Waterwatch Australia and NHT (ongoing for over 5 years). Local government (Eidsvold Shire) provides in-kind support and a Weeds Officers technical support and training. Other collaborators within this project include BP Australia, Eidsvold State School, Kingston High School and Dow Agriculture Science.

The objectives of this group focus on control and eradication of noxious weeds, education relating to their control (wash down facilities etc) and monitoring of waterways and properties for spreading and invasive weeds. Small Creek Landcare Group does not currently monitor water quality and do not possess any water monitoring equipment (therefore no QA noted) or water quality data. This group has considerable capacity on ground, however, and may be willing to incorporate some water quality monitoring into their waterway monitoring activities.

Section Note: Three of the four catchment groups within the Central Area (Gayndah and Mundubbera Landcare and BCCA Central) have formed project links with each other and with external industry sectors, including citrus farmers. With BCCA taking a leadership role, there is good framework in this area for the roll out of collaborative projects, including the integration of industry as contributors/supporters.

South Burnett Subcatchment

Cherbourg NRM group/Cherbourg Conservation Council: This group has not been active in monitoring water quality in the past (therefore no QA systems were noted) and does not possess water quality equipment or data. Past projects undertaken by this groups include the Barambah-Burnett Bush Botanical Gardens (NHT 1998/99).

At the time of this report, however, the Cherbourg community was seen to have good momentum for furthering their NRM and water related activities. This was due to the presence of a NRM coordinator on council and six NRM traineeship positions that would be funded for 12 months and filled by Cherbourg youth. Other members of the Cherbourg community also expressed an interest in monitoring water quality to find out about possible detrimental influences in the region (for example feedlots were noted as a probable influence).

On this basis, human resource capacity is apparently available within this group for the undertaking of on ground projects. Initial assistance within technical areas may be required and this could occur as formal training or development of links with other groups with some technical capacity (BCCA South) or local in kind providers (Tarong Energy supplies in kind support through laboratory space/assistance for calibration for BCCA south).

Nanango and District Landcare: This Landcare group has been active in the past in implementing local rivercare activities, and plays an important part for NRM in the local area. Their mission is to develop community partnerships to help implement strategic projects to protest and restore our local landscape. They do not undertake any water quality monitoring (therefore no QA noted) and possess no monitoring equipment or data. Projects and activities include the Sandy Creek Clean up (2002). Achievements for the group (when active) include:

- A forum to share and discuss information between landowners and urban residents;
- Greater involvement and understanding of Landcare issues;
- Tree planting trials in saline areas;
- School related tree planting, planning of tree gardens, NRM education etc;
- Running of a garden club group.

Kingaroy Landcare: This Landcare group has a strong NRM history within the South Burnett District, with most activities taking a rivercare or groundwater focus. They do not undertake water quality monitoring at present (therefore no QA systems), and do not possess any water quality monitoring equipment or data. The group may, however, be amenable to widening their current scope of work to include water monitoring, given that aims of water quality programs meet their present and future agendas and budgets. The main impediment to water monitoring at present is a lack of water quality equipment and trained persons to implement on-ground action and a lack of systems for data housing, analysis, interpretation and understanding.

Activities by this group are largely restricted (by lack of equipment) to riparian/water use improvement projects. Past projects/activities (see case study – Community sponsorship for Kingaroy Landcare – Table 11) have worked in collaboration with 15 local businesses, Kingaroy Shire Council, Tarong Coal, Tarong Energy and Bean Association and two local high schools (for example the case study Community sponsorship for Kingaroy Landcare – Table 11). Some current projects by Kingaroy Landcare include:

- Increased riparian management through tree planting, fencing and weed removal (a number of smaller projects are related to this).
- Kingaroy Shallow Groundwater Project by DNRM (funded by National Landcare Project) in 1994-1995,
- Broadleaf pivet in riparian zones removal project
- Minimum Tillage Project - machine design, booklet (Kingaroy Landcare are partners in this project)
- Management and general running of the native plant nursery (owned by Kingaroy Council)
- Support and commitment to the SGAP (Society for Growing Australian Plants, Kingaroy Branch) project "revegetation of a damaged area within an endangered ecosystem". The site for this project is roadside bordering Nanango and Kingaroy Shires.

With respect to current projects (particularly the ongoing Increased Riparian Management Project), the initiation of a parallel water quality program would enable the (beneficial) effects of rivercare projects on the water quality of adjacent creeks and rivers to be determined.

Kingaroy Shire Council is a partner in Kingaroy Landcare and facilitates the development of projects and acquisition of funding with the group. Collaborative projects with Kingaroy Landcare that are currently under negotiation include (1) investigation of groundwater and salinity levels focusing on Kingaroy and the Crawford district (with sites along the Stuart) and (2) rehabilitation of the Gordonbroke foreshore (a collaborative project between five councils).

Section note: The collaborative project currently under negotiation between Kingaroy Landcare and Kingaroy Shire Council for investigation of groundwater and salinity is considered potential gap filler in PAP2.1.

South East Burnett Landcare (Tansey Landcare): This group has established and currently maintains a native vegetation area (a local park in Kilkivan). In the past they have been active with Goomeri (P10) School on Landcare issues. South East Landcare is not presently active in water quality monitoring (therefore no QA noted) and possess no water quality equipment or data. The contribution of this group to rivercare activities in the region is minimal, however, they have expressed an interest in becoming involved with any water related collaborative projects.

BCCA South/Waterwatch: The BCCA south office is also the office for South Waterwatch. These groups already have reasonable existing capacity within technical and human resource areas (human resources are within school driven programs, including 32 schools, with coverage from the Bunya Mountains to 'end of stream locations' at Gayndah and Mundubbera – site locations are shown in Figure 2). Data is collected in hard copy and stored in both Microsoft Excel spreadsheets (entered by the Waterwatch Officer – presently Dr Bert Bamberg) and hard copy form (original data sheets) within the Waterwatch office at Wondai. The BCCA south own one complete set of equipment (purchased by the Waterwatch program from 1998-2003) for measuring temperature, pH, turbidity, conductivity, nutrient levels and macroinvertebrate diversity, and additionally one water quality multi-meter data logger.

Data collection methodology does not follow formal or documented QA procedures as such, primarily because current objectives of monitoring and use of data do not necessitate quality systems (student educational purposes). However, typical and appropriate base quality procedures appear to be followed during sampling (implemented by the Waterwatch Officer). These procedures include training prior to sampling, rinsing of sample bottles, use of clean hands and/or gloves where necessary, appropriate handling of samples, collection of duplicate samples etc. BCCA South/Waterwatch have made formal links and in-kind arrangements with Tarong Energy for calibration of their water quality equipment (combination data logger) was via access to the environmental laboratory of Tarong Energy, located at the southern end of the subcatchment (offered as in-kind support). Once again, there appears to be limited formal quality check/maintenance systems attached to calibration, however the fact that equipment is calibrated regularly by a professional laboratory and trained personnel greatly increases the confidence attached to data collected.

The location of the BCCA South Office in the same building as the BMRG Inland Office (housing a community support officer and an officer for indigenous communities) and the availability of highly trained technical capacity (Dr Bert Bamberg – PhD and attendee at the several workshops including WQO5 Quality Control workshop) support the establishment of this location as a technical node/NRM centre for support of the WMN. The BCCA framework itself consists of appropriate structure for project management, with the umbrella organisation (the BCCA Committee), comprising of representatives from EPA, DNRM, DPI and local government and members of subcatchment BCCA groups (further discussed in section 3.1.1 North Burnett – BCCA North).

BCCA south catchment group has been involved in several local projects including the South Burnett Tree Pear Eradication Trials in collaboration with Gayndah and Wondai Shire Councils, Agriscience Grants and DNRM (Industry Funding 1999/01), obtaining of Waterwatch funding (NHT-1999/2003) and production of the Conservation Farming Booklet (NHT-1999). Their project focus in 2003/4 included Biodiversity and fire management (environfund project), with workshops throughout the catchments (NHT-2003/4).

BCCA(S)'s involvement in on ground water quality related projects (besides those which are Waterwatch initiatives) is limited. However this group often initiates and/or supports other water related projects for example recent collaborations with South Burnett Catholic College (detailed below) and has trained staff for support and training. Further, the BCCA framework itself is thought to consist of the appropriate structure for and set-up for future water quality project management (with an umbrella organisation, the BCCA Committee, and subcatchment groups with members) as discussed in section 3.1.1 North Burnett – BCCA North.

South Burnett Catholic College: This school has developed detailed projects in conjunction with BCCA south/Waterwatch relating to the macrophyte biomass (*Salvinia* growth) and nutrient issues within the Barker/Barambah Creek systems. There are three components to the projects:

1. Monitoring nutrient levels in the Barker/Barambah system;
2. Lab research to determine the nutrient levels when the *Salvinia* weed stops growing seriously (this may be a long term target)
3. Laboratory research aiming to grow Salvinia in sewerage effluent and analyse biomass production & uptake of nutrients (both factors may determine whether councils could use this weed as part of an effluent strategy).

The South Burnett Catholic College is a partner with SGAP (Society for Growing Australian Plants, Kingaroy Branch) and supports their local projects.

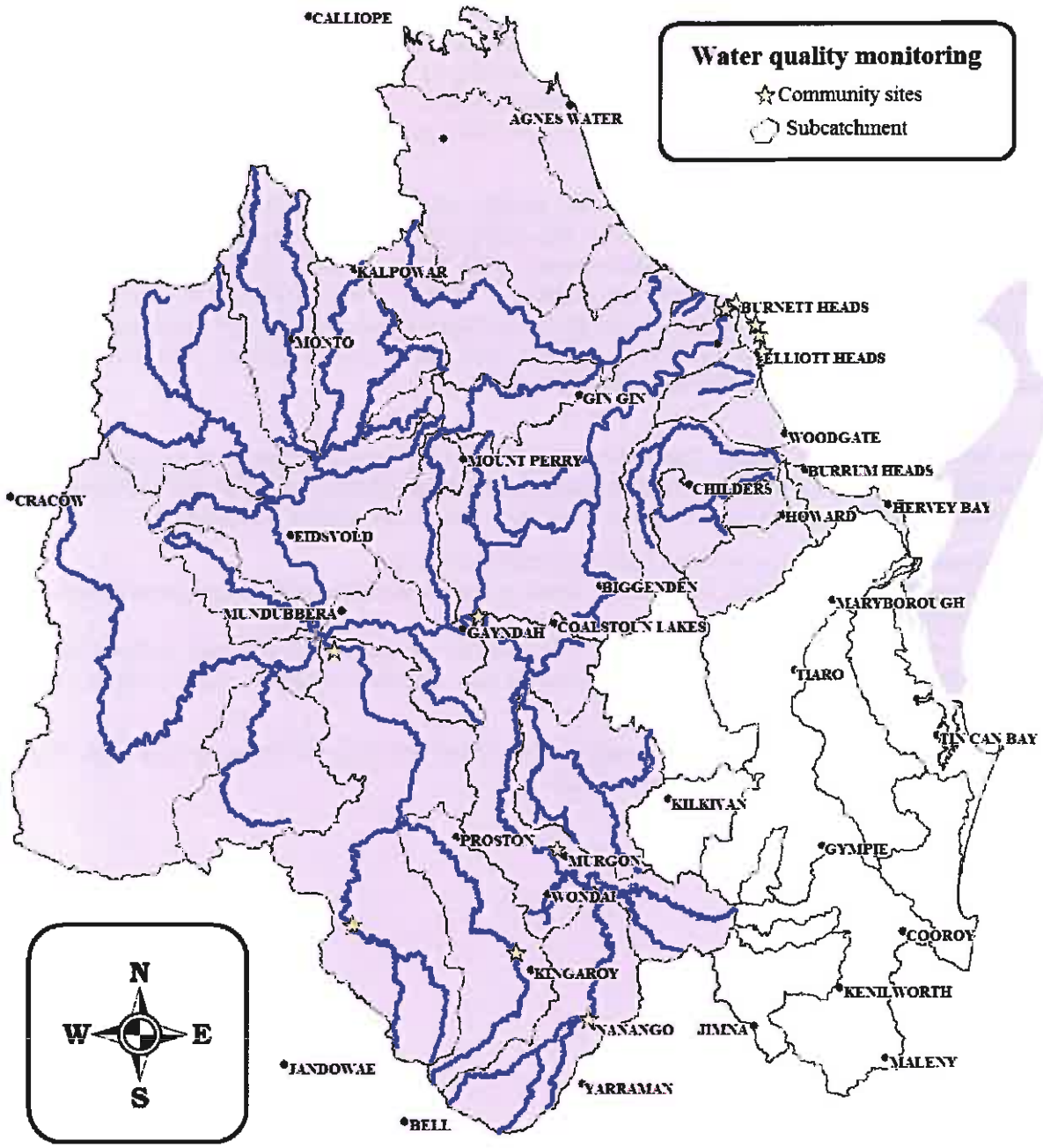


Figure 2: Locations of community water quality sites monitored by Waterwatch (inland sites) and Woongarra Marine Park Monitoring and Education Project (coastal sites).

BMRG Inland Office: This office is used as the base for community support officers (Viv Sinamon and Tamara Boland) with the building also housing BCCA south/Waterwatch and the Department of Primary Industries (DPI). The convening of NRM interests within a central location is creating positive momentum in the district in NRM issues and is seen as an appropriate location for BMRG's assistance in the rollout of on ground projects. This is further discussed in Section 5 of this report.

Other Landcare Groups in the South: Two other Landcare groups within the South Burnett subcatchment (namely Wondai Landcare and Proston Landcare) are presently inactive (partly due to the need to acquire some funds for functioning). These groups do not monitor water quality and possess no water monitoring equipment or data (therefore no QA notes are provided). These groups may be able to provide additional human resource capacity for collaborative projects.

"South Burnett Landcare," was a strong Landcare group who acted as an umbrella group for several projects and acquired funding for a project officer based in Kingaroy from 1998 to 2000 (NHT1998/00). South Burnett Landcare dissolved in 2001. Its main achievements included the mapping of dryland salinity (data for this project remains in hard copy form and is stored with Yarraman Landcare). This project and associated data is considered worthy of assessment (which was beyond the scope of this project), and may contain information relevant to salinity outbreaks in the south Burnett subcatchment.

The "Kilkivan Landcare Group" obtained funding in 1998/99 (NHT) for promotion of sustainable land and resource management. It is uncertain if this Landcare group is now part of existing groups (like South East Burnett Landcare) or whether it was distinct and since dissolved.

East Burnett subcatchment and coastal catchments

BCCA East Subcatchment Group: The primary focus for BCCA in the last few years has been reduction and management of large quantities of macrophytes present in the lower sections of the Burnett River, and to educate the wider community about the causes of these infestations and their implications for water quality. These rivercare related activities are considered widely beneficial by dispersal of knowledge relating to wider catchment management issues (nutrient and soil run off etc) as well as for local river management (removal of weeds). The funding for this work was obtained through several sources including Envirofund, NHT, local government, Sunwater and other collaborations. The group has demonstrated proficiency in positive acquisition of funding and project management (the weed project has been ongoing since 2001). Presently a Water Weeds Boat is functioning in the lower Burnett to remove macrophytes as the result of collaborations between BCCA East, local government and Sunwater. A boat coordinator has also been employed. Data collected by the group remains primarily in hardcopy from with BCCA group members.

At present BCCA East does not undertake any water quality monitoring and possess no monitoring equipment (therefore no QA systems were noted) or water quality data. Given the current weed management projects stemming from this subcatchment group, the lack of projects to gather supportive data to positively determine the effects of weeds and their reduction on water quality is disappointing. However, the volunteer time available for development of such proposals is already over utilised within this group.

As mentioned previously, the BCCA framework itself is thought to consist of the appropriate structure for project management (with an umbrella organisation, the BCCA Committee, and members of subcatchment groups (discussed in section 4.1.1 North Burnett – BCCA North).

Baffle Creek and District Landcare and Conservation Group: This relatively new group of about 15 members has not undertaken any on ground activities to date. Their priority at present is acquisition of funding to facilitate movement of the group into activities. Their current interests lie in land

management and conservation and rivercare-type activities; they are also very interested in Waterwatch training and involvement. Until this group becomes officially incorporated they will be sponsored (administratively) by the Baffle Creek Catchment Group Inc.

Agnes Water Landcare: The Agnes Water Landcare group plays a role in informing the wider community of NRM and water issues within the regions, including publication of a newsletter on local activities and NRM information. Geographically, this group is the responsible for a large piece of the coastline, much of which has not been studied in any detail. The group does not undertake water quality monitoring and do not own any monitoring equipment. Agnes Water Landcare group contributes to weeding and revegetation of town developments (like the new skate park). They own and operate a native plants nursery to support their local on ground activities.

Isis Landcare (Childers): This Primary Industries based Landcare group maintains continuous high membership and is currently working in collaboration with DPI&F/DNRM and local cane farmers under the Rural Water Use Efficiency Initiative Program for water efficiency in cane projects. Isis Landcare is based in Childers in the Sugar Board Building.

Other projects have included a Natural Innovation Grant (Envirofund) to implement sustainable land use practices and educational project School Salinity for Decade of Landcare (NHT 1998). Isis Landcare has not been involved in water quality monitoring projects and no not possess any water quality equipment or data. They do not currently monitor water quality due to water use efficiency projects taking most of their focus.

Bundaberg and District Urban Landcare: The Bundaberg Landcare group work together with the BCCA to inform the general community on catchment issues, through information displays such as weed information and presentations. They have a small following and have been successful in the past in obtaining Envirofund grants for community capacity building and revegetation projects including Native Revegetation project - Woongarra and Isis Scrub species (NHT 1999/2000). They do not currently monitor water quality, do not possess water quality monitoring equipment or data and were not receptive to inclusion within a wider community-monitoring network.

Baffle Creek Catchment Management Group: This group has been proactive in the area since their inception and was officially recognised as the coordinator of community activities involving the sustainable management of the Baffle Catchment (under the Qld Integrated Catchment Strategy). In past years the acquisition of a project officer (NHT funding) for coordination of activities further increased the proficiency of this group in water quality monitoring and project management. At this time BCCMG were successful in obtaining the support of government agencies including EPA (for in-kind support, provision of water monitoring equipment –Hydrolab, and training and information on its use), DNRM and local government. The mainstay of data collected by this group remains in hard copy field sheets with group committee members and/or within schools (Waterwatch). Methodology did not follow strict Quality Assurance checklists but did appear to incorporate appropriate base QA measures (e.g. rinsing bottles, clean hands, gloves, duplicate samples etc).

Past projects of BCCMG include the design of a water quality monitoring program (this included extensive geographic cover up to the Turkey Beach area and over 60 sites), rivercare and catchment projects (seagrass watch, recreational fishing surveys etc). Unfortunately most of these projects did not fully progress into data collection due to funding gaps and lags, and consequential loss of collaborators/monitors. The Waterwatch program, however, was highly successful in gaining participation by all of the seven schools in the Baffle Creek Catchment area including Bororen, Agnes Water, Miriam Vale, Lowmead, Rosedale, Wartburg and Winfield State Schools. The BCCMG's major accomplishment to date is creation of the Baffle Creek Catchment Strategy, a comprehensive

document that forms a basis for future catchment activities by giving recommendations for community projects.

For the last couple of years various on ground activities within the group, including the water/rivercare monitoring projects and activities mentioned above, have been inactive due to lack of ongoing funds (the exception to this is the Waterwatch component, which has been successfully continuing through Rosedale and other local schools, although sampling frequency was reduced to two events in the last year due to lack of funding support). The groups has, however, initiated and maintained other activities (below).

In collaboration with Rosedale School, other schools and community, BCCMG continues to contribute to a number of both indigenous and non-indigenous educational NRM studies throughout the area. The science teacher of Rosedale School (Keith Wilson – secretary of BCCMG and primary driver of current BCCMG activities) currently facilitates the funding application process to keep group activities functioning and ongoing. Recent proposals for funding include "Spread the Word"; a tabloid publication aiming to raise the awareness of the Baffle Creek itself, its benchmark qualities, catchment issues, to address actions within the Baffle Creek Catchment Strategy and to create a long term sustainable place based activity (within school curriculum). BCCMG and Rosedale School are also highly active in indigenous and non-indigenous NRM place-based learning (a centre is being established at Lowmead for this purpose in conjunction with the Lonweigh Aboriginal Corporation), which may provide possible human resources for on ground activities, and Rosedale school leads the community at present in education of NRM, particularly related to water sustainable usage together with monitoring of aquatic systems.

The BCCMG currently provides support to other catchment groups by acting as an umbrella organisation (they have invited the Baffle Creek & Distinct Landcare group to function under their constitution until this new group becomes incorporated) and are proactive towards the sharing of human and technical resources. The BCCMG is seen as the appropriate body in the Baffle Catchment through which to invest future funding for on ground projects and activity.

Wide Bay Burnett Conservation Council: This group is active and significant in representing environmental issues at public forums, information sessions and environmental panels (10 submissions on public comment applications were submitted in 2002-2004) and in initiating funded natural resource studies for increased knowledge to advise government, the community and planners (for example the Identification of Coastal Wetlands Report (WBCC, 2001).

Wide Bay Burnett Conservation Council does not undertake water quality monitoring and own no water quality monitoring equipment, however past projects have gathered information on certain water quality parameters (for example the coastal wetlands report measured salinity, and also provides qualitative estimations of aquatic and terrestrial vegetation). On ground volunteers are minimal and community activities are not active at present. WBBCCC also represent indigenous water interests, within an ongoing project to assist the Butchulla people (at Fraser Island) in protecting the Wongi Water holes against the potential flooding from the raising of Lenthalls Dam (Hervey Bay).

The planned activities of Wide Bay Burnett Conservation Council are presented in Table 11a, while the achievement of targets for 2002-2004 is presented in Table 11b. Several of these planned activities align strongly with objectives of BMRG, particularly those relating to stabilising declines in water quality and encouraging community involvement. It is suggested that WBBCC may be well placed to provide substantial support to future BMRG activities for the mutual achievement of common objectives relating to the Great Barrier Reef Water Quality Protection Plan.

4.1.2 Coastal and Marine community water monitoring groups

There are only two community groups who currently monitor water quality in the coastal estuarine and marine environments of the Burnett Basin, these being Woongarra Marine Park Monitoring and Education Project (WMPMEP) and the Baffle Creek Catchment Management Group (BCCMG). Two other significant environmental organisations exist, that have worked with volunteer community groups or community members to undertake environmental research in the Wide Bay Burnett coastal region, these being Wide Bay Burnett Conservation Council and the Centre for Environmental Management, Central Queensland University. An account of these groups is included in the section below.

Table 1 is a list of all members of community and respective water monitoring (or NRM) groups who have been contacted within the project either independently or through community meetings to. Discussions with these members via meetings, phone calls and emails provided the information necessary for the section below. Section 4.1 provides a summary table of the information described below.

Woongarra Marine Park Monitoring and Education Project: The WMPMEP was established in 1991 and undertakes several ongoing projects (both monitoring and educational) within the Woongarra Marine Park, off the coast of Bundaberg. These studies represent a significant proportion of the entire monitoring effort within this area. Current monitoring projects include water quality parameters, benthic monitoring, tidal rock-pool monitoring and user group observations. Educational projects include rocky reef watch, leads to the sea, tidal pools and schools and fish focus. Generally the monitoring projects are undertaken at four sites within the Woongarra Marine Park and two sites in the Burnett River. Minimal river monitoring is also undertaken; water quality is measured at two sites in the Burnett River, the most upstream site being at the bulk sugar terminal. Parameters within the water quality monitoring program include water temperature, pH, electrical conductivity, salinity, dissolved oxygen, secchi depth (clarity), suspended sediment, total phosphorus, ortho-phosphates, total nitrogen, ammonia, nitrates and chlorophyll a. WMPMEP functions under the guidance of a steering committee to ensure a high level of direction within projects and is a member of the Local Marine Advisory Committee.

With the recent acquisition of a project officer (Liz Tanner through Envirofunding), WMPMEP works to a high technical standard across all of their projects and methodology incorporates QA measures to increase confidence in data. QA measures include general practices such as cleaning bottles, cleaning hands, appropriate use of gloves etc as well as more involved procedures such as regular calibration of water quality meters and maintenance of calibration records for each meter, collection of replicate samples, shadow testing, fully documented training procedures for all new volunteers for all techniques, following of 'standard operating procedures' and methodology, use of a standardised field data sheet and spot checking for errors in data entry. WMPMEP has recently started volunteer entry of data from hard copy to Excel spreadsheets (within the WMPMEP office).

Further, WMPMEP has participated in large resource-data gathering projects (with partners including CEM/CQU, QPWS and DNRM) resulting in outputs that have been noted by local and state government agencies as timely and relevant (data was analysed by DNMR to produce local maps of coral locations).

WMPMEP is ideally placed to offer assistance and capacity to other coastal catchment groups through their establishments as a technical node/NRM centre of the Water Monitoring Network. This group has gathered a considerable amount of water quality and resource data since their inception, which, with appropriate analysis, would contribute significantly to local knowledge of processes within Woongarra Marine Park.

Centre for Environmental Management (CEM), Central Queensland University (CQU): The CEM, CQU has undertaken considerable environmental monitoring within the coastal marine environmental of the Burnett region, both independently (consultancy or research related) and in partnership with Woongarra Marine Park Monitoring and Education Project. Several CEM projects included water quality components; however, some of this data would be unavailable (due to confidential intellectual property). Other water related data would be available with permission from project partners (for example data collected on behalf of Gladstone Area Water Board (GAWB) in the Baffle Creek were made available with consent of GAWB). The aims and objectives of WMPMEP compliment similar activities undertaken by CEM/CQU across a broader marine ecology portfolio, allowing the two groups to work together to effectively meet respective agendas, and significantly increasing WMPMEP's resources and capacity. A major past collaborative study undertaken by the CEM and WMPMEP researchers was "Coastal Habitat Mapping in the Woongarra Marine Park" which received a high level of support by local and state government departments to ensure maximise data collection and overarching research outcomes.

Baffle Creek Catchment Management Group/Rosedale School (Waterwatch): The Waterwatch component of BCCMG, in particular Rosedale school, has conducted a seagrass watch at the mouth of the Baffle Creek. At present this activity is in active. There is, however, current momentum within the school for incorporation of marine activities within their curriculum – particularly the establishment of a marine studies program. Establishment of this program would provide useful information in an area presently lacking in ecological monitoring programs and possible reinstate the seagrass watch activity.

Wide Bay Burnett Conservation Council: This group is discussed in the section above, and their interests extend to include estuarine and coastal management. WBBCC achieved significant accomplishments for coastal management in 2002-200, including assisting with finalisation of the State Coastal Management Plan and significant input into plans for the Wide Bay Burnett and the Curtis Coast.

The planned activities of Wide Bay Burnett Conservation Council for 2005-2006 are presented in Table 11a, and include (a) significant contributions to coastal management for example promoting the stabilisation and reversal of the decline in water quality of the GBRMP, (b) encouraging community and stakeholder involvement in coastal activities, (c) contributing towards the declaration of additional marine protected areas, (d) contributing to the protection of internationally important Australian shorebirds, and (e) contributing to the development of effective management plans for Ramsar sites/migratory shore bird sites. (The achievement of targets for 2002-2004 is presented in Table 11b).

Several of these planned activities align strongly with objectives of BMRG, particularly activities A and B relating to stabilising declines in water quality and encouraging community involvement. It is suggested that WBBCC may be well placed to provide substantial support to future BMRG activities for the mutual achievement of common objectives relating to the Great Barrier Reef Water Quality Protection Plan.

Table 12a: Planned activities for the Wide Bay Burnett Conservation Council for 2005-2006

Major Activity	Government Priority Area	Long Term Objective	Expected Outcomes 2002-2003
Native vegetation retention	1 **Natural Resource Management** a) Protecting and restoring habitat of threatened species + ecological communities and migratory birds b) Reversing long term decline in the extent and quality of native vegetation d) Preventing and controlling the introduction and spread of feral animals, aquatic pests, weeds and other biological threats to biodiversity	Assured protection for all Endangered and Of Concern ecosystems in the region and areas of high nature conservation value including areas with rare and threatened species.	• Detailed input into Regional Vegetation Management Plans, and clearing codes • Increase public awareness of shortfalls of current vegetation management regime • Monitor EPBC website and provide input where required on proposals in our region. • Encourage revegetation by providing technical advice and support for local tree planting projects.
Fire Ecology Research	**1 Natural Resource Management** a) Protecting and restoring habitat of threatened species + ecological communities and migratory birds b) Reversing long term decline in the extent and quality of native vegetation f) Establishing institutional and organisational frameworks that promote conservation and ecologically sustainable use and management of natural resources	An increased community understanding of fire on the landscape, effects on ecology and economic costs and benefits.	• Provide a representative on the Ministerial Rural Fire Council to press for improved environmental outcomes in fire management • Increase the scope of the Council to cover all land managers • Increased public awareness of fire issues as they relate to the maintenance of biodiversity through the provision of reliable information and educational materials
Coastal Management	**2 Coasts and Oceans** a) promoting the stabilisation and reversal of the decline in water quality entering the GBR b) encouraging community and stakeholder involvement in coastal activities c) contributing towards the declaration of additional marine protected areas g) contributing to the protection of internationally important Australian shorebird sites. 3 Inland Waters d) contributing to the development of effective management plans for Ramsar sites/migratory shorebird sites	Production of two regional coastal management plans providing for ecologically sustainable management of the coastal zone in our region, and declaration of a new marine Park for Great Sandy	• Progress in development of the coastal management plan for Wide Bay through input from our group. • Increased public awareness of coastal issues. • Provide a conservation representative on the Great Sandy Marine Park working group • Assist with planning for the new Great Sandy Marine Park • promote recognition and better protection of Ramsar wetland and

			shorebird sites in Great Sandy Strait
Construction of conservation information website	**4 Human Settlements** c) Environmental education (activities designed to raise awareness etc.)	User friendly website with conservation information easily accessible by all those interested	• Group website completed • website maintained with current information on regional environmental issues
Publication of quarterly magazine	**4 Human Settlements** c) Environmental education (activities designed to raise awareness etc.)	Continued production of magazine on environmental issues which serves as a vehicle for public comment	• Raise awareness of regional environmental issues and the need for public involvement in conservation issues. • magazine published on the web
Catchment care in the Mary, Burnett and Burrum River systems.	**3. Inland Waters** a) contributing to national water quality reform to improve environmental flows and water quality b) contributing to the regional outcomes for the protection of water quality and wetlands g) contributing to research to provide high quality information and assessment tools for conserving Australia's wetlands	Sustainable catchment and water management which protects the natural environment of our region	• Continued involvement in Mary River Water Resource planning process to ensure sustainable use of catchment, including adequate environmental flows • Increase in community awareness of sustainable use of catchments through presentations, and providing educational information. • Participation in irrigation water use efficiency project with the aim of achieving real improvements in outcomes • Promote and distribute our Coastal wetlands report
Flora and fauna database	**1 Natural Resource Management** a) Protecting and restoring the habitat of threatened species, threatened ecological communities **5 Other Environmental Priority Areas** c) fostering and promoting local government's roles and responsibilities in protecting the environment	A continuously updated information base of regional biodiversity values. Data is used for research, planning and educational purposes.	• Increased flora and fauna site records added to database. • Increased information available to local government planners and community. • Information and database support for the Naturesearch and Land for Wildlife programs. • Training of further volunteers in use of database

Table 12b: Achievement of targets (water quality and rivercare related) by the Wide Bay Burnett Conservation Council for 2002-2004

Major Activity	Intended Outcome for 2002-2004	Outcome Achieved
Identification Of Coastal Wetlands	• Finalisation of report on location and status of coastal wetlands • Copies of report made available to all interested parties including local government planners and state government departments • Information input into local government planning process.	• Detailed Status of Coastal Wetlands report and recommendations completed. • Hard copy reports distributed, and electronic CD version produced and advertised. • Wetland Report made available to relevant Local Governments and other agencies. • Report used in Burnett Mary Regional plan
EPBC Submissions on biodiversity protection	• Completed 10 submissions on public comment applications	• Obtained 8 controlled action referrals for significant impact projects
Cultural Heritage	• Assisted the Butchulla people (Fraser Island area) with applications under s 9 and 10 of the Aboriginal and Torres Strait Islander Cultural Heritage Protection Act 1984, for protection of Wongi Waterholes against potential flooding from the raising of Lenthalls Dam (Hervey Bay)	• Still in progress
Native vegetation retention	• Regional vegetation management regime in place which maximises biodiversity retention outcomes across all tenures. • Volunteer participation in data gathering, on-ground works, production of final Teddington Management Plan for the Tinana Creek biodiversity project, and finalisation of Nature Refuge Agreement with Local Council. • Monitor EPBC website and provide input where requested on proposals in our region.	• Provided input to vegetation management process set up by Queensland Department of Natural Resources (continuing). • Provided logistical support (use of office space and computer), advice and data to conservation representatives on vegetation management committee • Volunteers finalised biodiversity management plan for Teddington Weir reserve, Nature Refuge Agreement pending • Presented public information forum, Land and Water Roadshow to promote vegetation retention and sustainable landuse • Monitored EPBC website and made one submission regarding Landfill proposal in Cooloola Shire resulting in Federal Minister calling in the proposal. Passed on information to other groups in region.

Coastal Management	• Finalisation of the State Coastal Management Plan with group input. • Further progress in development of the coastal management plans for both the Wide Bay Burnett and the Curtis Coast regions through input from our group. • Maximise environmental and coastal planning outcomes.	• State Coastal Management Plan finalised after input from our group. • Volunteer representatives attended meetings of Coastal Management Committee for Curtis Coast regions. • Curtis Coast Regional Coastal Management Plan advanced to draft stage with significant input from our conservation representative. • Wide Bay – Burnett Plan process stalled but about to be recommenced, with input from our group.
Catchment care in the Mary, Burnett and Burrum River systems.	• Mary Water Resource planning process underway with input of data and participation of our group. • Broad acceptance of ecologically sustainable options for water use. • Participation in irrigation water use efficiency project with the aim of achieving real improvements in outcomes. • Increase in community awareness of sustainable use of catchments through presentations, and publication of educational information materials.	• Our group has provided a representative for the Mary River Water Resource Plan Community Consultation process, recently commenced • Ecologically sustainable options accepted as the basis for the Water Resource Planning process • Continuing participation in irrigation water use efficiency project for the Burnett River. • Information campaign undertaken to raise community awareness regarding sustainable water use in the Burnett, through local print and television media and information kits and public information forum, "Land and Water Roadshow" held in July 2002.
South east Queensland Forest Agreement	• Participation in local area community advisory committees to transfer high value conservation areas currently in state forest to the reserve system • Provide advice and input information into handover process which lead to appropriate tenure and management decisions • Creation of a much larger and more representative reserve system in our region • Protect high value threatened regional ecosystems and species	• Provided representative for the Mt Walsh and Burnett/Bania community advisory committees and successful in achieving new additions to National Park area • Detailed input achieved into tenure allocation and future management planning including site visits • Conservation reserves increased in the Wide Bay Burnett with finalisation of tenure transfer for Mount Walsh forestry areas to National Park • Regional ecosystems previously not represented in reserves now designated as part of National Park including areas of threatened ecosystem.

4.2 Capacity of community groups to monitor water quality

Please note that information from which the following table is drawn (detailed in section 4.1) is based on dialogue between CQU employees and representatives/members of community groups, local shire councils and government and may not, therefore, be completely reflective of each group's current situation (group capacity was found to be a subjective topic even within groups).

4.2.1 Summary table of group capacity

Organisation/Name	Human resources (volunteers)	Current capacity to acquire WQ funding	Project steering and management	Previous project collaborators	Previous WQ projects /data?	Previous Rivercare/ Coastcare projects	WQ technical capacity in group	Water quality equipment	Laboratory access
Landcare - Monto (Nth Burnett)	Low	Low	In group/LG	NHT/LG	No	Yes	Low	No	No
BCCA North Burnett	Low	Moderate - assist from BCCA committee	BCCA Committee (EPA, DNRM, DPI, LG)	NHT/WW/ LG	No	Yes	Low	No	No
Three Moon Salinity	Moderate	Low	In group/LG	Monto school/LG/BP	Yes - salinity	Yes	Moderate	No	Yes –school
Landcare - Kolan	Low	Low	In group/LG	NHT	No	Yes	Low	No	No
Landcare- Gayndah	Low	Low	In group/LG/ BCCA	NHT/ BCCA/ Mundubbera Landcare/ CVA	Yes – engagement not monitoring	Yes	Low	No	No
Landcare - Mundubbera	Low	Low	in group/LG	Gayndah Landcare/ BCCA Central/schools	Yes - Engagement not monitoring	No	Low	No	Yes - school
BCCA - Central	Low	Moderate - assist from BCCA committee	BCCA Committee (EPA, DNRM, DPI, LG)	Gayndah Landcare/ BCCA / Mundubbera Landcare/ LG/ CVA	Yes – engagement not monitoring	yes	Low	No	No

Organisation/Name	Human resources (volunteers)	Current capacity to acquire WQ funding	Project steering and management	Previous project collaborators	Previous WQ monitoring projects?	Previous Rivercare/ Coastcare projects	WQ technical capacity in group	Water quality equipment	Laboratory access
Smalls Creek Landcare Group	Moderate	Moderate	In group/ LG, BCCA/ Kingaroy Landcare	NHT/ LG/ BCCA, Kingaroy Landcare/ WW/BP/ School/ Dow Agri-Science	No	Yes	Low	No	No
Cherbourg NRM/ Conservation Council	Low at present but could be moderate with NRM trainees	Moderate – assisted by NRM coordinator	In group (NRM coordinator)/LG	LG	No	No	Low at present but could be High with NRM trainees	No	No – but may be able to access Tarong lab through a BCCA link
Landcare – Nanango and District	Low	Low	In group/LG	LG	No	Yes	Low	No	No
Landcare- Kingaroy	Moderate	High - assisted by LG partner (Kingaroy Shire Council) and other partners	In group/LG/ LG Remnant Vegetation Steering Committee	NHT/LG/ Tarong Coal, Tarong Energy/ BGA/ 2x schools/ 15x local businesses/ National Landcare/ SGAPKB	Yes – WW and Salinity Project	Yes	Low	No	Maybe use of Tarong Energy's Lab?
Landcare - South East/ Burnett (Tansey)	Low	Low	In group/LG	LG	No	No	Low	No	Possibly access to school lab
BCCA South- Wondai/ Waterwatch South	Moderate - WW	Moderate - with assistance by BCCA committee	BCCA Committee (EPA, DNRM, DPI, LG)	NHT/WW/ 2x LG	Yes - WW	Yes	Moderate	Yes (some)	Yes – Tarong Energy lab

Organisation/Name	Human resources (volunteers)	Current capacity to acquire WQ funding	Project steering and management	Previous project collaborators	Previous WQ monitoring projects?	Previous Rivercare/ Coastcare projects	WQ technical capacity in group	Water quality equipment	Laboratory access
BCCA East	Low	Moderate - with assistance by BCCA committee	BCCA Committee (EPA, DNRM, DPI, LG)	NHT/Environfund/ SW/ LG	No	Yes	Low	No	No
Landcare - Baffle Creek and District Landcare	Low	Low	In group/LG		No	No	Low	No	No
Landcare - Agnes Water	Moderate	Low	In group/LG	LG	No	Yes	Low	No	No
Landcare – Isis (Childers)	Low	Moderate	In group/LG/ DPI/ DNRM	LG/ DPI/ DNRM/Envirofund / NHT/ Sugar Industry	No	No	Moderate	No	No
Landcare – Bundaberg and District Urban Landcare	Low	Low	In group/ LG/	LG/ NHT	No	Yes	Low	No	No
Baffle Creek Catchment Management Group	Low - moderate	Moderate	In group committee/ LG/ Schools/ EPA	LG – Miriam Vale/ NHT/ EPA/ WW/ DNRM	Yes	Yes	Low-Moderate	No (access via EPA possible)	Yes – school lab
Wide Bay Burnett Conservation Group	Low	High	In group committee/ LG	LG/NHT	Yes	Yes	Moderate	No	No
Woongarra Marine Park Monitoring and Education Project	Moderate - High	Moderate - High	AIMS/ LG/ CEM, CQU/ DNRM	AIMS/ LG - Burnett/ CEM,CQU/ Envirofund/ NHT	Yes	Yes	High	Yes	Yes

Notes: LG - local government, WW- Waterwatch, NHT - National Heritage Trust, SW – Sunwater, CVA – Conservation Volunteers Australia, BGA – Bean Growers Association, SGAPKB – Society for growing Australian plants – Kingaroy Branch

4.2.2 Current state of affairs within Catchment groups

The following section documents the general state of affairs within the current community monitoring networks of the Burnett catchment. No groups, with the exception of WMPEMP (and Waterwatch programs in the South Burnett Subcatchment and the Baffle Creek area), have active water quality monitoring programs at present.

Membership and human resources

Membership in most groups is not defined by fee-paying members, but by mail out lists, and membership is fluid (everyone who attends a meeting or activity is a member). At any stage there are many members, but some have not actively contributed for long periods of time. Over the last few years most NRM groups in the Burnett Basin have experienced a significant decline in membership and the active participation at meetings and project activities etc is often left to a core group of dedicated people (usually the Chairs, Vice Chairs, Treasurers and Secretaries) or a lone 'champion', who prevent the collapse of their respective groups.

This scenario is not universal, particularly where groups have been divergent and have secured external stewardship. For example, the active engagement of partners (industry or line agency) with leadership strength appears to fortify and focus groups and their respective members. The primary industry based Landcare group in Childers maintains continuous high membership and is cooperating in long term DPI irrigation efficiency projects. Due to their permanent project officer, WMPEMP functions with high capacity in most areas (technical, human resource etc). School based Waterwatch activities retain their focus through curriculum (and science staff) and provide a form of human resource capacity. Future projects requiring a volunteer base should consider pooling human resources (this would be one function of a technical node) for a supportive network including council staff, schools, industry-sponsored personnel, NRM volunteers, project officers and support officers from the regional body, to overcome the current situation.

The general decrease in community engagement recently is, however, untimely in light of the new community driven NRM system (via regional bodies like BMRG) of independent leadership, access to science, comprehensive planning, professional advice and financial assistance. However, despite the advantages of the new system, several groups give the impression of having not being appropriately informed and some NRM groups are impatient with the regional body and confused as to its role (BMRG). Many attribute this to the lack of initial correspondence to inform groups of new timeframes, procedures and development of frameworks necessary under the new (NHT2) rules.

However, without exception, all groups contacted through this study have declared they are ready for a fresh start. If properly resourced, trained and guided to enter the investment phase, they believe in their ability to re ignite interest in local NRM and water issues throughout their respective region. There is opportunity here to make best use of the momentum shown by groups and their willingness to cooperate with Shire Councils and other stakeholders.

Summary: Low current membership numbers in NRM community groups does not reflect the potential interest in NRM topics although most groups are currently kept alive by a hard core of people. Most groups have insufficient human resource capacity to contribute substantially to a water-monitoring network, however there is capacity for reliable long-term partnerships. Strategic partnerships (to create a supportive network) would overcome the current situation. The willingness by all groups to establish the extra capacity required is universal.

Water quality equipment

Most community groups in the Burnett basin and associated catchments (and certainly those who monitor water quality) have been interviewed about the availability or ownership of equipment to monitor water quality, including condition of the equipment and access to calibration agents or services. The focus was on equipment to monitor standard parameters used during previous

Waterwatch activities facilitated by the DNR&M. (water temperature, pH, turbidity, dissolved salts, dissolved oxygen, nutrient concentration and diversity of macro-invertebrates). Only the BCCA South and WMPEMP own the above set of equipment and have access to calibration facilities. BCCA (south) also own a combination data logger (from Waterwatch, needs repairs), calibrated via Tarong Energy environmental laboratory (in-kind support).

Besides water quality, groups were queried about other resources. The majority of community groups (with the exception of WMPMEP and to some extent BCCAS) own no field equipment except shovels for tree planting (no cameras, GPS, nets etc) and no administrative equipment (computers, printers, database and/or analyses programs etc) for the effective running of projects. Several groups have arranged access to GPS equipment, (usually from a State department), to record site location and for mapping, however no group besides WMPEMP owns GPS equipment. Likewise, several groups use members' resources (computers etc) to maintain functional administration.

Other sources of WQ equipment: The town shire councils' water treatment plants work with standard equipment to monitor water quality but this equipment is not freely available to be used outside the plants. Further, the majority of inland town shires send water away to laboratories for testing and do not own or used monitoring equipment themselves.

Several industries within the basin undertake their own water quality monitoring programs and are well placed to offer assistance to groups and programs (discussed in section 3.3 of Chapter 3). Arrangements have been made previously with Tarong Energy (for calibration of equipment for Waterwatch South) and other industries. Several school based Waterwatch groups have purchased basic equipment with financial assistance from Mitre10 Landcare funds. This equipment is housed in the schools science labs and is well maintained and calibrated by technical support staff and science teachers.

Summary: Very few NRM groups own or have access to water monitoring equipment or have the necessary training to operate it. The quality standard of data required will determine what equipment the groups will need. If this equipment were available, ongoing training would be necessary for its effective use.

Technical capacity and training

Generally without a scientific understanding of NRM issues, there was previously no momentum for obtaining scientific equipment for action in NRM groups – groups focused on hands on projects (like revegetation). Where technical capacity was required, groups employed project officers, who brought the appropriate technical capacity with them. These short-term employees were project specific and their scope of work did not include training the group itself; therefore minimal knowledge transfer took place.

A recent collaborative project between BCCAS, Gayndah Landcare and Mundubbera Landcare to reignite water monitoring within the community in the central Burnett involved training days with schools, farmers, industry and councilors. These capacity building workshops/projects are considered effective for development of group technical capacity.

Currently, most groups have limited knowledge of use and calibration of water quality monitoring equipment, the obvious exceptions being BCCA south and WMPMEP. However, within respective regions of the Basin, and even within groups, there are a small number of technically skilled individuals and/or organizations that are well placed to offer assistance (through strategic locations) to groups and projects. These individuals/industries should be recognised as they could play a valuable role in the provision of expert advice and/or training to NRM groups, and indeed some of them are already active in this role (Tarong Energy and others).

Summary: Of the existing community groups only two have the technical capacity, (and one is still limited and not fully quality assured), to consider being part of a long-term water-monitoring network. Collaboration and engagement between water groups and from experts within community (including both individuals and industry/company staff) is recommended to build NRM groups' skill base.

Knowledge building

Knowledge has not been readily available to the majority of group members (partly due to the remote location of inland groups). For people older than 30 (the vast majority of inland group members) the application of physical, chemical and environment principals was not learned in schools, as environmental education was only incorporated into the Queensland curriculum in the late 80's. This lack of knowledge is a particular issue within inland systems due to their remoteness. Surprisingly, this issue has not been seriously or systematically addressed. In modern NRM, changes are required to achieve sustainability, but voluntary change without understanding is not readily achievable.

All groups contacted agreed that it is vital for the entire NRM movement, (whether Landcare or Catchment groups), to upgrade their educational foundations as well as to receive the training for use and maintenance of technical equipment. Also of vital importance was a desire to learn and understand the relevance of data in relation to their own local environment; for plants, stock and humans. There was a strong belief by all stakeholders approached, that school education needs to be an integral part of the movement. In academic terms, school monitoring groups have been extremely successful: winning Queensland's science awards and achieving fourth place in a national science competition. School public relation efforts in local media (newsprint) and radio have had outstanding effects on the community and school field days have generated unexpected interest in parents (further discussed in section 4.3.4 knowledge and training (capacity building)). School based monitoring groups have used their case studies effectively to put their viewpoint to Shire Councils, who have been optimistic both towards new studies and the schools involvement in NRM issues.

Provision of knowledge through education by highly trained personnel is also essential for group members to recognise the specific, direct and/or long-term effects of their own interactions, including remediation work, with the environment. Examples are the problems associated with chemicals used for weed removal (run off can affect the algal compositions in receiving waterways), and problems associated with physical removal of weeds from waterways (algal can potentially grow in their place if nutrients remain high). It was in this regard that community work received a high level of critique in the past, as not all community projects were well researched and various project conclusions were not favorable.

Summary: All NRM groups will need to be educationally prepared if serious community participation in designing a sustainable future is to become a reality. The development of a technical nodes structure will be facilitative of the dispersal of knowledge by providing central NRM locations (addressed in Section 5 of this report).

Home base – and administrative capacity

Most NRM groups, although having been established for more than a decade, have not managed to appropriate office space or office space has been temporary (during a campaign or project). The are a few exceptions: BCCAS has an established subcatchment office as in-kind support from Wondai Shire Council, and space for meetings (council sponsors a phone line, but the group has no computer or e-mail access), WMPMEP also have permanent office space from where to work and a couple of Landcare groups use facilities provided by leading industries (the sugar industry in Childers and Bean Growers in Kingaroy), but generally groups do not operate from a permanent office space.

There are multiple benefits in having a central base of operations and it is a telling fact that the two most successful and ongoing catchment groups in the basin operate from such a base. A central office allows for the administration of activities and projects in an organised, effective and timely manner as well as for housing of equipment. Provision of a computer allows for housing of data and a phone line enables dispersal of general project and activity information to assist in keeping and engaging members. Currently data collected by groups' remains in hardcopy form (although some groups have started data entry into Microsoft Excel spreadsheets by volunteers). Training to enable appropriate administrative and data handling capacity should be provided.

Conclusion: Only the BCCA South subcatchment group and WMPMEP have established office and the BCCA south office is recently developing into a NRM Centre. Other catchment groups are increasingly realising the need for a home base and the benefits to both groups and the wider district of an administrative Centre. Some NRM groups have started to negotiate with stakeholders, primarily councils at this stage, to establish a NRM office.

Overlap and duplication and/or wasted effort

There has been no overlap or duplication within community based water quality monitoring networks (most likely due to the lack of them). State agency monitoring sites may be proximal to the community monitoring sites, however, parameters and temporal cover differ.

Despite the inactive state of community monitoring within the Burnett basin, the effort to lift awareness and basic knowledge through informing the wider community has improved the understanding of water management issues significantly. Stakeholders have been generous in their support for water monitoring and communities at large have been appreciative, participating in field demonstrations and annual Water Day celebrations.

Despite data limitations (and its according use), the efforts undertaken to date in community driven NRM have had a significant learning effect and brought great benefits to regional and coastal communities.

Conclusion: There was a perception in most sectors of ongoing lack of collaboration for site selection between State agencies and community groups. This is thought to be due to the historic role of community groups; their activities were valued as awareness and educational exercises rather than serious data collection points.
This role appears to be changing, with community groups looking to adopt QA standards. The relevance of community groups to larger monitoring networks requires clarification.

Summary of gaps identified in community monitoring

Within the Burnett Catchment (both fresh and marine), whole regions are currently depauperate of sites and community monitoring activity. The central, north and east subcatchments of the Burnett River, as well as the Kolan and Gregory River catchments and most of the catchments coastal zone have not been monitored systematically or at all by their community NRM groups.

The Burnett south subcatchment (BCCA – Waterwatch) and Woongarra Marine Park (WMPEMP) are the only areas where groups are actively monitoring a full suite of water quality parameters, with aims to investigate their water quality situation and build an understanding within local communities of how the system works and where the problems are. In the past the Baffle Catchment was successful in receiving funding for such investigations, however, following release of the Baffle Creek Catchment Management Strategy the inconsistent nature of funds to implement on ground action resulted in minimal data collection. Investigations of salinity are being undertaken in the North Burnett subcatchment; however, The Three Moon Salinity Group does not monitor other parameters.

This study has defined large gaps in spatial cover (where there are no groups and/or no monitoring of water quality parameters or for contamination), human resources (for on implementing ground activity), and equipment for monitoring (computers to store data on etc), knowledge to activate project design/direction, training to use equipment (data storage) and administrative capacity for managing projects and maintaining funding. Currently, most community groups would be unable to deliver professional outcomes without substantial funding and support. As most groups are not geared for professional work (both organisationally and equipment and training wise) this is not surprising. Historically, groups did not need equipped offices and there was no need for them to work within high quality systems.

Since the introduction of the new regional arrangement three years ago, many community groups appear to have been waiting to be educated and trained, housed, equipped, and integrated into the a

wider network of actions to achieve a more sustainable future. Through this PAP many groups were informed for the first time of the different roles they may choose to play in the future and of what is required of them to achieve the desired outcomes. All groups were favorable to the future development of their present capacity to undertake water monitoring projects.

4.3 Conceptual models/strategies for community capacity building investment

Development and implementation of the following concepts would provide a solid foundation for expansion of current community water monitoring within the NRM networks of the Burnett Basin.

4.3.1 Technical nodes within a Water Monitoring Network (WMN)

The establishment (and development) of a limited number of technical nodes/NRM centres (adequately resourced) in key locations around the catchment would serve as valuable bases for the support and training of local on ground NRM groups/activities. This strategy will be particularly effective in a catchment like the Burnett due to the large geographic area and remote nature of much of the basin. The primary purposes of the nodes are for the implementation of technical field initiatives, (particularly relating to partnerships, resourcing, data management, quality and training – they are to implement strategic actions) and to allow an effective communication and feedback mechanism to groups. The locations for nodes are currently being conceived as North (Monto), Central (Gayndah), South (Wondai), East (Bundaberg) and possible North East (for the Baffle region and north – located at Miriam Vale, Baffle or Agnes).

Technical nodes would allow the central convening of available contribution by industry and other network providers, which are at present group specific and perhaps not fully utilised. In this way, technical nodes would provide a permanent forum in which to form partnerships - service providers and stakeholders would be expected to 'cluster' around the node to utilise it fully (draw on available resources in a structured manner, design potential projects that address both local and regional priorities and arrange training for these projects). A logical method of implementing technical nodes would be to utilise council services and space. In some inland areas the only available central space exists within council buildings, and in view of the increased NRM interest within councils at present, there is a logical progression for technical nodes to represent 'cluster groups' which are maintained by local government.

The above in combination with the data integration and communication strategy detailed in Chapter 4 (section 4.6 Data Integration and communication) will facilitate the construction of a formal community "Water Monitoring Network" (WMN) to allow new or existing groups to use the Technical Node system to access data and reports and to allow them to pursue local agendas within larger issues in a strategic and prioritised manner. The WMN will provide both real and virtual environments to allow provision of knowledge, interaction, data storage and access and reporting mechanisms.

4.3.2 Re-engagement of BCCA subcatchment groups

The BCCA has an appropriate structure for project management; the organisation includes an array of subcatchment groups along with local council, functioning under an umbrella arrangement (the BCCA committee). As described in section 3.1.1 this committee has served effectively in the past as a management group, providing support in funding applications, collaborations, management and acquittal of projects. The Committee of the BCCA was comprised of representatives from EPA, DNRM, DPI and local government and BCCA subcatchment groups.

As mentioned in section 3.1.1, the BCCA committee is presently reduced, due to Department of Mines and Energy, Natural Resources, Primary Industries and Forestry and the Environmental Protection

Agency no longer endorsing their officers to attend BCCA meetings. With the BMRG now playing an essential role in NRM decision-making and funding priorities (previously undertaken by BCCA), it is speculated that future support from government departments will be to BMRG rather than to BCCA. However, how BMRG will channel this support and how this change will affect the current role of the BCCA is not fully determined.

The BCCA (committee and subcatchment group representatives) have been contacted within this PAP and are amenable to future capacity building and community engagement activities to facilitate a progression within BCCA from their current role as primarily project managers/coordinators to a future role of increased community involvement in on-ground activities to implement priorities for the inland and central region. It is thought this change in BCCA culture (from management to active collection) is necessary to strengthen the inner core BCCA and achieve the strategic objectives defined by this group in the Burnett Catchment Strategy. The integrated nature of this approach is an important aspect of the technical nodes/NRM centre strategy. Provision of a project officer to BCCA would no doubt expedite the process of community re-engagement and capacity building within BCCA subcatchment groups.

Members of BCCA were found to have appropriate backgrounds (PhD, Agricultural degrees, Local government etc) and knowledge of the significance of appropriate systems for running projects to successful conclusions (management and quality assurance – at least one member has received their certificate from WQ05 QA workshops). The BCCA has long standing contacts and support from locals, government and industry. The importance of building capacity within established and recognised groups like the BCCA, rather than attempting for form other/new water groups was apparent when this subject was discussed at community forums. BCCA is universally recognised by the communities of the inland Burnett as 'The Catchment/Water Care Group' and therefore the appropriate group through which build capacity, locate project officers and manage volunteer driven water monitoring projects.

4.3.3 Essential requirements of a technical node (NRM Centres) strategy

Permanent office space

In view of the long-term approach required in NRM issues, the proposed monitoring networks will need to be viable for the long term; therefore groups require a suitable base. The Central and North Burnett regions have already recognised this need with Landcare, Catchment Care groups (BCCA's) and Shire Councils, presently in the process of establishing offices. Pooling of human resources assists to overcome the shortage of manpower, generate new interest, attract new activists and utilise office space and equipment more efficiently. It has been recognised that council NRM staff could play an important part through these NRM Centres. BMRG also has an important role to play within technical nodes/NRM centres in setting strategic direction and assisting with development and coordination of funding applications (the current role of community support officers). The channeling of funds and training through technical nodes by BMRG for development of technical expertise and general knowledge is anticipated. It should be noted that the technical nodes strategy does not support amalgamation of NRM groups. Community groups differ in their respective focus and agendas and diversity would be lost with amalgamation.

An office is more than just a space – it is a local NRM 'point of contact' for both group members and the wider community. Face to face contact may provide impetus for engagement of new members. Office space would enable all groups to appropriately store their literature, documentation, equipment and data records with available access (and reduce duplication of the above). A fixed telephone/fax line and email (web access) would greatly enhance communication; the current policy of change in NRM groups is that contact numbers changes with the project officers and/or committee members.

Conclusion: Permanent office space is required for NRM groups to operate reliably at the professional standard required. The current willingness of NRM groups to cooperate (Landcare and Catchment Care) provides an opportunity to pool human resources within technical nodes at strategic locations. The BCCA south building is already practically a NRM Centre, housing the BCCA south-subcatchment group, two BMRG officers, the South Burnett Waterwatch project and DPI. Minimal provisions would be necessary for this location/group to be established as a technical node.

Knowledge and training (capacity building)

Knowledge building: The necessary change in attitude from landholder/urban dweller to a natural resource manager working on the principles of sustainability will be a challenge; many landholders appear threatened and uncertain of their legal rights and responsibilities relating to NRM plans and other regional management. The role of the regional body (BMRG) and altered role of state agencies is also vastly misunderstood (this is more obvious in the inland Burnett than the coastal sectors). The necessary change most likely requires an information strategy to be developed, relating to the role of management agencies (how actions will be determined, administered and funded) and the achievability of NRM principles within practical farm management as well as logistical information (relating to how actions will be determined, administered and funded). The phrase "redefining the utilisation of the landscape" might be a valid long-term goal, but in practise is merely an academic concept without relevance. Without substantial capacity building in this regard, regional communities will experience problems understanding NRM issues.

To be effective, NRM capacity building must particularly target landowners and urban dwellers that are not already part of an NRM group. These community members are the vast majority and the most difficult to attract. Several avenues allow for knowledge dispersal and connection with this sector of the community:

1. School based water monitoring groups have generated unexpected interest from parents (rural and urban) who would otherwise be unapproachable. Parents often attended field trips (usually uninvited) and have stated, "we have to know what our kids know". This new interest should be utilised and expanded upon, perhaps to the extent of school NRM curriculum including parent days or including projects that draw in/utilise neighboring properties (comparable practices, questionnaires etc).
2. Results of the BMRG commissioned CQU communication research revealed that the women in a rural household may be more approachable that the man. Women were found to be better informed with superior verbal skills and a greater sensitivity to social and environmental propriety.

Training in water monitoring: Community monitoring has some advantages (flexible in site selection and monitoring frequency and the capacity to react quickly during events), however the lack of quality assurance systems in community monitoring has resulted in uncertainty of data integrity. If community datasets are to be used with line agency data, consistent quality assurance procedures are required. The basis of such a system will include minimal standards in equipment, technical expertise including calibration and collection methodology.

Several stakeholders throughout the basin already provide calibration services; pooling of these services could occur through the technical nodes structure. With provision of a base and appropriate training it is feasible that NRM groups would calibrate and maintain their own equipment in the future.

Conclusion: An investment to establish technical nodes should be complimented by investments in base knowledge building (to ensure a baseline understanding of NMR issues) and training regimes (skills in administration, computer literacy, technical use of equipment and calibration etc). These skills are particularly lacking within groups of the inland Burnett regions.

Standard water monitoring equipment:

A complete set of monitoring equipment per technical node is necessary. Equipment would be of minimal standard to achieve uniformity among monitors and allow measurement of parameters including pH, temperature, electrical conductivity, salinity, water clarity (via suspended solids, turbidity or secchi depth) and collection of nutrient samples. This would allow for immediate on ground action in water quality monitoring and also enable monitoring of the long-term effects and success of Rivercare projects aimed at improving water quality. It would be most efficient for community groups to use existing surplus equipment currently held by industry and agencies rather than acquiring a complete set from scratch.

Access to equipment may enable some groups to offer additional services to their community. For several years BCCA south has measured water quality at garden shows, agricultural shows and field events as well as testing bore water for landholders and real estate agents and providing advice on water utilisation. This service and contact has advanced the standing of this NRM group significantly within the community and has educated the wider public on NRM issues.

Chapter 5 Component C: Gaps/Issues Review and Action Plans

5.1 Context to issues/hotspot identification within the Burnett Basin

Specific objectives of the Funding Plan (BMRG 2003) refer to 'hotspots' as those identified by the State of the Region study (LRAM, 2004) and the Reef Water Quality Protection Plan (State of Queensland and Commonwealth of Australia, 2003). This section provides an assessment of 'hotspots' or issues per subcatchment based on (1) the above documents, (2) previous regional assessments (Queensland Government, 1999; NLWRA, 2000; NLWRA, 2002), (3) metadata review provided by NRM (NRM, 2004), (4) community derived catchment information (Waterwatch where data exists) and (5) anecdotal information.

The State of the Region Study (LRAM, 2004) is a desk-based assessment of what is known of the natural resource condition of the region and the main drivers of change of that condition and is thought to represent the most comprehensive summary of information and use for NRM planning. The information base for reviewing stream condition and water quality within catchments (regional assessments) was largely derived from the Testing the Waters Study (Queensland Government, 1999) and subsequent National Land and Water Resources Audit (NLWRA, 2002).

The Reef Water Quality Protection Plan uses a risk assessment approach, which is used here to allow local issues to be graded and prioritised at a catchment level. Within the RWQPP, the Burnett Basin (especially the near coastal parts) was identified as the second highest risk catchment from calculations based on criteria used (rank descriptions and relative rankings within the Burnett Basin are given in Table 13).

Table 13: RWQPP Burnett Mary Regional Catchment Risk Ratings (The State of Queensland and Commonwealth of Australian, 2004).

Basin	Biophysical risk	Social risk	Development risk	Risk to marine industries
Baffle	M	H	M	L
Kolan	L	H	M	L
Burnett	M/H	H	M	M/H
Burrum	M	M/H	H	L
Mary	M/H	L	H	M/H

Criteria:

Biophysical risk: summarises the magnitude of (potential) land-based pollution from the catchment or basin and their impact on coastal/marine ecosystems in the catchment impact area.

Social risk: encapsulating various factors of the capacity of a catchment community to change practices that (potentially) cause land-based pollution. Therefore social risk is an indication of the *lack of* capacity to change.

Development risk: providing an assessment of future development pressures, which may result in increased pollution from the catchment/basin to the reef.

Risk to marine industries: assessing the economic impact of land based pollution on industries, which operate within the catchment/basin impact and rely on Reef integrity for income and profit.

Besides 'hotspots' being those identified by State of the Region and past reporting efforts, hotspots noted within this report include those identified from colloquial sources. The majority of colloquial information was gathered through community group engagement while gathering information for Component 2 of this PAP (community monitoring network) and through a series of community meetings held around the Basin, which were organised to enable acquisition of this sort of information. Knowledge of current land uses within the catchment also assisted in determining potential water quality hotspots where sites and data were minimal (Figure 3).

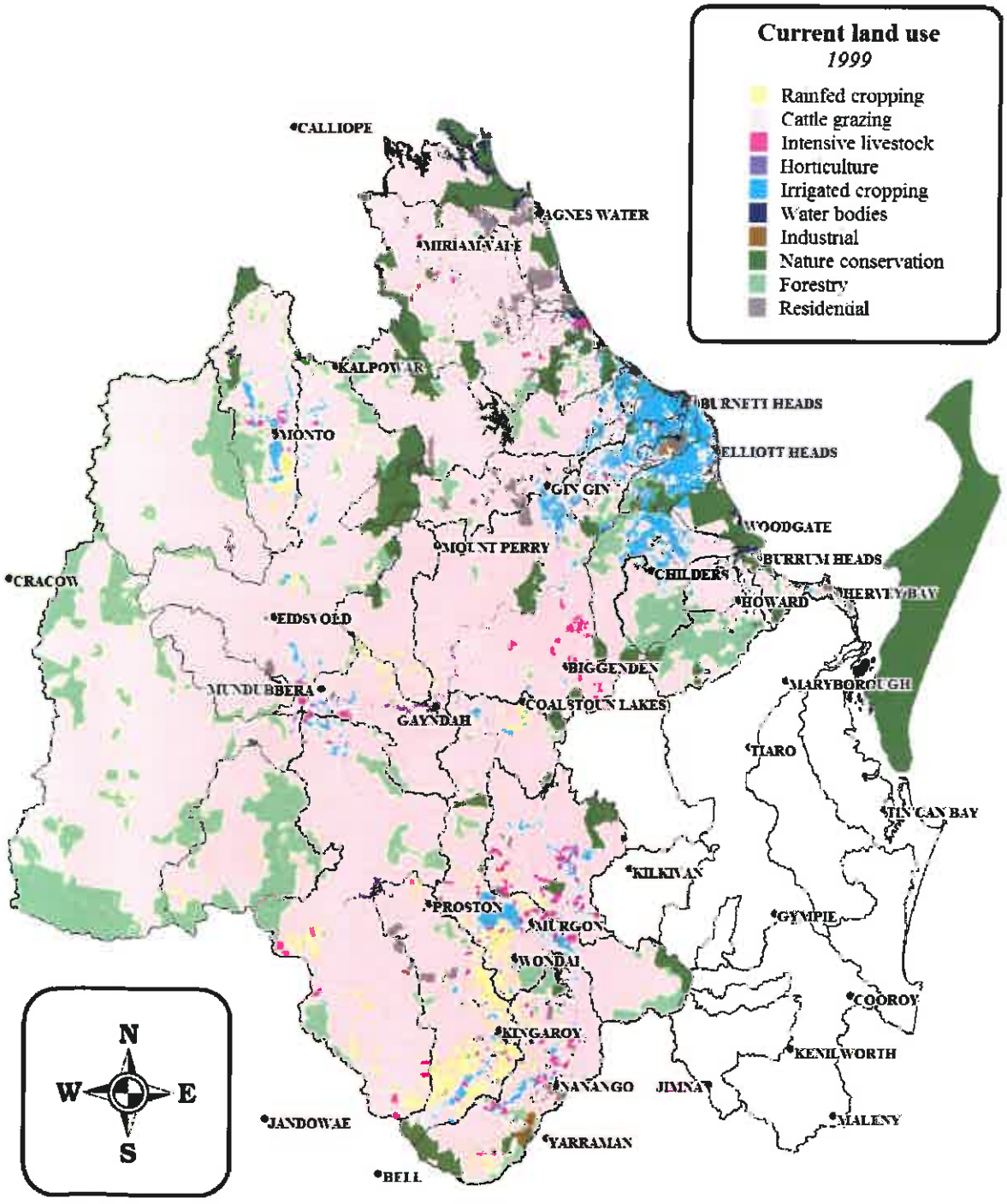


Figure 3: Land uses within the Burnett Catchment in 1999.

Initially it was envisaged that the content of the following section would be described within River Management Units (river reaches) to facilitate understanding at a local level. However, due to the lack of consistent approach in defining geomorphic reaches within the Burnett Basin (past studies have used different break up, hence difference river reaches) this was not undertaken (the various approaches to geomorphic breakups within the Burnett are discussed in Chapter 6 of this report).

It was later evident (with the extent of available data apparent) that the above approach would have yielded major difficulties at this time, as the collection points (GPS) of much data and information (hotspots/issue areas/past sites) are unknown; therefore mapping within reaches could not be undertaken. However, this exercise (mapping of issues, hotspots and sites within a reach context) is recommended for each sub-catchment as the one of the first steps of a Subcatchment (Rehabilitation) Action Plan.

5.2 Identification of hotspots/issues within the Burnett Basin

5.2.1 Kolan River catchment and estuary

Water resources: Gin Gin Creek, Kolan River
Infrastructure: Kolan Barrage; Bucca Weir; Fred Haigh Dam (Lake Monduran) – storage for Bundaberg Water Irrigation Scheme.

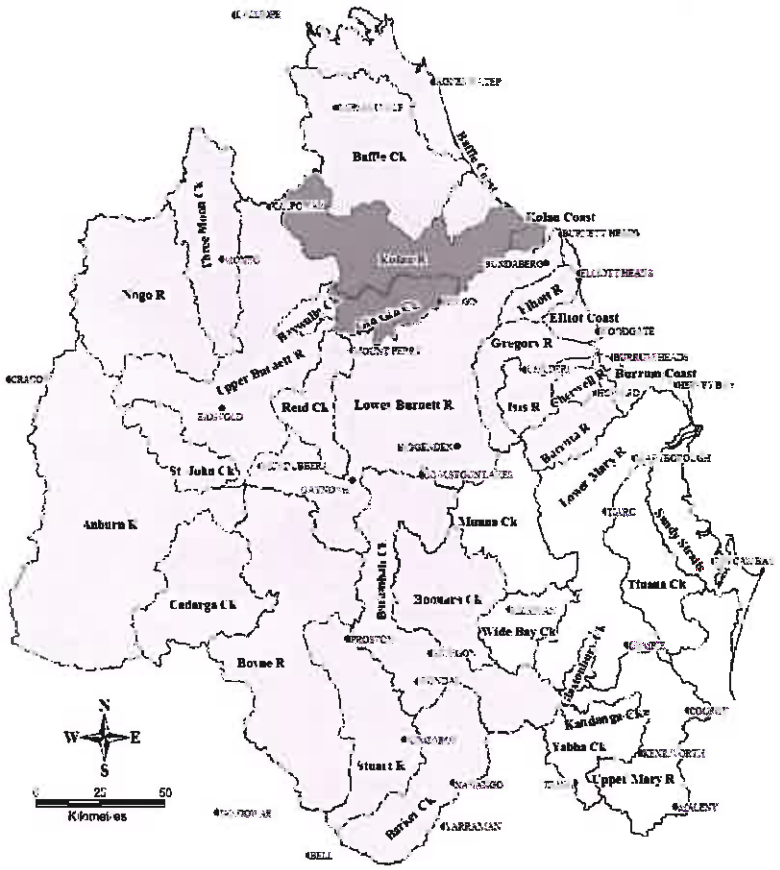


Figure 4: Position of the Kolan Catchment (highlighted) within the Burnett Basin

The Kolan was classified as the catchment with least biophysical risk (potential for land based pollutants) in terms of within the Burnett Mary region, despite a moderate risk from development (State of Queensland and Commonwealth of Australia, 2003) and the basin was classed as "moderately modified" for disturbance, habitat and "severely modified" for nutrient and suspended loads (NLWRA, 2002). As for the Baffle and Burnett Catchments, there was a high risk associated with the perceived lack of capacity for communities to change practices that cause land-based pollution (State of Queensland and Commonwealth of Australia, 2003). However, the introduction of property management plans (PMP's) may assist in modifying current land practices to lessen land-based pollution. It is suggested that declines in water quality may be related to poor riparian condition (erosion, weeds- cats claw etc) and subsequent loss of ecosystem services although little evidence of this is available. Instream service decline may stem from water extraction and point source influence. Recent studies highlight the lack of ongoing water quality studies, (both freshwater and marine and estuarine) for the Kolan area (Prange and Duke, 2004a).

The Kolan estuary is reduced by half due to impoundment, and water regulation has resulted in physical changes to the estuary (LRAM, 2004). The estuary was classified as modified, a wave dominated delta (NLWRA, 2002).

Due to knowledge of this catchment arising primarily from regional assessments, there is little evidence of information on local hotspots or issues relating to point and diffuse sources. Thus the need for quality site data to advise management in the short term is critical, particularly as stream reaches are highly variable within this catchment (reach environs ranged from very good to very poor condition (Van Manen, 1999)). Past studies have noted a high stability of total bank lengths surveyed in the Kolan Catchment, with no streams having unstable or very unstable banks. Despite this, bank erosion (unvegetated banks) was the dominant process affecting bed stability (Vann Manen, 1999), which has implications for future rivercare management (revegetation). Ecologically, the Kolan subcatchment is significant, with 75% of stream reaches having "good to very good" conservation value (gauged by quality of aquatic/riparian vegetation and value of stream length as remnant habitat or wildlife corridor).

General issues for the catchment have been noted as clearing (86% of the catchment is grazing), presence of sheet and rill erosion due to susceptible soils, woody weed invasion, salinity associated with high water tables on cultivated lands and salt water intrusion of groundwater due to overuse of aquifers, contamination by agricultural chemicals of ground waters, and changes to faunal species arising from habitat change (Anon (Scientific Working Group), 2001).

Issues, hotspots and gaps: Previous studies have noted moderate concentrations of salinity in Gin Gin Creek, which are possibly related to salinity outbreak sites. Nutrient and suspended sediment (turbidity) concentrations have been classified as "extremely modified" within the catchment (NLWRA, 2002) but have not been related to either land use or diffuse or point sources. The obvious gap is the lack of analysis of local long-term data (NRM, EPA and Sunwater) to determine issues within the system or to identify the need for a more comprehensive water quality program design (this may arise from the SIP WQ02 project). The lack of availability of Sunwater data since 2002 (due to commercial in confidence) decreases the value of DNRM's current site design to community and water managers, however negotiations are underway for access to this data. There is limited monitoring of water parameters in Gin Gin Creek (only pH conductivity and water temp taken by NRM below confluence of Gin Gin at Sheep Station Creek) despite this area being noted for salinity outbreaks. There is no current monitoring effort by EPA or community. There are no current programs investigating previously noted contamination of groundwater by agricultural chemicals.

Catchment groups: Kolan Landcare group, Kolan Shire Council

5.2.2 Burnett River catchment and estuary

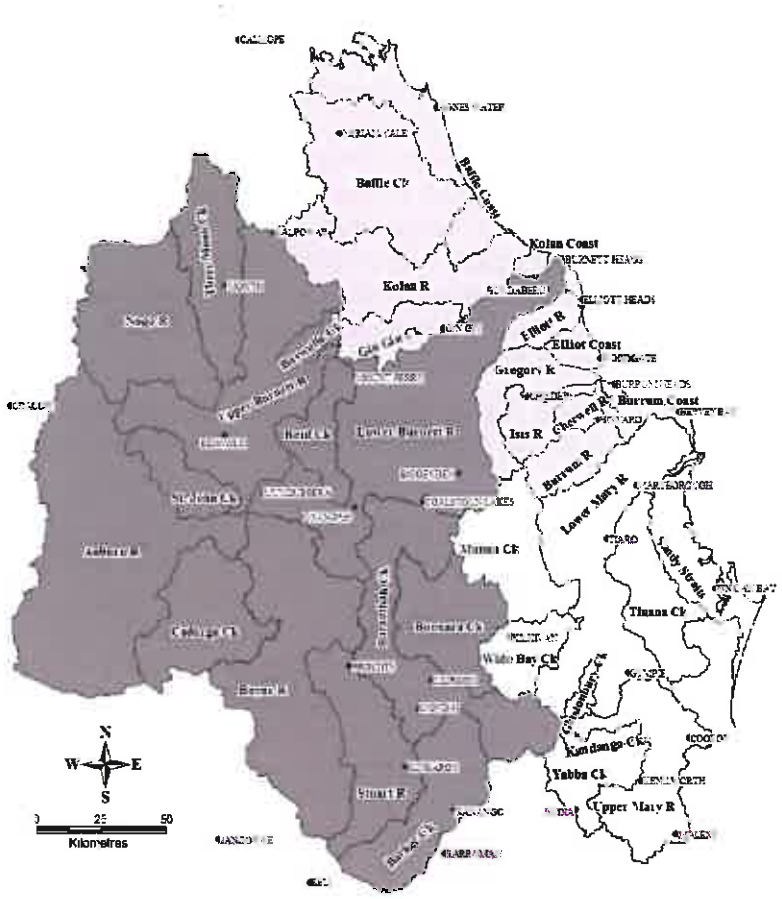


Figure 5: Position of the entire Burnett River Catchment (highlighted) within the Burnett Basin

The Burnett catchment has been assessed as having moderate to high risk for biophysical, developmental and economic impact, and a low capacity for communities to change practices to reduce these effects (Table 10 - State of Queensland and Commonwealth of Australia, 2003). Despite the variability between natural resource attributes in subcatchment environs and /or lack of previous ecological studies in the region (LRAM, 2004; Prange and Duke, 2004), the underlying themes of sediment and nutrient runoff appear consistently in literature as issues for targeting in order to improve resource condition within the catchment. Obviously, in view of the impounded nature of the river system, the numerous impacts from impoundments and reduced flow also form a major theme for the catchment and are addressed in several reports (Bluhdorn and Arthington, 1994). Previous studies have found that most parameters (including total phosphorus and total nitrogen concentrations) through the Burnett catchment were within ANZECC guidelines (Queensland Government, 1999).

The majority of studies (NRM, 2004) within the catchment provide audit assessment information with regard to either EIS requirements (project specific) or give regional assessments (basin wide), and are not geared towards detection of change in ecological communities over time in relation to environmental variables (flows, turbidity, nutrients etc) or detection of hotspots within subcatchments. However, several existing studies of ecological relevance (Boardman, 1996; Tucker *et al* 1999; Brooks and Kind, 2002; Choy *et al* 2002; Arthington *et al* 2002; Bluhdorn and Arthington, 1994) provide valuable baseline data against which future changes to impoundment or discharge regulation can be compared – in particular the reach data from the State of the Rivers study is considered to be of significance (LRAM, 2004).

Water quality within the Burnett estuary has frequently been poor in the past, within numerous fish kills occurring over the years (Miller, 1985). The estuary was classed as extremely modified in past studies, with the sub classification being a tide-dominated delta (NLWRA, 2002). Anecdotal evidence suggests that historically there were seagrass beds in the mouth of the Burnett River, however recent studies did not locate this resource (NLWRA, 2002). Bundaberg Port Authority undertakes ecological monitoring in the estuarine and marine environment, which would benefit from parallel water quality monitoring to assist in detecting impacts.

Burnett River

The Burnett River itself has reported as severely modified based on the nutrient and suspended sediment loads (NLWRA, 2002). As reported in the State of the Region Study, there is some evidence of localised problems within the catchment (LRAM, 2004), however, given the insufficient collection of available data for most tributaries (Boonara Ck, Stuart R, Cadarga Ck, Boyne R, Bayulla Ck, Three Moon Ck, Nogo R, St John Ck and Reid Ck), the full detection and evidence of local issues relating to point or diffuse sources within subcatchments was beyond the scope of most regional assessment studies and hence, this report. The State of the Rivers Reporting represents the most comprehensive information available for the Burnett River and each of its subcatchments.

More specific information relating to local issues is noted in the following sections for areas where data is available or where anecdotal information appears relevant.

North Burnett subcatchment

Water resources: Three Moon Creek, Monal Creek, Splinter Creek, Eastern Creek, Upper Burnett River, West Burnett River
Infrastructure: Cania Dam.

The Monto/Mulgildie area is a declared groundwater area (LRAM, 2004). Three Moon Creek is the major primary tributary for the Burnett River and has intermittent flows south to its confluence with the Burnett River (Gardiner and Brennan, 2004). In earlier years twice yearly releases from Cania Dam allowed flow for about 6 weeks (Horn, 1993) and rainwater sourced flows are intermittent and rare. Deteriorating water quality (surface and aquifer) has long been recognised as a problem within the Three Moon Catchment (Horn, 1993), along with siltation and salinity. Deterioration of groundwater is suggested to stem from:

- Extraction lowering groundwater levels (suggested influence from the adjacent Mulgildie Coal Measures), and
- Historic salts mobilized by deep drainage (irrigation) into groundwater below.

Downstream of Monto salinity remains high along Three Moon Creek and water is suitable for tolerant crops (Authors various, 1983). There is a significant saline influence from the unnamed creek that runs down Muldgildie Coal Measures (near Bazley's Rd) that decreases after recharge events from either dam release or rainfall. Hurdle Valley has been noted as supplying reasonable quality water in the past, however this requires confirmation.

The Goondicum Mine (owned by Monto Minerals) has initiated several studies relating to groundwater supply and the proposed weir development. The surveys also provide baseline aquatic flora and fauna data (and associated instream habitats), and assessment of the ecological importance of water holes. This data represents some of the most comprehensive collection of information for the upper and west Burnett River (sites were mostly semi-permanent water holes and the implications of sampling ephemeral sites were addressed). The data confirms the presence of high nutrients and temperatures at some sites, although the majority of water quality data points fell within recommended guidelines, particularly within the West Burnett River (conductivity values in West Burnett were reasonable). Poor water quality and reduction of instream diversity was often related to cattle

tramping and runoff, highlighting the need for external watering points and established riparian zones (high temperatures can rule out the presence of crustaceans such as *Cherax* and *Macrobrachium* species found in this study). The presence of higher vertebrates (water rats and particularly turtles) suggests presence of adequate water and food supplies.

A review of DNRM data collected from Yarrol gauging station between June 1967 to August 1995 noted pH levels ranged slightly (pH units 6.5-7.7), salinity ranged from fresh to brackish and metal concentrations were generally below or close to detection limits (Woodward Clyde, 1996). Groundwater studies have noted limited storage and recharge capacity of aquifers along the Yarrol Fault (which crosses the west Burnett River), suggesting these aquifers are unsuitable for water supply (Woodward-Clyde, 1996).

While no section of stream was in overall very good condition, almost half (47%) were in good condition in the SOR report (Van Manen, 1999). Although bank condition was generally stable, a large percent of banks were devoid of vegetation (82% of lower banks and 74% of upper banks) and the main process identified as affecting streambed stability, was erosion (evident along 56% of stream reach). Updated information of this kind (which will be provided by SIP WQ04 Riverine habitat condition assessment and review of guidelines) will assist in future identification of areas for rivercare activities (as would undertaking a broadscale inventory of reach bank/bed conditions). About half of stream reaches in the north Burnett subcatchment were ecologically relevant, with 58% having good to very good conservation value (gauged by quality of aquatic/riparian vegetation and value of stream length as remnant habitat or wildlife corridor).

Issues, hotspots and gaps summary: Salinity problems are noted for the upper and lower parts of Three Moon Creek – these areas in particular require investigation to determine specific salinity outbreak areas and plan for their management. There is no monitoring of parameters other than salinity by community in the catchment (the Three Moon Group monitor salinity only), which expounds on the lack of testing by government (one site only in the upper Three Moon that tests water quality only – no nutrients). There is no water quality monitoring in the West Burnett River (besides Goondicum Mine). Previous reports have noted a lack of knowledge re: distinction between dryland salinity and irrigation salinity, which emphasises the need for school and formal awareness programs. There are no subcatchment level aquatic resource management plans to address the above gaps and issues.

Catchment groups: BCCA North, Monto Landcare, South Moon Salinity Group, Monto Shire Council, Local school. There is capacity present in Monto Landcare and South Moon Salinity Group (although they need equipment).

Central Burnett subcatchment

Water resources: Nogo River (downstream of the confluence of Holsworthy Creek and Rawbelle River), Cattle Creek, Montour Creek, Auburn River, Cadarga Creek, St.John Ck, Burnett River at Gayndah, Reid Ck (Branch Creek), Ends of the Barker/Barambah system.

Infrastructure: Lake Wuruma

There was a paucity of current local information for the Central Burnett River and associated creeks although some site information exists within the State of the Rivers Report (Van Manen, 1999). Water quality problems within the Central and southern subcatchments have been identified as similar, although the southern subcatchment maintains a much higher population and is much more industrialised.

In 1999 the overall resource condition of surveyed stream reach lengths was: 18% in good condition, 49% in moderate condition and 33% in poor condition. No section of stream length was in overall very good condition (drawn from 166 sites) (Van Manen, 1999). Although bank stability was generally classed as stable or very stable, a high percentage of sites included banks devoid of

vegetation (38% of lower banks and 64% of upper banks), which should be noted for future management efforts. The major factor affecting bank stability was stock access (followed by runoff and clearing of vegetation), highlighting the need for increased riparian zone management including off stream watering points, fencing and revegetation. About half of stream reaches in the central Burnett subcatchment were ecologically relevant, with 45% having good to very good conservation value.

The Auburn River is one of the major primary tributaries of the Burnett River, located in the West of the Burnett Catchment (and the second longest primary tributary behind Barambah Creek). Some areas of the river within Auburn National Park are thought to contain higher quality water than unprotected areas (anecdotal information) and potential comparative values as a reference environment. The Nogo is located in the North West Burnett Catchment and has been noted for its distinct drainage pattern, where the channel width doubles downstream of confluences (Gardiner and Brennan, 2004). State of the Rivers (Van Manen, 1999) provides the most comprehensive information available for the Auburn and Nogo Rivers.

Catchment groups: BCCA-central, Gayndah Landcare, Mundubbera Landcare

South Burnett subcatchment

Water resources: Boyne River, Stuart River, Barker Creek, Barambah Creek, Boonara Creek, Meandu Creek

Infrastructure: Gordonbrook Dam, Proston Weir, Boondooma Dam, Meandu Creek Dam, Tarong Cooling Water Dam, Tarong Ash Dam, Nanango Weir, Bjelke-Petersen Dam (Lake Barambah), Joe Sippel Weir, Francis Weir, Murgon Weir, Silverleaf Weir

As mentioned, there are similar water quality problems within the Central and Southern subcatchments, however, the southern area supports a much higher population and is much more industrialised. While some tributaries within the south subcatchment remain poorly studied (Stuart River, Boyne River), the Barker-Barambah sub catchment has been the subject of several environmental studies assessing water quality, river ecology and water allocation including effects of flow regulation and managing electrical conductivity with water releases.

The Stuart River system (which is the primary tributary of the Boyne River and a major (second) tributary of the Burnett River) has been noted for salinity and chloride levels that exceed those recommended for crops (LRAM, 2004). Nutrients are problematic and a major issue for management in both the Stuart and Boyne Rivers, causing large amounts of aquatic macrophyte biomass or severe blue green algae blooms. Blue green algae blooms are particularly severe in the receiving water body of the Gordonbrook Dam, which is Kingaroy's water source. As a consequence, the dam is often closed to the public (as at the time of this report) and recreational activities have ceased. This is a small shallow dam presently at about 60% capacity (down from 1800 to 1400ML) that also has problems with siltation. Rehabilitation of the Gordonbrook foreshore is the current focus of The Greencorps Team (discussed in 3.2.18 Kingaroy Council) who, in collaboration with five councils are applying for funding to initiate this project. Anecdotal accounts identify the sewerage treatment plan as a hotspot of the system, which releases effluent to the river, compounding the nutrient problem (this information requires verification).

SOR data represents the majority of available information for the Boyne River. This information notes generally good bank stability (76% of reaches were stable or very stable) but poor bed stability (47% of stream having unstable to very unstable beds), due to bank erosion. Community also noted upstream bank and bed erosion as hotspots, which may form the basis of future rivercare projects. These issues should be addressed within primary stages of a subcatchment rehabilitation plan for the South Burnett Subcatchment.

Barker Creek is the primary tributary of Barambah Creek, which is a primary tributary of the Burnett River (Gardiner and Brennan, 2004). The major catchment wide issues in the Barker-Barambah catchment include stream salinity, nutrification and a degraded riparian zone (Bluhdorn and

Arthington, 1994; Arthington *et al* 1992; Poplawski, 1989). High levels of Total Phosphorus were noted particularly at the confluence of Barker and Barambah Creeks (below the Bjelke-Petersen Dam), and the presence of high nutrient concentrations are currently obvious in the high biomass of *Salvinia* in Barambah Creek (at Flicks Crossing in October 2004). General studies note that salinity and chloride levels exceed those recommended, particularly within the middle sections of Barambah Creek where high incidence of dryland salinity has been noted (LRAM, 2004). Scientific reports recommended primary (gauging station sites and water monitoring) as well as secondary (height only and water monitoring) water monitoring sites within a long-term design (and including nutrient and Chlorophyll a samples) and suggest using environmental releases to mitigate effects of high seasonal electrical conductivity levels (Bluhdorn and Arthington, 1994). Other recommendations were for monitoring of agricultural chemicals including

- Monitoring of a wide range of pesticides
- Analysis of sediments, groundwater and biota as a priority and also monitoring and analysis of surface water to determine levels of pesticide input (below)
- Monitoring of pathways of entry of pesticides into the stream (spray drift, runoff) both in low flow and first flush by water collection and analysis. Sampling and analysis take into account timing – and should occur soon after spraying to detect contamination as many pesticides now have low persistence, between December and March to time with cotton spraying.
- Sites should include Flicks Crossing, Silverleaf and Stonelands
- Groundwater samples should be routinely monitored for pesticides

Most of these recommendations were not addressed and remain as issues for management in the Barker-Barambah subcatchment.

Besides general water quality issues, the downstream environment of intensive industry (feedlots, meat works, lucerne flats etc) and sawmills in the Barker/Barambah Creeks system have been identified as specific hotspots through community meetings with suspected industrial seepage being noted as causal. Other community concerns include lack of flushing in the river, influence of the abattoir (settling pond overflows in rain) and general poor water quality (community and particularly the indigenous sector would like to be able to use the creeks recreationally again) were high. Saline discharge from Tarong Power Station (via Meandu Creek – Knights, 2004) has the potential to impact adversely on Barambah Lakes water quality in the long term as discharge from the Power Station provides the major flow in Barker Creek during normally dry times (Arthington *et al* 1992). Further, measurements of salinity and selenium found in past studies of Meandu Creek indicate that ambient levels may be elevated in comparison to guidelines (Arthington *et al.*, 1992).

SOR data indicated the upper Barambah system (including Barker Creek) had good bank and bed stability but very poor riparian vegetation, which contributed to the low percent of stream lengths with good or very good conservation value (19%, Van Manen, 1999) and the low percent of stream lengths in overall good condition (9%). A reasonable percent of stream reaches in the lower Barambah system also had good bank and bed stability (67% and 70% respectively), however the percent of streams with ecological relevance decreased from the upper system (the percent of stream reaches with good to very good conservation value was 17%). The percent of stream reaches in overall good condition was slightly higher than within the upper Barambah/Barker system (12%).

While water quality and nutrient levels have been measured within past studies, these studies were not geared to detect and advise of the relative contributions of adjacent land uses to water eutrophication, and were not continued long term. Due to this, there has been no management advice regarding attempts to influence large-scale land use to decrease property exports of nutrients and sediment (this can include reassessment of grazing numbers, maintenance of ground cover, property NRM plans, riparian establishment/ thickening projects etc) through out the catchment. Ultimately, changes in landuse may be necessary to circumvent the numerous current water quality issues in the sub catchments, however informed advice to guide the necessary changes will only arise only through consistent and dedicated monitoring as recommended in past studies.

The Barker/Barambah, Boyne and Stuart River systems are monitored by school Waterwatch (WW) groups under the Burnett South Waterwatch. The data collected by WW is considered valuable, however the lack of QA attached to its collection (and the variable nature of nutrient measurements) limits the usefulness of this data. Further, inclusion of chlorophyll a and water height measurements would increase the value of this monitoring. The implementation of quality assurance procedures would be also highly beneficial in attaching assurance to data but may present problems to coordinators and teachers, as the primary objective of this monitoring is educational.

Issues, hotspots and gaps summary: Frequently high salinity, chloride and nutrient concentrations are present throughout rivers and creeks of the south Burnett subcatchment. Nutrient related blue-green algae blooms or macrophyte infestations frequently dominate water bodies. There is no current adequate water quality monitoring program that will allow the detection of land-use influences on water quality (current sites are either lacking in water quality parameters, nutrient measurements, Chlorophyll a, pesticides etc or data is unavailable). There has been no identification of salinity outbreak sites within the salinity hazard areas of Kingaroy, Wondai, Mundubbera etc areas. Community monitoring needs QA and training to ensure defensible data. There is a perception (by community) of point source pollution by local industries. There are no subcatchment level plans to address local issues strategically. There is minimal government monitoring of water quality and inadequate cover of parameters and nutrient and chlorophyll a measurements. There is no active community monitoring due to lack of capacity (see Table 10), besides Waterwatch.

Catchment groups: BCCA South Kingaroy Landcare, Nanango Landcare, Tansey Landcare, Cherbourg NRM group

Other stakeholders: Six shires (including Kingaroy Shire council, Wondai Shire Council), Tarong Energy, Tarong Coal, South Burnett Meatworks, Swickers Abattoirs, several feedlots up to 30,000 head, significant pig- and horticulture industries, Murgon Leather, extensive irrigation industries along natural waterways such as lucerne, cotton, small crops.

School groups who monitor: Nanango High School and Nanango State Primary School monitor the Barker Creek Site. St Josephs, and Murgon High monitor the Barambah1 site. Gayndah High School, Gayndah Primary School and Gayndah St Patrick Catholic School monitor the Barambah end site. Durong State High School monitors the upper Boyne site. The Mundubbera and Boynewood State Schools monitor the lower Boyne site.

East Burnett subcatchment

Water resources: Lower Burnett River, Degilbo Creek, Boundary Creek, Sunday Creek, Perry River, Bundaberg Ck, Baldwin Swamp etc.

Infrastructure: Ben Anderson Barrage, Ned Churchward Weir, Equigold Dam, Walla Weir, Claude Wharton Weir, Jones Weir, John Goleby Weir, Bingera Weir

The recent extensive exotic macrophyte infestation of the lower Burnett River is indicative of the serious underlying problems for water managers (like the compounded effects of reduced flow, high concentration of nutrients and/or dysfunctional nutrient cycling). Their presence emphasises the need to study the system to understand the nutrient sources and pathways preceding these plant blooms. Past reports identify that reduced flows could result in prolific growth of native and exotic plant species resulting in water quality degradation and potential negative impacts to resident aquatic flora and fauna communities (Moreton *et al.*, 1998). Other research warns of sediment bound nutrient sources with bioavailability in anoxic conditions (Moss, 1988). Regarding current activities to remove macrophytes, a note of caution should be extended: as freshwater macrophytes are indicative of nutrient rich conditions, their ill-considered removal could result in a shift to prolific growth of algae or blue-green algal blooms with potential toxicity issues.

Past studies have noted 23% of stream reaches were in overall good condition and the majority of stream reaches had stable or very stable banks and beds. Riparian vegetation varied and about half of the stream lengths were of ecological significance (50% had good to very good conservation value)

(Van Manen, 1999). There are a number of point source releases on the Burnett River from various industries and councils (Bundaberg Sugar, Caravan Park), however these have not been noted as hotspots by the information sources defined for this study and data collected for point source releases were unavailable to confirm or refute their influence.

Additional future infrastructure (proposed Burnett Dan) will further impact on river water quality within the lower Burnett River. Water quality downstream will be influenced by dam water releases (which will create flows in the lower system), which are likely to be of poorer water quality than the receiving environment. Dam water can become stratified, stagnant and cold at lower depths or highly turbid with inflows and will most likely contain potentially toxic blue green algal communities (Burnett Water Pty Ltd, date unknown).

Issues, hotspots and gaps: The high nutrient and sediment exports from the river are issues for management. The expanding macrophytes and their subsequent die-off will have an effect on water quality. There is a lack of water quality monitoring by catchment and Landcare groups and a lack of subcatchment management plans to identify and address local problems.

Catchment groups: BCCA East – limited capacity relating mostly to management of weeds, Urban Landcare Bundaberg, Isis Landcare, WMPMEP – lower reaches,

5.2.3 Baffle Creek catchment and estuary

Water resources: Baffle Creek, Three Mile, Granite Creek, Oyster Creek, Littabella Creek
Infrastructure: No infrastructure

Figure 6: Position of the Baffle Creek Catchment (highlighted) within the Burnett Basin

The Baffle Estuary (Colosseum Inlet, Rodds Bay and Baffle Creek Estuary) has been described as being in near pristine condition by Oz estuaries classifications (NLWRA, 2002). Despite this, the GBRWQPP rated the biophysical risk and development risks for the Baffle Catchment as moderate (see Table 1 for risk categories) (State of Queensland and Commonwealth of Australia, 2003). Further, recent studies have estimated a high degree of sediment input from the Baffle Catchment to the coastal marine environment and moderate input levels of nitrogen and phosphorus (Furnas and Mitchell, 2001, Furnas, 2002). The Littabella Creek estuary was classified as largely unmodified (NLWRA, 2002).

Despite this, past studies have noted Baffle Creek itself to be in much better condition (scoring highly in river-health reports) than adjacent systems (Burnett, Boyne and Calliope Rivers), with regard to water quality, with some areas in reference condition (Sinclair Knight Merz, 1999; BCCMG, 2001; Lupton and Heidenreich, 1996). Within past reports the Baffle Creek scored average values (within a Good to Moderate category) for water quality parameters including dissolved oxygen, conductivity, turbidity and nutrient levels of total phosphorus, total nitrogen and chlorophyll a (DNR and DEH, 1999). Of particular significance is the fact that the Baffle Creek remains one of the few unimpounded coastal waterways (with relatively minor changes to natural flows) on the southeastern Queensland coastline (Sinclair Knight Merz, 1999) and in the past this was reflected in the healthy state of particularly freshwater fish populations (Lupton and Heidenreich, 1996). There is a paucity of data regarding creek resource condition, however, application of State of the Rivers survey techniques revealed a very high overall aquatic habitat rating for all Baffle Creek reaches studied (Sinclair Knight Merz, 1999).

The rating for Social risk for the Baffle Catchment (perceived lack of capacity for communities to change practices that cause land-based pollution) is high, indicating that existing land use will probably not change for the better, although the implementation of property management plans and an increased awareness of management practices may lessen this risk (State of Queensland and Commonwealth of Australia, 2003). This high risk also implies that future environmental impacts (degradation) for this catchment will be associated with expanding industry and future development. Community concerns for water quality issues included the likely influence of future broad acre harvest of farmed forestry plantations (as best practice is not yet determined) and the suspected influence of the Queensland Prawn Farm (Littabella Creek). The (positive) effect of revegetation of the catchment since 2002 (through farmed forestry) on water quality is also of interest to community.

Recent regional assessments of the Baffle Creek Catchment highlight the lack of ongoing water quality studies for the area, and emphasise the critical need for baseline assessments (Prange and Duke, 2004), which could determine the future effects of changed land use on water quality. DNRM declared a moratorium for the Baffle in 2004, which halts further development of water in watercourses, lakes and springs in the Baffle Basin (not applicable to groundwater or overland flow water) (NRM, 2004).

To maximise use of the extensive groundwork undertaken by BCCMG in developing the Baffle Creek Catchment Strategy (BCCMS), authors have further developed a proposal (originally written by BCCMG and based on principals of the BCCMS) to initiate a water quality monitoring for the Baffle Creek and surrounds. The site design within the proposal encompasses a large area of the Baffle Creek and surrounds, including sites in Baffle Creek, Granite Creek, Colosseum Creek, Oyster Creek and Round Hill Creek. The proposal utilises a novel approach, which envisions initial expert (university or line agency staff) assistance to facilitate implementation of the program and training competence, followed by gradual transferal of project ownership from external personnel to trained community (BCCMG) over a three years timeframe. The full proposal is available in Appendix 5.

Issues, hotspots and gaps: There is an urgent requirement for baseline studies to fill the critical need for reference data both locally and across the catchment (EPA also require reference sites to determine Queensland Water Quality Guidelines) as there is no water quality parameters measured by community or government within the freshwater reaches at present, including nutrients (community has capacity). There is sediment and nutrient export from the catchment (nitrogen and phosphorus) but monitoring is required to obtain a clear picture of relative contributions. Monitoring sites adjacent

to farmed forestry within the Baffle and the Queensland Prawn Farm within Littabella Creek would assist in determining their (future) effects. The BCCMS provides basis for development of rehabilitation/action plans for the Basin. There are no current flow determination sites (gauging ceased in 2003), which would provide essential data to future studies in determining flow requirements of specific communities. There is no Resource Operations Plan for the Baffle Catchment, although work is underway on a draft ROP document.

Catchment Groups: Capacity available in Baffle Creek Catchment Management Group – (have undertaken water quality, macroinvertebrates in the past), Baffle and District Landcare Group, WMPMEP – to assist in lower reaches, Agnes Landcare.

5.2.4 Elliott River catchment and estuary

Water resources: Elliott River
Infrastructure: No infrastructure

Figure 7: Position of the Burrum Subcatchment (highlighted - including subcatchments of the Elliott, Gregory, Isis, Cherwell and Burrum Rivers) within the Burnett Basin.

The Elliott estuary is classified as largely unmodified and classed as a tidal flat/tidal creek through Ozestuary surveys (NLWRA, 2002). Estuarine reaches of the Elliott River have remained fairly consistent (little effect from water resource development) and no dredging has occurred for over 30 years while water extraction is 88% of mean annual flow (LRAM, 2004). Past studies by Lupton (1993) noted the Elliott River as a significant nursery area with high diversity of fish (97 species) and crustacea (13 species). Approximately 50% of the catchment runoff goes to aquifer recharge in the

upper sections resulting in little intrusion of freshwater to marine habitats unless significant rainfall occurs and hence extended distributions of some commercial species (*P.plebijus* – eastern king prawn). Maintenance of the diversity of habitats and nursery areas (in particular seagrass beds in the mouth and central estuarine area and mangrove wetlands) was noted as of paramount importance for fisheries production to be sustained (Lupton, 1993). The current health of these habitats is not known, however, initiation of a fisheries resources study (using same methods to enable comparison to Lupton 1993) would provide information on the changes in fishery resources since 1993.

The riverine section consists of series of waterholes connected by small flows for short durations. Headwater wetland areas are within State Forest (Appendix 4) and have been classed as relatively pristine, with management issues noted as protection from fire and rural and urban encroachment (WBBCC, 2001). Despite the nominal effect of water resource development on the Elliott estuary, studies have noted high pH in the river section and nitrogen levels were noted as poor to good (NLWRA, 2001, Australian Government, 1999). Generally the Burrum River Basin (including the Elliott, Gregory, Isis and Burrum Rivers) condition was noted as substantially modified based on the NLWRA nutrient and suspended load index. Community members noted some local erosion along the Elliott River, although exact areas were not specified and the Gazaford Prawn Farm was noted to be a potential source of additional nutrients to the system.

A broad assessment of the Elliott River and catchment by authors revealed significant seepage from sugarcane waterways and other agricultural drainage points into wetland and riverbed areas of the Elliott River. Given the high recharge potential noted within the upper half of the Elliott (Lupton, 1993), the potential for contamination of the underlying aquifer by agricultural chemicals is high, and requires investigation.

Given the lack of current local information on the state of water quality (regional assessments usually describe the "Burrum Catchment" rather than individual river systems) for the Elliott River, authors undertook analysis of EPA (water quality and nutrients) and NRM (discharge) data collected over the last 10 years (1995 – 2004). The results (refer to Appendix 4 for the full report) noted changes in the proportions of nutrient concentrations over the years and that mean ammonia nitrogen was often elevated in comparison with guidelines. Analysis also revealed highly significant effects of water discharge (flow) on all water quality parameters. Further, at the freshwater site, dissolved oxygen levels were frequently below guideline levels and within ranges that would have a substantial adverse impact upon fish populations. The report confirmed occurrence of acidity in the upper reaches of the Elliott and also of concern is the correspondence between low oxygen and the sporadic records of acidity (refer to Appendix 4 for the complete report). However, analysis did not reveal any major decreases in water quality over the ten-year period.

There appears to be adequate cover of the estuarine reaches of the Elliott River by government (EPA) water quality monitoring sites, however only two of the four sites measure nutrients and three of four sites measure chlorophyll a. There has been no available water quality data for the freshwater reaches of the Elliott River since 2002 (EPA discontinued monitoring at freshwater site 1100 at this time). Recommendations for the system include initiation of freshwater monitoring sites, including nutrients, (as observed upstream-downstream differences between concentration of nitrogen species would help show the major sources of inorganic and organic nitrogen), investigation of water quality of the aquifer and suspected seepage points, biological monitoring for the estuary and development of rehabilitation plans including the mapping of significant features of the catchment (point sources, seepage, river features, land use etc).

Issues, hotspots and gaps: There is nutrient and sediment export into the estuary – contamination pathways should be investigated including agricultural seepage and local erosion points (as noted by community). The possible influence of Gazaford Prawn Farm requires investigation. There are no active community groups in the catchment and therefore no community monitoring. There is no current water quality monitoring of parameters or nutrients in the freshwater reaches and a lack of subcatchment planning for the catchment.

Catchment groups: WMPMEP (lower reaches).

5.2.5 Gregory and Isis Rivers

There was a paucity of information regarding water quality and resource condition for the Gregory and Isis Rivers. Interruptions to flow regimes for these rivers have been noted as minor (LRAM, 2004) and no dredging has occurred for over 30 years, although weirs would reduce the sediment input to the estuary. As mentioned in the preceding section, the Burrum River Basin (including the Elliott, Gregory, Isis and Burrum Rivers) condition was noted as substantially modified based on the NLWRA nutrient and suspended load index. Past studies note high chlorophyll a in the upper Isis River, and the need to investigate salinity in the upper reaches (Australian Government, 1999).

The Gregory and Isis catchments are intensive agricultural areas (horticulture and irrigated cropping) and it is suggested that engagement of local industry (Canegrowers, Growcom etc) may assist in developing a long-term water monitoring network for the area. There are currently two water quality monitoring sites (EPA) in the Gregory River measuring a full suite of parameters, with nutrient measurements being taken at the downstream site only (upstream sites is tidal but with fresh influence). Of the four sites in the Isis River (the upper of which is freshwater), two monitor for nutrients. Each river has one gauging station that measures level and discharge. Analysis of local government data for each river would allow for assessment for changes in water quality over time within each catchment.

Issues, hotspots, and gaps: There is a lack of community water quality monitoring in the Gregory and Isis Rivers and a minimum of government monitoring (including nutrients) of the freshwater reaches of both systems. There is a lack of subcatchment planning for water quality and no local NRM strategies to engage community. There is a lack of analysis and reporting for current local sites to determine water quality problems within the systems (as was undertaken for the Elliott by authors).

Catchment groups: WMPMEP, Friends of the Burrum River System Group.

5.2.6 Coastal and marine environments - general

Although some high-level water quality monitoring is undertaken within estuarine and marine (limited) environments (WMPMEP, EPA), several large gaps were recently identified (Prange *et al.*, 2004) regarding marine regions of the Burnett Basin. These include the need for:

- Rapid response and monitoring programs by organisations for identification of rapid deterioration of ecosystem health.
- Analysis and reporting on long term trends and changes in the state of the environment – there is a need for a full review of current, past and ongoing changes in estuarine and marine water quality, particularly with regard to the Woongarra Marine Park data collection program.
- Filling of large knowledge gaps on ecosystem health and historic rates of change within key habitats including mangrove wetlands, seagrass, corals, macroalgae, freshwater wetlands and salt marshes. This calls for quantitative studies relating to water quality measurements/flows etc.

A key component of the Great Barrier Reef Water Quality Protection Plan (The State of Queensland and Commonwealth of Australia, 2003; GBRMPA, 2001) is the implementation of a long term monitoring program in the Great Barrier Reef. Five monitoring components have been identified as suitable for 'hands on participation by community/industry groups as part of RWQMP. These include (1) river mouth water quality monitoring, (2) marine biological monitoring, (3) marine water quality monitoring (both chlorophyll and pesticides), and (4) bioaccumulation monitoring. Of these, only (1) river mouth water quality monitoring is likely to be undertaken in the Burnett, which will add moderately to the current data and information base.

Unfortunately, at this time the Burnett Basin is not one of the river basins selected for the full implementation of marine components for water quality monitoring (and sediment), biological monitoring (mangroves, salt march and seagrass, coral) and for bioaccumulation. Therefore, the

majority of these valuable ecosystems will remain without monitoring and health programs. WMPMEP is best placed to provide support to development of coastal and marine projects (particularly in view of their partnership with the Centre for Environmental Management, CQU).

The majority of the coastal sector is currently devoid of ongoing water quality or ecological monitoring. Hotspot areas for water quality and health monitoring programs are initially identified as expanding urban and rural communities proximal to river mouths, where coastal resources are susceptible to increased sediment and nutrient loads (primarily seagrass and also mangroves). Areas devoid of monitoring programs include the Tannum Sands/ Colosseum Inlet coastal area (although CEM, CQU have undertaken one-off water quality and ecological monitoring to some extent), Rodds Bay/Rodds Harbour coast, Bustard Bay and Coast and the Agnes to Burnett River Coastline.

Issues, hotspot and gaps: The possible effects of catchment discharges on near shore communities and habitats, particularly relating to associated nutrient and suspended sediment loads on receiving environments. There is a lack of short or long-term strategic water quality monitoring programs of the coastal sectors by community and/or government. There is a lack of ongoing coastal programs to monitor the health of mangroves, seagrass, saltmarsh or coral (besides the Bundaberg outfall project by Burnett Shire which provides WQ and transect information and WMPMEP) within estuarine and coastal regions of the Burnett Basin.

Catchment groups: WMPMEP (who are keen and with capacity to expand), Local community through engagement.

5.3 Summary of catchment wide environmental issues

5.3.1 Nutrients

Estimated catchment export has been via various models (Moss *et al* 1993 and Furnas, 2002). Recent studies have identified exports of nitrogen and phosphorus from the Burnett catchment to equate to 11% and 13% of total nitrogen and phosphorus loads to the Great Barrier Reef (Furnas, 2002).

Within the Burnett Region, estuarine and marine water monitoring for nutrients has been primarily limited to the estuary of the Burnett River and Baffle Creek (Prange and Duke, 2004). Although regular monitoring of nutrients (nitrogen and phosphorus) and nutrient indicators (chlorophyll a) has been undertaken to some degree (QEPA long-term monitoring sites – see Component 1 report), analysis of this data to examine any trends within the area has not been undertaken (Prange and Duke, 2004). Long term nutrient measurements for freshwater reaches of the Burnett Catchment and its tributaries are limited or non existent for the majority of the streams, however, where data is available certain waterways have been noted as eutrophic, for example the Barker/Barambah system (Bluhdorn and Arthington, 1994). As stated (Bluhdorn and Arthington, 1994), dysfunctional nutrient cycling is the result of imbalances in critical levels of nutrients in the water body and such conditions are often represented through prolific plant, algal growth and blue green algal growth.

There is a priority need for an integrated catchment model for long term monitoring of nutrients to determine condition and trend and nutrient pathways. This should strategically cover the inland areas at key points and extend to the coastal fringe. It is recommended that initial local projects target the Barker/Barambah and Stuart systems and/or the lower Burnett River initially with key parameters including nutrients (total phosphorus, total nitrogen and nitrogen species) and chlorophyll a along with water quality to enable assessment of nutrient dynamics over time. The project should use pre-existing sites (EPA/DNRM and community) where possible to maximise use of existing data. The program includes a requirement for standard and documented methods of sample collection by groups or agencies (quality assured procedures) to ensure data integrity (there is reduced certainty of current cover by schools).

Catchment wide approaches to reduction of nutrients in streams are detailed in Bluhdorn and Arthington (1994) and include:

1. Reduction of inputs through alternative agricultural products (organic fertilisers) and best management practice to reduce the quantity of nutrients for export to waterways
2. Isolation of the stream by intercepting and storing the nutrient by increasing vegetated buffer strips (riparian zone) along stream banks and removing stock from stream and bank environs. In extreme cases effluent lagoons or levy banks prevent higher volumes reaching the river.
3. Active nutrient removal through physical harvesting of nutrients in an economically viable form - for example waterweeds for mulch or compost, and fishmeal from appropriate species (bony bream).

Cyanobacteria and catchment management

Blue green algal blooms are an ongoing issue within most impoundments within the Burnett system and the following section serves to provide some explanation of their causes and effects.

The construction and filling of an impoundment leads to many changes in a river system. Besides the imminent loss of habitat bought about by inundation (riffle and riparian zones), impoundments generate a number of effects on water quality including thermal layering of a water column (stratification) and accompanying modification of the aquatic biota; reduction of oxygen concentration in the bottom waters of the storage especially where nutrient and organic loads are high; modification of nutrient cycling in the dam and river system and modification in patterns of freshwater sediment and nutrient export within the river and to marine systems. Many of these conditions create a habitat favourable to species of cyanobacteria (otherwise known as blue-green algae, as are present across Burnett River impoundments).

Cyanobacterial blooms can occur at any time of the year although are more prevalent when temperatures are warmer and bioavailable nutrients high (phosphorus and nitrogen) (Mc Gregor and Fabbro, 2000). Cyanobacteria can become a public health concern, impacting upon the quality of drinking and contact waters sometimes resulting in unpleasant tastes and odours, skin reactions (conjunctivitis), asthma, gastroenteritis or more severe effects associated with toxin production (kidney, intestine and liver damage) (NHMRC/ARMCANZ, 1996). As of yet, no human deaths have yet been attributed to cyanotoxins in Australia, however, hospitalisation has occurred and stock deaths have been widespread (ABS, 2002). Recent research at CQU suggests that bioaccumulation of toxins in shellfish (and possibly other aquatic produce) are a serious health concern (Andersen, Fabbro and Eaglesham, 2005).

Given the large database of information that indicates a high potential for toxin producing algal blooms in Queensland waters, especially those of cytotoxic *Cylindrospermopsis raciborskii* in Queensland impoundments (Mc Gregor and Fabbro 2000, and local water treatment data), it is likely that there will be substantial costs for water treatment; increased costs for primary producers and loss of aquatic organisms and food industries as a result of exposure to toxins. A financial cost associated with damage, remediation and repair of the aquatic environment should also be anticipated.

Lyngbya has been identified as the marine cyanobacterium most likely to pose future problems in the Burnett Basins estuarine and marine region (Prange and Duke, 2004, Buchanan Heritage Services, 2003). Lyngbya has been found historically in adjacent estuaries (Hervey Bay) and may occur naturally in the coastal section of the Burnett Basin. The oversupply of land-based nutrients (phosphorus, iron and humus) has been identified as the underlying cause of recent blooms in Moreton Bay (Moreton Bay Waterways and Catchment Partnerships, 2002), and estuarine eutrophication may potentially alter the timing and magnitude of blooms in other regions.

5.3.2 Sedimentation and turbidity

Sediment export rates for the region are estimated at approximately 2 million tones per year (Furnas and Mitchell, 2001; Furnas, 2001). Quantifying and controlling (through appropriate management) sediment and sediment-bound nutrient export from the Burnett Basin should, therefore, be a priority for water quality management plans. Runoff, natural vegetation and land use (in conjunction with topography and rainfall) are named as the principal factors that determine spatial and temporal patterns of sediment from catchments to the GBR lagoon (Neil *et al*, 2002).

There is a limited array of strategic ongoing monitoring sites within the inland Burnett river systems to provide sediment-related measurements (sediment bound nutrients, turbidity, secchi depth – light penetration, TSS) for holistic long-term condition and trend analysis. Likewise, (although many past studies exist, which provide some indication of the degree of turbidity in estuaries - Lupton, 1993; Lupton and Heidenreich, 1996 Lupton and Heidenreich 1999), there is a lack of sites in the coastal zone, with the EPA and Woongarra Marine Park Monitoring and Education Project being the sole current monitors of sediment and turbidity. Despite this, selected sites from previous one-off studies may be adequately placed to provide some baseline conditions for future monitoring.

There is a priority need for sediment related measurements (sediment bound nutrient, suspended solids, turbidity or secchi depth – light penetration) to be taken across a large site array throughout the Burnett Basin (particularly those sites which presently undertake other water monitoring). Sediment measurements should also be incorporated into water quality programs to monitor the success of revegetation projects in reducing sediment inputs (for example the rehabilitation works in the upper systems of Kingaroy, Monto, and upper and lower Burnett areas or adjacent to coastal rehabilitation).

Past reports have noted reduced riparian zones as being direct effects of clearing for agricultural purposes and access by stock (resulting in greater erodibility and reduced sediment buffering/filtering capacity). There is a requirement for specific local projects to targeted problematic areas with riverbank stability/restoration project or riparian thickening projects to reduce diffuse sources of sediment. Formal identification of subcatchment hotspots and issues is necessary and would be one of the first steps of a rehabilitation plan for each subcatchment. Identification of specific degraded areas through broadscale assessment and water quality monitoring facilitates engagement of property owners and possible modification to land use. The SIP WQ4 project is presently mapping riparian extent through the Burnett River and may be well placed to advice in relation to priority areas for riparian thickening and or bank rehabilitation to minimise sediment input.

Coastal sites should be situated at positions that allow investigation of turbidity derived effects on vulnerable estuarine habitats in the long term (seagrass communities, mangrove communities). Methodology should be as for freshwater sites (for comparisons) and should possibly also include assessment of siltation and/or accretion also.

5.3.3 Salinity

Landscape salinisation problems have been identified in the Burnett Basin and associated coastal lowlands (the irrigated cane farm areas of Childers and Burrum) and western and northern subcatchments (Kingaroy, Barker/Barambah and Monto). The main gap identified is the lack of monitoring within the inland plains, which were listed as having the highest (salinity) hazard areas but with no knowledge pertaining to past or current outbreak sites (LRAM, 2004). There is a complex saline groundwater issue in the Monto area (described in section 3.2.2) that also requires further investigation.

Priorities for salinity therefore relate to the investigation of inland salinity hazard areas to facilitate identification of outbreak sites (initially Kingaroy and Monto there is current capacity in local community groups). There is a need for an integrated project to identify and address outbreak sites in a strategic manner including investigation into locally specific and applicable management options. Increased salinity is a catchment-wide problem and the benefits of revegetation have been questioned, however, the success of revegetation work in adjacent catchments (Memerambi Creek) imply that

short term revegetation may be successful on a local scale. Other management options may include increasing water releases from upstream to decrease salinity (as has been suggested for the Barker/Barambah system) or developing a water use/reuse study to stabilise local salinity problems.

5.3.4 Agricultural contaminants (pesticides, herbicides)

There is a paucity of available information regarding the relative levels of pesticide, herbicides and related compounds in water, associated benthic sediments and biota in fresh and marine environments of the Burnett Basin. However, recent studies in adjacent estuaries (Hervey Bay - Gaus *et al* 2004 In Prange and Duke, 2004) have detected elevated dioxin levels in marine sediments, dugong and turtles, highlighting the need for investigations of contaminant pathways within the Basin and associated levels in water and sediment. Previous freshwater studies in other agricultural catchments (Emerald Irrigation Area where extensive cotton growing occurs) have shown elevated levels of compounds (DDE, diuron, endosulfan, atrazine) in river water and sediments (DNR, 1998), and preliminary freshwater studies investigating biota, stress the urgent need for formal investigations of contaminant pathways and effects on biota (Arthington *et al.*, 1992; Tucker, 1999).

Current ongoing water quality monitoring programs (EPA, NRM and community) are not presently scoped to identify contamination of waterways or biota by agricultural compounds (by measuring levels of compounds) pathways of contaminants, or effects (if any) on biota. Available information has usually been collected via one-off or independent studies and does not enable temporal comparisons. The effects of chronic (long term) and acute (during flood events) levels of exposure to receiving marine communities (mangroves and seagrass) are presently unknown, although certain studies have implicated diuron as being associated with mangrove die back (Duke *et al* 2003).

There is a priority need to include monitoring for a wide array of agricultural chemicals in current water programs and sites, particularly within intensive agricultural areas like the Barker/Barambah subcatchment and the lower Burnett, Elliott and Burrum Rivers. Projects should be geared to investigate levels and pathways of contaminants in water and biota and should link with rivercare projects to upgrade riparian environmental services (such as revegetation to increase filtering and buffering capacity) and identify degraded areas for rehabilitation etc.

5.3.5 Reference locations

There is currently no water quality monitoring of reference-type sites within the Burnett Basin (the criteria for a reference site are specified in the Queensland Guidelines, which are presently in development phase). The Baffle Creek catchment is thought to represent the least modified catchment in the Burnett Basin and past data gathered in this area have been used as reference material in several comparative studies (SKM, 1999). The Baffle Creek Catchment Management Group has negotiated with EPA in the past for equipment and support to undertake water quality monitoring, however, despite the large effort by the community group, the partnership did not progress.

Although the Baffle Creek and its tributaries have been identified as the best possible freshwater reference environment within the Burnett, they are also highly susceptible to current and future developmental and large-scale land use change. Consequently, it is recommended that appropriate reference locations be identified in secure areas i.e. conservation and national parks.

A similar process must take place within the estuarine and marine environments. Identification of local reference conditions within estuarine and marine reaches should be undertaken in conjunction with trained personnel (EPA or CQU) using criteria developed in Queensland Guidelines. Some monitoring sites currently undertaken by Woongarra Marine Park may prove useful for this process.

Projects should identify (through water quality monitoring) appropriate reference sites within the Baffle Creek Catchment initially. Other suggested reference locations (areas within the Kolan Catchment were suggested but not identified at the site scale) should be investigated (including freshwater, estuarine and marine sites).

5.3.6 Reduced riparian zone

Past studies indicate that many streams within the Burnett Basin contain a riparian zone which is degraded in size, structure and, therefore, function (Van Manen, 1999; Arthington *et al.*, 1992; Bluhdorn and Arthington, 1994). Degradation is indicated through presence of weeds, scarcity of native vegetation on and above banks and narrowness of the zone. The creation of a vegetated buffer strip is often greatly effective in increasing buffering capacity with regard to diffuse sources of contamination (sediment, nutrient and chemicals) such as grazing and low intensity agriculture. A number of studies further emphasise the importance of established riparian zones in fostering healthy aquatic systems (Bunn *et al.*, 2003).

Greatest impacts on the riparian zones of the Burnett, Fitzroy and Mary are from clearing for agriculture and free access of stock. Management mechanisms include exclusion or better management of stock, removal of exotic weed species and rehabilitation of native species (through regeneration or revegetation), and were previously addressed via Landcare programs.

5.3.7 Education

Information arising from component B Community Water Quality Monitoring Networks (including meeting with existing groups to determine capacity, information gathered through the project reference group, and information gathered through regional meetings) was useful in determining public opinion with regard to education within the basin. There was a strong impetus for continuing school based formal awareness programs such as Waterwatch, as such programs are considered to be constructive tools in furthering NRM education and development within regions (the benefits of these education programs were previously discussed in section 4.2.2 and 4.3.4). It is recommended that the education system could be improved by developing activities that require the structured involvement of parents or neighbours. A level of QA is also necessary for school data collection programs to ensure comparability among schools and a clear understanding of the data limits (this would be a different standard to groups functioning).

5.3.8 Gap analysis - general

The major gap is the lack of any strategic and integrated programming among water monitors across the Burnett Basin. Previous studies from the early 1980's highlight the need for an integrated catchment approach for the management of water resources (Horn, 1993). Ultimately a water-monitoring network should be developed, which includes all existing water monitors. This network should serve subcatchment needs through the implementation of local on ground activities, while supporting (and assisting) whole of basin (or higher level – between basin) investigations that will provide essential information relating to catchment-wide issues.

Recently GBRMPA has been involved with co-ordination of a river monitoring program specifically targeting the sampling of two North Queensland rivers during flood events (Devlin *et al* 2001). The monitoring program is run in conjunction with DRN Waterwatch and involves sampling of first flush, extreme flow and post flood conditions with trained volunteers. This program provided valuable information about concentrations and movement of nutrients within the subcatchments (Devlin *et al* 2001). The framework used for this project may be applicable within the Burnett system to provide critical data for a number of issues.

Several studies have identified specific research needs across the Burnett Basin; these were reiterated in this report (LRAM, 2004; Choy *et al* 2002; Horn, 93) and include environmental flows, environmental health parameters, long-term assessment and monitoring, ecosystem processes, function and services, and ecological impacts and remediation technologies.

CEM has put forth a strategy for the establishment of technical nodes within the Burnett Basin (Chapter 2). Potential nodes already exist in the form of groups with particular type of capacity (project officers, technical ability, office space etc). It is envisaged that future NRM activity

participants (including community groups, industry and individual) would form clusters around technical nodes to allow the effective delivery of on ground projects within river subcatchments.

The following section identifies strategies for Water Monitoring Networks as well as a number of on ground projects that address water quality hotspot areas within the basin. Projects will take into account potential collaborators.

5.4 Targeting hotspots issues and gaps to strategies and projects

The following section details investment strategies and general project descriptions within the Water Monitoring Network to address water quality hotspots within the Basin. The project descriptions take into account potential collaborators. Full scoping for these projects including associated costings and confirmed collaborative links within current monitoring groups/organizations is not covered here, however a list of priority actions for each subcatchment is provided in the next section. All of the following projects require a communications strategy (a reporting mechanism back to community groups and BMRG), which should be included in the full scope and costings of each project.

5.4.1 Part 1: The Water Monitoring Network (WMN).

Provision of capacity to the WMN (and existing groups) via establishment of technical nodes

This relates to the strategy detailed in Chapter 4, Section 4.3 of this report - the establishment of technical nodes within the Burnett Basin to support and develop NRM group activity, in particular water quality monitoring and rivercare programs. This has already started to occur in some regions (Wondai), where a number of natural resource personnel (Waterwatch, BMRG officers) have essentially become a local Centre for NRM). Future NRM activity participants (including community groups, industry and individual) would be expected to cluster around the node relevant to their subcatchment or interest area.

The combination of technical nodes (above) in combination with the data integration and communication strategy (section 4.6) is in essence the construction of a formal Community Monitoring Network which will allow new or existing groups to access data and/or reports to pursue their own agendas. Where particular partnerships are formed will depend of geographic convenience. Minimal support necessary for the effective rollout of this provision is discussed in detail in Chapter 4, section 4.3.3).

5.4.2 Part 2: Projects within the WMN

The following projects are considered priorities within a particular areas (an area may pertain to a river reach or the river itself or a general locality) based on the importance of the issue/hotspot/problem (historically reported hotspot of colloquial importance to community), the ability of the area to undertake the project (community groups capacity, local government, Landcare groups, school groups) and a current lack of (or minimal) monitoring effort within the area. Although several of these projects are thought to be specific enough for immediate on ground action, the development of subcatchment rehabilitation plans (detailed in section 5.2) would provide further strategic support for their initiation.

Project 1: Investigation of nutrient sources/pathways in the Barker/Barambah and Stuart systems.

Ambient nutrient concentrations have been measured in the past, but determining the primary sources of land-based nutrients to a system can be difficult. Only through determination of the relative contributions of both point and diffuse sources of nutrient to the water body, can appropriate stream management be developed with the overall aim of reducing nutrient input to the system. This would

involve monitoring for a suite of nutrients (total nitrogen, total phosphorus, ammonia-nitrogen, nitrite, nitrate and FRP) and related parameters (chlorophyll a) across a wide array of sites along the river.

This project would provide essential knowledge to assist future management of diffuse and point sources in the Barker/Barambah system (the system has been noted as eutrophied and community concerns regarding lack of flushing in the river, influence of the abattoir (settling pond overflows in rain) and general poor water quality (want to be able to swim in the river again) were high. Upon identification of sources and their location (which would arise from a comprehensive water quality program and involve GPS to allow mapping within river reaches), management would include restoration of riparian zones, implementation of best land practices, (groundcover, overgrazing, targets to maintain ground cover etc) etc.

Most potential participants/collaborators have significant economic interest in this waterway system. Schools listed have extensive knowledge of the two creeks, having participated in a range of systematic BCCA-South run Waterwatch activities over several years.

NRM groups for Barker/Barambah and Stuart River (Burnett South Subcatchment): Nanango/ Murgon/ Cherbourg/ Kingaroy Shire Councils, Nanango Landcare, Wondai Landcare, BCCA South, Cherbourg NRM Group, Kingaroy Catholic College, Nanango High School, Byee Food and Fibre Irrigators, Barker Ck Irrigators, Kingaroy Landcare, BCCA south.

Valuable side projects:

(1) In view of the current collaborations between Wondai Shire council, Gayndah Shire Council, Sunwater and various BCCA groups (south and central and east) there are valuable opportunities, as well as community synergy, at the present time to investigate Water Weed Nutrient Stripping capabilities as well as weed harvest opportunities (mulching etc).

Although this side project is not given particularly high priority basin-wide, the present situation of available opportunity (weed harvester), capacity (BCCA technical node) and possibility of research dollars creates a valuable opportunity favourable to rapid onset of action.

(2) Investigation into carbon loadings and pathways and nitrification processes: Establishing the linkages between ecosystem components is crucial to effective management. It is theorised by ecologists that hydrological changes (lack of flushing) in weir pools results in overloaded carbon pathways that can take the system into anoxic condition. Identification of carbon pathways and loadings would confirm or refute this possibility within the Barker/Barambah system. One NRM target of the GBR Water Quality Protection Plan is to reduce phosphorus exports by 50%. There is concern that this is unattainable due to ineffective nutrient pathways and carbon assimilation within the river. (Graeme Esslemont - NRM NAP Water Quality Coordinator – is well placed to provide advice on this topic, having worked on similar projects (CRC for Freshwater Ecology and Monash University).

There is some important modification to key processes in waterways when anoxic sediments are present. Nitrification is inhibited when sediments are anoxic (or carbon loadings excessively high) and this can cause lowering of denitrification efficiencies (denitrification is one of the few processes capable of counteracting eutrophication as it permanently removes nitrogen from the system) (Moss, 1988). When this occurs more nitrogen is recycled to the system as ammonia (not denitrified). This further stimulates primary production, which can continue the supply of organic matter to sediment leading to decomposition, oxygen consumption and potentially anoxic and hypoxic conditions. In larger streams any significant nitrate loss may be mostly due to nitrification. Studies have shown that waterbodies where denitrification was operating inefficiently are susceptible to nutrient buildup, potentially enhancing algal growth (Palmer, *et al* 2000).

Project 2: Identification of salinity outbreak sites in the inland plains

The inland plains, including the middle reaches of the Barker/Barambah system, Kingaroy and Monto areas, have been identified as having the highest salinity (outbreak) hazard ranking, yet there are no currently known outbreak sites in these areas (LRAM, 2004). There is the need for a strategic program to preempt outbreaks and identify existing outbreak sites within problematic areas.

This project should be scoped/costed for the Monto and/or Kingaroy areas initially (using the relevant technical node for support).

The project will focus initially on identification of current salt outbreak sites, determination of their extent and management options. This will include:

- Investigation of any indications that salt outbreak are impending, for example warning signs – salt levels rising in groundwater, bores etc?
- Determination of poor management practices within the current land management systems – are current poor land practices likely to negatively influence a saline outbreak (this assumes diversity in land management in these zones/recharge zones which may not be the case, however if some lands are managed in a way that (if changes are not forthcoming) will lead to a probable outbreak, this needs to be addressed.
- Determination of the potential issues for dealing with this situation - land changes, salinisation in groundwater – can you predict how what action will be viable for how long?
- Addressing current outbreaks – can anything be done – studies are recommended to investigate possible remediation, prevention of any extension of the outbreak, development of new land management practice that can return value in some way (turn the area into a habitat area instead) or reduce the effect (possibly through revegetation – a thorough review of literature associated with use of specific plantings to reduce salinity is recommended to determine approach).
- Investigating the possible need/use for a hydrodynamic model using dam releases and pumpback systems, using dams for recharge?

Project 3: Baffle Creek water quality monitoring and assessment programme

The high values attributed to the pristine nature of the Baffle Creek system causes the maintenance of this system and early detection of changes in water quality to be a high priority within the region. The need for quality reference sites in coastal draining systems is also of high priority in light of the impounded and degraded nature of similar systems in Australia. There is also a critical need for reference sites to determine Reference Guidelines for the Queensland Water Quality Guidelines, a project presently being undertaken by EPA. Both CQU (Centre for Environmental Management) and EPA have expressed an interest in site placement within the Baffle system (Moss, A., pers. com., 2004) and collaboration with community for training and equipment provision.

A full draft proposal to undertake water quality monitoring in the Baffle Catchment and surrounds, including site locations and approach is detailed in Appendix 5 of this report.

Project 4: River event monitoring program

Many studies show the increase of nutrients and sediments (Mitchell *et al*, 1997; Moss *et al* 1993, GBRMPA, 2001) moving from the catchments of the Great Barrier Reef (GBR). The measurement of quantities of sediment, nitrogen and phosphorus in flood conditions provides valuable data and for this reason GBRMPA has directed research programs to assess and quantify riverine input into the GBR (Devlin *et al* 2001). Long term ambient water quality monitoring, while recognised as essential to determine condition and trends within systems, is ineffective in providing knowledge relating to maximum land exports of nutrients and sediment, which is known to occur during rain events.

In other regions (Cairns and Innisfail), targeted monitoring programs using community (trained Waterwatch volunteers) in collaboration with government resources (Department of Natural Resources) and with coordination by GBRMPA, have proved extremely successful in collecting valuable data on dissolved and particulate nutrient concentrations in flood conditions.

The high number of community groups within the Burnett Basin is favorable to the development of such a program. Further, other monitors within the basin (Bundaberg City Council) are undertaking projects along similar veins (water quality modeling), which could provide guidance and assistance to future projects. Ultimately the coordination and steering of this program should be largely from GBRMPA in conjunction with local and state government authorities and the regional body (BMRG).

Project links: This project links in with the SEDNET NRM team who are at present (November 04) looking to set up event monitoring sites to calibrate their SEDNET model. Some sites will be similar and collaboration is essential to prevent overlap.

Project 5: Development of community cover in the Elliott, Gregory and Isis River systems

The lack of any community monitoring groups within the Elliott, Gregory and Isis Rivers is an obvious gap for the area. Of the five EPA monthly ambient water quality monitoring sites in the Elliott River, nutrients are also collected at the upper two sites. Of the two EPA sites on the Gregory, nutrients are sampled at the lower, and two of the four sites in the Isis River test for nutrient concentrations. There are no records of macroinvertebrate health assessments for these rivers. One DNRM gauging station exists on each of the Elliott River (a second existed up until 2003), Gregory River and Isis Rivers.

It is suggested that technical assistance for this project come from the lower Burnett Basin technical node, in conjunction with either Bundaberg City Council or WMPMEP. The opportunity for the "Friends of Burrum" catchment group to extend their current cover to include other rivers (besides the Burrum) was not investigated within this report. Bundaberg City Council has expressed interest in involving community in their current monitoring program and providing training facilities for monitors and may be a supportive party. Alternatively WMPMEP may be well placed to extend their cover to this region. Other principal stakeholders include Canegrowers and Growcom.

Project 6: Initiation of marine monitoring and water quality monitoring program (for coral, seagrass and mangroves) to determine ecosystem health

There is a large gap relating to marine monitoring of ecosystem health and historic rates of change within key habitats including mangrove wetlands, seagrass, corals, macroalgae, freshwater wetlands and salt marshes. There is a priority need for quantitative studies relating to water quality measurements and river flows to determine system interactions, dynamics and drivers. Hot spot areas are initially identified are communities proximal to river mouths that are susceptible to increased sediment and nutrient loads (primarily seagrass and also mangroves). CEM, CQU manages similar programs in other regions and can provide unbiased advice regarding effective parameters for long-term programs. Regional mapping of these habitats is essential to determine long-term goals relating to maintenance of total areas and for efficient management.

New and innovative (cheap, simple and non invasive) methodologies are available for the monitoring of coral bleaching, and assessment of coral health that may enable the effective monitoring of such systems by community driven programs (The Coral Health Chart is basically a series of sample colours, with variation in brightness representing different stages of bleaching/recovery, based on controlled experiments. In the field, users simply compare colours of corals with colours on the chart and record matching codes. The charts can be used by anyone - scientists, school children, tourists and politicians).

Project 7: Investigation of agricultural contaminant pathways and levels in the lower Burnett River catchment and coastal catchments (including groundwater).

There is a priority need for investigations into contaminant levels and pathways within the lower Burnett River and adjacent agricultural catchments (Elliott River, Gregory River, Isis River, Burrum River). This project should ideally be linked to Bundaberg Council's future event monitoring program to allow the collection of water samples in first flush. The project should initially target the lower Burnett River and Elliott River systems depending on funding allocation in other subcatchments of the Burnett (investigation of possible agricultural contamination is also high priority for the Barker/Barambah Creeks, however nutrient issues may receive funding priority within this sub-catchment).

A wide range of agricultural chemicals should be tested for and the sampling design should take into account the timing of pesticide use in adjacent lands and major pathways of entry including spray drift and runoff from rainfall following spraying. Monitoring regimes should initially concentrate on sampling river water at low flows for ambient levels of contamination and the first flush of storm runoff (to determine various levels of pesticide/fertiliser input). The analysis of sediments, groundwater and biota should be priorities for future studies.

Prospective groups include Bundaberg Shire Council, Bundaberg Urban Landcare group, WMPMEP, BCCA, CEM/CQU.

5.4.3 Part 3: Rehabilitation plans

The need for a dedicated and adequately resourced rehabilitation plan for each of the sub catchments, estuarine and near coastal areas.

One key tool or outcome of this PAP was to be 'Monitoring and management (on a priority and needs basis and appropriately resources) in all Basin management units'. Authors suggest that allocation of priority targets for management at a subcatchment level is premature at the current time, in view of available catchment resource information (although this has been attempted in the preceding and following sections based on hotspots identified through literature, community and available capacity). On this premise the development of Catchment Rehabilitation Plans is suggested to ensure a strategic approach to prioritising subcatchment local activities and use of resources (including community groups).

There is a general lack of any subcatchment (or catchment) rehabilitation plans, which are an essential component to assist in prioritising catchment projects, and the next step for existing groups who have already compiled catchment management strategies (Baffle Creek Catchment Management Strategy and The Burnett Catchment Strategy). One general problem with catchment management strategies is a lack of translation of Strategy Objectives or Strategy Actions into on-ground activity. This often arises from the language of the Catchment Management Strategy being incomprehensible (too scientific for grass-roots community groups) out of date (catchment management strategies should be updated regularly) or just too general (no clear idea of how and where the activity is to occur). The development of Rehabilitation Plans or Strategy Action Plans often serves to provide a clear and common translation of catchment objectives in a local context (within creeks or reaches of creeks).

The project should involve breaking the various rivers and creeks into water management units (WMU) or "reaches", as for State of the Rivers reporting (discussed in detail in Chapter 6). Current information (state of the rivers, geomorphology, environmental condition, adjacent landuse/pressures) should be allocated to respective locations and used to scope and prioritise potential rehabilitation strategies for the Basin. This task should be undertaken ASAP by an appropriately placed organisation or individuals within the Basin in conjunction with existing catchment groups and respective catchment strategies. The background to application of river reach methodology including discussion on the best approach for Rivercare and rehabilitation plans in the Burnett catchment is available in Chapter 6.

Development of plans for the marine zone should consider GBRMPA monitoring and state and regional strategic planning and legislation for coastal regions (development for a port, for the ongoing urbanisation of the coastal zone, sewerage etc).

5.4.4 Part 4: Other research needs

Development of condition and trend reports with existing data

The lack of any integrated trend and condition reports within subcatchments severely decreases the effectiveness of existing programs. Regional assessments to give a snapshot in time are useful for comparisons between basins but serve little use in determining drivers and dynamics within systems. There is a requirement for both regional and local assessments of water quality data.

Compilation of existing data sets (as undertaken by Graeme Esselmont NRM Regional Water Quality Coordinator) and subsequent analysis (by SIP WQ02 analysis of water monitoring data - spatial and temporal) to determine trends in existing parameters will provide useful information to assist in water managers in understanding the differences between general regions (data for the Burnett Catchment was divided into Upper Burnett and Lower coastal Burnett). However, (primarily due to the need for substantial reference data) these analyses were not undertaken at the site level within subcatchments, hence their use in understanding water quality issues at a local site scale level is minimal.

Ultimately, it is local site analysis (as undertaken by authors for the Elliott Catchment – please refer to Appendix 4) that will provide essential information at the reach level of management. This is required for freshwater data within subcatchments (or even streams), and for estuarine and marine data.

Specifically: Lack of data on distribution and linkages between ecosystem components mitigates against basin specific planning (LRAM, 2004) For example long-term environmental data should be assessed for temporal and spatial changes in conjunction with environmental variables and physico/chemical parameters to determine drivers and increase knowledge of system dynamics. Examples of collected data that would benefit from trend and condition reporting include EPA data at a subcatchment level and Woongarra Marine Park ecological and water quality data in conjunction with DNR flow data.

This should occur particularly in problematic areas - for example those where nutrient concentrations are a recognised issue (Barker/Barambah, Burnett River). There is a need for a knowledge base in order to guide management of the water body.

Project links: This project links with the SEDNET NRM team who are presently (November 04) investigating the possibilities of event monitoring at selected sites (20 over the Basin) to calibrate their SEDNET model. Some of these new sites by SEDNET may prove valuable by expanding the current spatial replication within reaches/subcatchments for trend reports.

5.5 Targeting hotspot issues and gaps to on-ground Action Plans

No.	Action	Short term target	Long term target	Regions
1	Data analysis of local data to provide local assessment (WQ02 – NRM, Sunwater and EPA data)	Local assessment of WQ condition and advise on site design within 6 months	To improve the ability of existing design to detect problems	All subcatchments and catchments
2	Initiation of community water quality sites to augment future local (and regional) assessment and fill gaps identified above	Initiate water quality monitoring (including full suite of parameters and nutrients) at the DNR site at Springfield within 3 months.	Initiate WQ monitoring at other sites as advised by Action 1	Kolan
3	Identification of salinity outbreak sites in inland salinity hazard areas of Monto, Kingaroy, Wondai and Mundubbera through mapping and landowner engagement	Engage landowners and community to map current outbreak sites (note contributing factors) and potential outbreak sites at two locations (Monto and Kingaroy) within 1 year.	Salinity outbreaks to be mapped in remaining areas (3 years) - maps to be updated annually	Monto and Kingaroy (initially)
4	Depending on cause of salinity in Hazard Sites - apply appropriate measures for prevention (appropriate land use)	Rehabilitation or preventative measures applied to at least 3 site within 1 year (Monto initially)	Prevention of possible outbreaks (by changed land use) and rehabilitation of current outbreaks	Monto initially
5	Broadscale inventory of "river issues" (including banks/beds degradation, other hotspots) and prioritise for rehabilitation or revegetation depending on adjacent land use This is essentially one of the first steps of a Rehabilitation Plan and should be undertaken for all subcatchments ideally using GPS and mapping within a River Reach context. (Data and information can be gathered initially while Reach methodology is established).	Degraded areas noted and prioritised within 6 months	Movement into active rehabilitation of priority areas (off stream watering, fencing, revegetation etc)	All subcatchments of the Burnett River, Kolan Catchment, Baffle Creek Catchment, Elliott and Gregory Catchments.

6.	Establish additional monthly WQ sites along the Stuart River (full range of parameters) to augment the DNRM program and initiate monitoring of the full range of parameters at the two DNRM sites (by either DNRM or community).	Establish at least three more sites within 6 months	Appraisal of site design and data (in conjunction with Action 1) to ensure adequate information will ensue (annually)	Stuart River
7.	Water samples for nutrient measurements to be taken monthly at all (5) sites above including the two current DNRM sites to augment WQ data (pH, temperature and conductivity) and increase knowledge of nutrients in the Stuart River.	Initial samples to be collected and analysed within 6 months	Appraisal of site design and data to ensure adequate information will ensue (annually)	South Subcatchment – Stuart River
8.	Establish monthly WQ monitoring at three additional sites (Stonelands, Boonimba Falls, and a third site to be located between Flicks Crossing and Stonelands) within the Barambah system (full range of parameters) to provide information currently unavailable due to Sunwater commercial in confidence (Stoneland site to be dropped if Sunwater data becomes available). Initiate monitoring of the full range of parameters at three current DNRM sites in Barambah Creek (Ban Ban, Litzows and West Barambah).	Establish at least 3 more sites in 6 months	Appraisal of site design and data (in conjunction with Action 1) to ensure adequate information will ensue (annually)	
9.	Water samples for nutrient measurements to be taken monthly at all (6) sites above including the three current DNRM sites to augment WQ data (pH, temperature and conductivity) and increase knowledge of nutrients in the Stuart River.	Initial samples to be collected and analysed within 6 months	Appraisal of site design and data to ensure adequate information will ensue (annually)	
10.	At least 2 of the WQ sites in Stuart River (DNRM sites) and the three sites recommended for Barambah Creek (these are DNRM sites monitored by Sunwater and therefore data unavailable) should monitor for pesticides in water, sediments and biota.	This target to be discussed according to regional priorities	To be discussed	South Subcatchment – Stuart River and Barambah Creek
12.	Establish WQ monitoring sites around suspected point sources to confirm contribution by industry to receiving water bodies (*this project may not be necessary as the EPA is currently creating a Point Source Data Base, which may be able to generate this information from existing data*).	Investigate capability of Point Source Data base and whether it can serve these information needs – within 6 months.	Increased knowledge of point source influences on water quality	South Subcatchment
13.	Establish QA procedures to add certainty to Waterwatch and	PAP 2.1/WQ SIP05	PAP 2.1/WQ SIP05	All regions/Statewide

	community monitoring data, particularly nutrient collection methods.			
14.	Initiate freshwater monitoring at EPA1100 site (Dr Mays Crossing – EPA stopped monitoring this site in 2002) and at least one additional upstream site.	Begin monitoring at freshwater sites within 6 months	Appraisal of site design and data to ensure adequate information will ensue (annually)	Elliott River
15.	Initiate investigation of levels and pathways of contaminants in key areas of the Burnett Basin (this program should align with water quality program sites).	Seasonal sampling of water, at least 5 sites in each of the lower Burnett River, Elliott River and Barker/Barambah systems within 1 year	Seasonal sampling of sediments and biota within 3 years.	Burnett River, Barker/Barambah subcatchment, Elliott River.
16.	Initiate monitoring in the Baffle Creek Catchment as per water quality monitoring proposal in Appendix 5	Costings and personnel to be determined within 3 months	Monitoring to be initiated within 6 months.	Baffle Creek, Granite Creek, Colosseum Creek, Oyster Creek and Round Hill Creek.
17.	Undertake investigation of water quality of groundwater and agricultural seepage	Scope of project to be determined within 3 months	Samples taken and analysed and recommendations made within 1 year	Elliott River
18.	Engagement of community and industry to initiate community monitoring and interest in NRM (BMRG is presently discussing capacity of the Friends of Burrum group to extend their current cover to include Gregory and Isis Rivers.	BMRG to engage community within 6 months	Water quality sites and monitoring (including nutrients and chlorophyll a) within 1 year	Gregory and Isis Rivers
19.	Seagrass Watch can often be related to water quality measurements and is easy for community to undertake. Noted areas include the mouths of Baffle Creek and Elliott River.	Initiation of Seagrass Watch within 12 months to complement existing program in Hervey Bay and Great Sandy Strait	Establish monitoring program for Seagrass within 1 year	To complement existing program in Hervey Bay and Great Sandy Strait

5.6 Data integration and communication strategy

The following section develops concepts for communication strategies to facilitate communication and collaboration of information and data between community groups, line agencies and independent contributors (individuals or industry). The resultant system should integrate vision, knowledge and sampling methodology (include links to method sections and QA systems). A primary consideration of these strategies was recognition of and respect for local communities and their activities. Advice by project managers for the development of a data integration and communication strategy was for (1) emphasis on easy access to data, (2) a rapid turnaround by line agencies that are involved and (3) consideration of data integrity and security.

The system should aim for increased community in (A) resourcing, (B) capacity building, (C) activity and (D) learning. Resourcing should be achieved through the thoughtful allocation of money and equipment. A strategy has been suggested that uses an array of properly resourced technical nodes, or "NRM centres", in Chapter 4, section 4.3 of this report. Each node has a project officer with appropriate technical skills, equipment and operating budget. This resourcing is considered necessary to provide an "available face" at geographically proximal locations to develop both real and virtual relationships for NRM groups within the WMN. Capacity will be achieved through support of the above (available resources) and through support of BMRG. Activity will be initiated through the technical node, which will work with the adjacent regional community cluster to address their issues. This includes undertaking strategic monitoring, including the training and support of NRM groups with the current capacity to monitor. The NRM centre model would provide an entry point for BMRG support and provisions and assist in forming links between groups and stakeholders to assist in moving groups to on-ground activity. Learning is achieved through BMRG providing feedback on data collected and providing scientific and management perspective on basin-wide activities. This is achieved through data analysis and interpretation relating to subcatchment and tributary issues and basin–wide issues. Effectively achieving objectives A-D as listed above requires the efficient integration of data management and communication systems.

Vision

Attaching a vision to a process is often an effective way of increasing understanding of why and how a process should take place. The following vision statement is suggested for the data/communication integration process:

To foster coordination of monitoring activities across the Burnett Basin from inland to coastal waters by sharing and disseminating data and information to improve our capacity to manage aquatic resources in a balanced way.

System concepts

Achieving effective integration of data management and communication systems requires systems and responses that are useful to all levels of the Burnett Basin community. Further, there must be a certain level of trust and assurance in a new system before individuals and groups are likely to contribute. There are requirements for an interpretation service, which can be provided through each technical node/centre, resulting in basin wide and regional activity reports, made available through the node and the WWW.

Suggestions to ensure useful systems and responses, include provision of a data management system that has

- Data accessed and entered through regional nodes
- A data report through that node for the regional stakeholders involved
- Centralised data integrating and analysis both local and catchment wide
- Interpretation service at each node

- Basin-wide reports accessible through that node for the regional stakeholders involved
- Web-enabling to ensure easy access to data (later in development). Initial access is via technical nodes/NRM centers.
- GIS provision – available through WWW and technical nodes (which will provide web access)

Developing consistent and dependable personal relationships with stakeholder clusters will be critical to the success of any action to integrate groups and data. This will include face-to-face contact with BMRG extension officers and regular outputs, for example hard copies of reports, newsletter distributions, web maintenance and collaborative periodic field days (have a calendar year with regular field days). Major outputs would include workshops, conferences and possible an annual river festival to celebrate river research and promote forward thinking in the catchment. Schools, individuals and community groups may present case studies to give positive examples of sustainable catchment management and to facilitate knowledge dispersal and generate pride and momentum within the catchment community.

Momentum must not be lost in the lower section of river as the coastal communities enjoy the benefits of cleaner rivers, and coastal water quality is also a primary issue highlighting the need for a focus catchment to coast focus. The recent partnership between BMRG and GBRMPA confirms this focus.

Structure

There is a progression within the integration plan, starting with individual data entry and safe storage to analysis and reporting which includes project and activity cover through local media (television and radio for local projects) and wider.

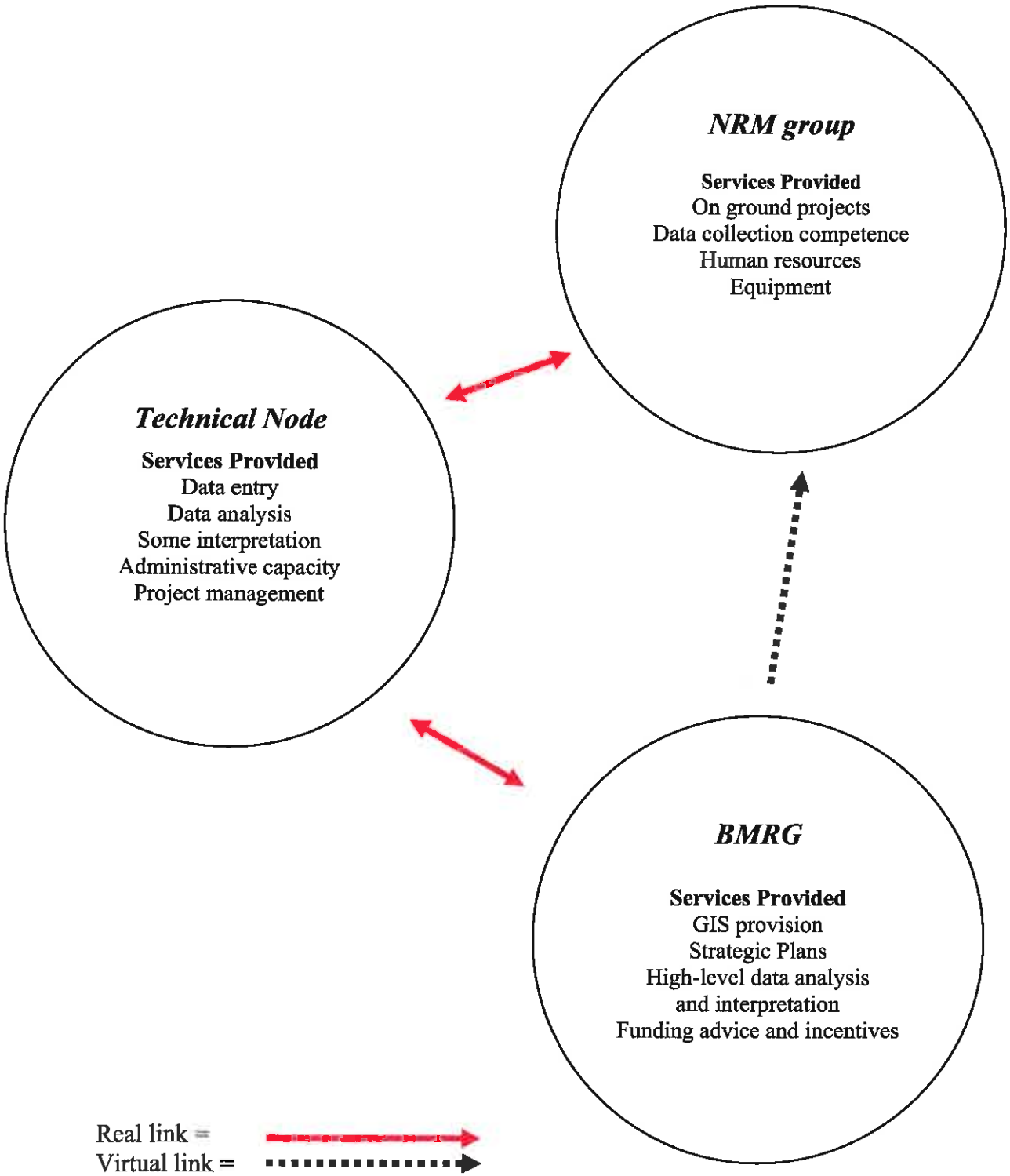
In its final stages it is envisaged the system will function within a three-tiered operation:

Level 1. This level will encompass individuals, NRM groups, project officers and industry. The role of this ground level is for collection of data and information through on-ground activity. QA at this level is primarily technical for collection of assured data.

Level 2. This level incorporates the technical node, regional NRM centre, NRM coordinator and project officer or group representative positions – this is a higher level, which would require further training, supervision and quality assured procedures. Activity at this level would include defining project descriptions, roll out of projects and assisted project management, coordination or human resources and equipment, data entry (group representatives could do this with training), some spatial and temporal interpretation of local sites (possibly by project officers or NRM coordinators, local temporal and spatial analysis) – and importantly - feedback to Level 1 (individuals or groups). Level 2 will have access to local information, but perhaps not to catchment-scale datasets.

Level 3. The responsibility at Level 3 will be primarily by BMRG for high-level integrated management (under agreed data confidentiality). Level 3 will deal with coordination of regional objectives, funding incentives, compilation of data submitted by Level 2 into catchment-wide datasets, higher interpretation of data (with whole of system datasets) and integration of knowledge, feedback and interpretation of knowledge to Level 2 (Centres and coordinators rather than individuals). Level 3 exists to inform at a high level.

Figure 8: Virtual and personal relationships within the data/communication strategy.



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Chapter 6 River Reach Plans

Under new regional arrangements (refer to Chapter 1), the BMRG is responsible for implementing Australian Government Initiatives such as Rivercare and Waterwatch. The Rivercare initiative is for improving the condition of Australia's water resources (including rivers, streams, wetlands and groundwater) resulting in improved water quality and environmental condition. This includes freshwater environments as well as estuarine and coastal waters and is being achieved by supporting actions that reduce the nutrients, sediments and other pollutants that reach waterways and groundwater, including the use of clean wastewater and stormwater systems and improved water efficiency and re-use (NHT, 2004).

This chapter is divided into two sections. Section 6.1 provides the theoretical background to lend support to an approach to river classifications (geomorphic river breakup) with an update of current literature and will also nominate general methodology for developing river rehabilitation plans (step by step approach and guiding documents). The development of river rehabilitation plans will direct the planning stages and strategic implementation of Rivercare initiatives and priorities for each study area (the Burnett, Kolan and Baffle Catchments).

Section 6.2 will provide a summary of current studies and project that will advise and inform River Rehabilitation Plans at the reach level and/or assist in priority setting and development of rehabilitation/action plans within Rivercare programs.

Discussion between CEM and BMRG yielded the following background principals for Rivercare:

1. Allocation of river management units or river reaches within the Burnett river system;
2. To base the reach classification on similar geomorphology within the catchment/ subcatchments (CEM to advise on which is the appropriate classification based on past/current studies);
3. To undertake monitoring in representative sites located within allocated geomorphic reaches;
4. To include community groups as much as possible in on-ground rehabilitation and data collection efforts and associated QA procedures and;
5. To enable comparability with other projects (CEM to provide an overview of current projects and their methods for reach breakup (e.g. SIP riparian project) and so promote parallel (and comparable) methodology between projects and analysis of ecological data.

6.1 Rivercare approach

6.1.1 Significance of river reach methodology

When a river system is very large, it is often helpful to divide the entire 'site' for management planning purposes into several contiguous zones or regions, and to develop separate management plans for each of these zones, under the umbrella of an overall plan prepared in advance. The division of river systems into 'reaches' or River Management Units (RMU) has been shown elsewhere to yield information suitable to guide management plans/strategies for respective areas. Approaches for this division of river systems have been variable, with criteria for designated reaches (RMU's) ranging from differences in adjacent land use, in hydrology and geography (Cottingham *et al,* 2001) to use of geomorphic units (such as pool, riffle and run).

The definition of 'geomorphic' is "relating to the form of the landscape and other natural features of the earth's surface" (Soanes, 2004). The use of geomorphic similarity as a basis for investigating changes in rivers/river communities relates very much to "geoecology" (also known as *landscape ecology*), an interdisciplinary science that studies the interactions and interrelations in the environment

(Mayhew, 2004). Geoecologists and geomorphologists are said to operate at basin and catchment scales (regional planning maps etc), whereas engineers operate at reach scales (Newson, 1986; Mayhew, 2004).

Using a geomorphic approach in river research has been shown to yield relevant and appropriate data supportive of the concept of river zonation (Ramierez and Pringle, 2001; Arscott *et al* 2003) – this concept predicts a change in community composition along the stream continuum due to geomorphic features. Many studies have confirmed this, with different geomorphic units appearing to support distinct biotic assemblages, particularly with regard to macroinvertebrates (Brierly and Fryirs, 2000; Carter and Fend, 2001; Arscott *et al,* 2003). This is due to the many instream processes (water quality, nutrient transfers, pH and temperature for example) relating intrinsically to variability in substrate and hydraulics variables. The high relevance of knowledge arising from studies of geomorphologic processes (particularly in conjunction with ecological drivers) to advise management scenarios, has led recent studies (particularly those assessing effectiveness of fish habitat restoration practices) to recommend that effective long-term rehabilitation schemes in particular, should carefully consider the varying sensitivities of river reaches due to different geomorphic contexts (Champoux *et al*, 2003). As stated in Brierly (1999) "Effective management is contingent on improving our knowledge of geomorphological interactions with ecological functioning in aquatic ecosystems".

6.1.2 Which classification scheme for Rivercare?

As noted in the section above, the geomorphic characterisation scheme used will be crucial to the outcomes of the study and, as such, classification methods are the topic of much critical debate (Brierley and Fryiers, 2000; Thoms and Sheldon, 2002). Some studies have suggested that the more generic methods of geomorphic reach classification (eg River Styles) are inadequate for detection of invertebrate community similarities (possibly because some large-scale drivers of local habitat condition are not included in River Styles classifications - Thompson *et al* 2004). However they do not offer suggestions for higher scale detection.

The State of the Rivers project (Van Manen, 1999) defined reaches within the Burnett Catchment according to homogenous stream sections. The attributes to determine homogeneous stream sections were soil type and geology, vegetative type, stream bank slope, stream gradients and sediment types (some of these are also attributes of River Styles). This classification was undertaken in the absence of detailed investigations of geomorphic river studies and associated classifications for the catchment. Later, with development of the Burnett Geomorphic Assessment of Reaches (GAR - Gardiner and Brennan, 2004 - discussed below) data collected from the State of the Rivers project were re-assigned as per the Burnett GAR's reach definitions and re-analysed (updated information was not released as there were minimal changes to overall condition assessments). This update occurred as the GAR was thought to represent the most comprehensive geomorphic assessment to date for the Burnett River and tributaries.

The GAR - Burnett Catchment and major tributaries was completed in 2004 (Gardiner and Brennan, 2004). The assessment methodology applied similar geomorphic principals as those in Brierley's "River Styles" and Thom's "River Process Zones" and breaks down whole lengths of river into reaches of similar character and behavior (Gardiner and Brennan, 2004). The document does not attempt to place ecological significance to geomorphic units and its authors recommend the report be used as a foundation for future ecological assessments by the appropriate professionals (Gardiner and Brennan, 2004). This report reiterates this recommendation as the Burnett GAR, in conjunction with current and future biological knowledge arising from State of the Rivers-type surveys, is thought to represent the most relevant structural and functional information on which to base river rehabilitation plans.

DNRM envisage that the Burnett GAR reach classification will be used extensively for future projects in the Burnett, and several new projects (AquaBAMM and SIP-WQ05) are already adopting its use to assist in representative site selection (Stephens, K. pers com., 2005; Henry, N., pers comm., 2005; Moller, G., pers comm., 1995). An objective of the AquaBAMM project (EPA) is to assess the

ecological characteristic and significance of stream ecosystems in the Burnett River Catchment. This was to be achieved partly through investigation of the best system of dividing waterways and developing methodology for this division. However, with the completion of the GAR (in 2004) these investigations were deemed unnecessary and the will advise reach break up.

Besides the Burnett GAR representing the most comprehensive geomorphic river work undertaken within the catchment to date, the GAR reach classification scheme is recommended to allow comparisons between future projects.

Management planning, including the development of river reach plans (and rehabilitation plans), must be regarded as a continuous, long-term process. It is, therefore, important to recognise that a river reach plan will grow or change as more information becomes available. There is a possibility that future ground truthing and testing of Burnett GAR attributes will alter the current classification scheme. In the event of this occurring (or if a newer, more ecologically relevant classification scheme is recommended in the future) sites and data would simply be reassigned within the new scheme (and re-analysed) and reach priorities and site activity would be updated according to the new classification. Planning in areas with a paucity of background literature should commence by producing a 'minimal plan' that meets (as far as resources and information allow) the requirements of the site and of the organisation responsible for managing the site, and no more (Ramsar Convention on Wetlands, 2002).

To inform each plans development, on-ground activities require synthesis and interpretation to provide timely advice.

6.1.3 Approach and methodology

Within the general context of RMU's described above, it is recommended that the approach for Rivercare (i.e. for preparing strategic rivercare actions for the Burnett and associated rivers) follow the general planning approach detailed in current literature for river restoration/rehabilitation. Examples include the conceptual framework of "Stream Rehabilitation Essentials" (Kapitzke, 1998), and the detailed steps within the "Rehabilitation Manual for Australian Streams" (Rutherfurd *et al,* 1999). The "River Restoration Framework" also describes general principles for a cohesive approach that would help overcome many constraints in technical knowledge transfer and exchange (Koehn et al, 2001). These documents should be used to guide both the planning (direction and strategies) and implementation stages of Rivercare to ensure actions are strategically well designed (planning stages include risk assessments to assist in priority setting). The target of most of these studies is "to return (as far as possible) the vegetation, structure, hydrology and water quality of the original streams" and there is the underlying assumption that by improving the physical environment (in a self sustaining way), the original communities can return and thrive (Rutherfurd *et al,* 1999). The Rehabilitation Manual in particular, sees stream rehabilitation as a subset of catchment management and focuses on geomorphic recovery followed by biological recovery. Similar studies have successfully used hybrid methods of Kapitzke *et al*, (1998; 1999a and 1999b) and Rutherfurd *et al*, (1999) to create appropriate and effective rehabilitation plans and associated actions (Erskine, 2000).

Rivercare (through use of river rehabilitation plans) should address broadscale as well as specific issues as they evolve and should use tried and confirmed methods as well as new and innovative approaches to implement on-ground activities. Specific activities should follow methods meeting minimum standards specified in the EPA Water Monitoring Data Collection Standards or (if unprecedented) should workshop with the relevant parties (EPA, NRM, DPI&F) to determine best methods.

Planning and implementation

Rehabilitation planning should proceed from a national or at least regional scale (comparing condition of whole catchments not just reaches). As such, priority setting is also necessary at different scales – whole of catchment, subcatchment and stream (reach) level in the context of regional and local

community aspirations. The 12-step approach defined in the Rehabilitation Manual for Australian Streams is highly understandable and Step Five describes principles for setting rehabilitation priorities at both catchment and reach levels (Rutherfurd, *et al*, 2000).

Problems need to be identified before priorities can be set. This is an issue that confounded the prioritising process within the water quality PAP (as often appropriate information was not available). This emphasises the critical role of the planning stages to a rehabilitation plan (particularly Steps Three and Four of the Rehabilitation Manual for Australian Streams) – the need for developing a template of the stream and identifying natural assets, degraded assets and problems/issues within defined reaches. Part of this step was completed through this PAP (collecting anecdotal accounts and documented issues within rivers), and other information is available through ecological studies. However increased knowledge of the locations of hotspots is essential for mapping (GPS coordinates). Ultimately, the undertaking of broadscale inventories of creeks and rivers would ensure that all appropriate information has been collected for mapping of individual reaches as well as corroborating anecdotal accounts and old information.

Projects currently utilising resource information data are well placed to advise the prioritisation process by flagging hotspots (arising from respective studies) at a subcatchment/reach level. These include various SIP (and PAP) projects, and are discussed further in the next section. State of the Rivers data and other past studies at the reach level will also provide detailed information worthy of investigation and comparison against current condition (Van Manen, 1999).

The general approach to river rehabilitation planning is detailed in Rutherfurd et al (2000) and follows a twelve step process listed below:

1. Define goals for rehabilitation in terms of the environmental value of the stream.
2. Gather support from stakeholders (this can be undertaken during the consultation for the above step).
3. Identify how the stream has changed – developing a template of goal condition.
4. Identify main natural assets and problems within the reach – (this is priority for the Burnett and associated catchments and tributaries).
5. Set priorities – which reaches and problems should you work on first (this uses a form or risk assessment)?
6. Decide upon strategies for protecting assets and improving your stream? (this should relate to strategies within the Burnett NRM plan as well as strategies developed specifically).
7. Set specific and measurable targets (this should relate to targets within the Burnett NRM plan as well as targets developed specifically).
8. Consider feasibility of objectives (affordability, consequences, risk). This step should also consider 'downstream impacts' to the extent of undertaking cost-benefit analysis to determine true feasibility of objectives.
9. Implement detailed design of projects to meet objectives – listing strategies and describing implementation in detail.
10. Evaluate projects (for increased certainty; also include future projects and improved techniques).
11. Plan for the implementation of effective project roll out (scheduling and detailed planning).
12. Assess the project – evaluate results to see whether the project succeeded or failed.

6.2 Current studies/ potential advisors for river reach plans

There are currently a number of State-level Integrated Projects (SIPS) taking place in the Burnett Catchment in order to provide critical information under the National Action Plan (both NRM and DPI), as well as specific EPA projects and technical papers. Several of these projects will serve to inform at the reach level and/or assist in priority setting and development of rehabilitation/action plans within Rivercare programs. Basic information is presented below for NRM state-level activities (SIPS – list present in Table 14) and EPA activities where available. However this project did not investigate the relevance of AG SIP (Table 15) projects.

Table 14: NRM State level activities (SIPS)

Key Areas	State level activities for capacity building - summary. Status - Current
SIP Capacity Building Projects	CB01 Capacity building with local government
	CB02 Integrating NRM and local government plans
	CB03 Learning and evaluation systems
	CB04/5 Research and adoption sustainable production systems. Status - Current
	CB06 Leadership for high performance in NAP regions. Status - Current
	CB07 Enhancing the technical/advisory & CE capacity within regional arrangements. Status - Current
SIP salinity projects	Introduction to SIP salinity projects. Status - Current
	SA01 Salinity hazard assessment for priority catchments. Status - Current
	SA02 Hydro-geological investigations. Status - Current
	SA03 Landscape attributes for salinity processes. Status - Current
	SA04 Integrated salinity modeling. Status - Current
	SA05 Information and data management (part of IM01). Status - Current
	SA06 Project co-ordination and technical. Status - Current
	SA07 & SA08 Airborne geophysics in the lower Balonne catchment. Status - Current
SIP water quality projects	Introduction to the SIP water quality projects Status - Current
	WQ01 Framework and process for target setting and monitoring Status - Current
	WQ02 Collation and assessment of existing WQ information Status - Current review of management
	WQ03 Modeling landscape processes, management impacts and catchment loads
	WQ04 Riverine habitat condition assessment and guidelines Status - Current
	WQ05 Enhanced community capacity to undertake monitoring of water quality targets Status - Current
	WQ06 Water quality impacts on ecosystem health. Status - Current
SIP social and economic projects	Introduction to the SIP social and economic projects. Status - Current
	SE01 Institutionalising social/ economic considerations & assessments in reg. Arrangements. Status - Current
	SE02 Coordination of social &economic information for development of a RIS. Status - Current
	SE03 Social research, development and extension. Status - Current
	SE04 Integrated research, development and extension for regional NRM. Status - Current
	SE05 Developing and trailing a toolkit of incentives & market-based instruments for regional NRM. Status - Current

SIP WQ02

This project is titled "Collation and assessment of existing WQ information status – current review of management". Results arising from this study will better advise upon the current status of water quality within subcatchments within the Burnett system. Graeme Esselmont (NRM WQ Coordinator, Bundaberg) is well placed to provide information on this project and its results to date. The report is currently in draft form. Unfortunately the data assessments were undertaken a sub regional level (upper Burnett versus coastal Burnett) and therefore local information of changes within individual streams would not result from this project.

SIP WQ03

This project is entitled "Modeling landscape processes, management impact and catchment loads". As the title suggests this is a modeling project that is now linked in with DNR's short term modeling (Chris Carroll 49384240) and will be delivering between April and July 2005. This project should be able to advise on relative contribution of subcatchments to total sediment loads in the Burnett River system, through strategic location of sites and collection of event data.

SIP WQ04

The Burnett River Riparian Assessment (a current project forming part of the SIP WQ04 project entitled 'Riverine Habitat Condition Assessment and Review of Guidelines') uses river reach classification information from the GAR (Gardiner and Brennan, 1994) to assist in representative site selection for riparian assessments (Stephens, pers comm.). Information arising from riparian assessment (site specific data in particular) is thought to be highly relevant for providing advice on river rehabilitation plans, particularly in regard to identification of

- Degraded riparian zones within reaches including eroded banks and gullies (instability, lack of cover), weedy areas (poor ground cover, impact), and poor species diversity (disturbance, fire prone?).
- Reference areas within reaches including remnant patches with high integrity as well as protected areas (national parks etc),
- Priorities at a subcatchment level and at a reach level for rehabilitation of 'hotspot' areas (degraded areas) and maintenance of reference reaches.

Reporting outputs are expected in May 2005. The SIP WQ05 project originally considered using State of the Rivers (SOR) methodology but decided against it due to the different focus of the current project. A review of SOR methodology by the current project is pending. Note: much of the information gathered during the original State of the Rivers Assessment is thought to be of high value for long-term condition and trend data (the basis of SOR methodology was to "divide the catchment into homogeneous stream sections which share similar natural features and conditions" (Van Manen, 1999)).

SIP AG05

The SIP AG05 project is titled "Benchmarking pesticide and nutrient movement in new cane and horticultural farming systems". This project will be modeling nutrient exports at the farm scale and may provide valuable information on exports from adjacent land to river reaches. AG05 is also likely to provide additional information to refine WQ models and is also being used with AG16 dissemination on information and capacity building.

SIP SA05

The salinity SIP titled "Information and data management" will provide information on salinity hazard areas and noted changes in salinity through the catchment. Identification of salinity intrusion in riparian habitats will assist in directing rehabilitation efforts to appropriate areas.

EPA – Environmental Values (EV's) and Water Quality Objectives (WQO's)

The Environmental Protection Agency is currently undertaking a project to develop EV's for three QLD waters (Moreton Bay, Mary/GSS and Douglas Shire) and draft WQ Guidelines. Methodology used and lessons learnt in the development of these values and guidelines may be applicable to assess the environmental values of rivers, subcatchment and reaches for rehabilitation plans.

EPA - Aquatic Biodiversity Assessment Mapping Method (AquaBAMM)

This is an EPA project that has recently started up in the Burnett. This project aims to provide a robust and easily accessible analysis of conservation values associated with the Burnett River system by development and pilot application of an Aquatic Biodiversity Assessment Mapping Method (AquaBAMM). The objective of this project is to assess the ecological characteristics and significance of stream ecosystems in the Burnett catchment. This will be achieved by:

- Developing a method for division of the waterways of the Burnett River system into practical mapping units at a landscape scale for assessment and reporting purposes (possibly through adoption or modification of one of many existing methods of catchment/wetland stratification).
- Constructing an AquaBAMM based on the best[1] system of mapping units (waterway division), including reconfiguring relevant elements of the existing BAMM where appropriate and using the LWA/EPA guidelines for criteria development and conservation value assessment (ecological characteristics and significance).
- Piloting the application of the AquaBAMM in the Burnett River catchment making use of the large volume of existing data and ecosystem condition information.
- Determining the robustness of the method by undertaking a ground-truthing exercise for selected reaches of the study catchment.
- Peer reviewing results in line with standard scientific practice.

This project is obviously very well placed to advise in relation to rehabilitation plans, however linkage and information transfer will be dependent on timing of project outputs.

[1] The best system of dividing waterways will be determined according to ease of application, ecological relevance and reporting usefulness in a local natural resource management-planning context. An expert panel approach would be employed to finalise the mapping platform prior to AquaBAMM construction.

PAP2.1 Burnett Basin Regional Community Water Quality Networks

The initial chapters of this report (PAP2.1/2.2 Burnett Basin Regional Community Water Quality Networks and Rivercare), particularly Chapter 3 Current community based water quality monitoring networks, provide an overview of the past and current on ground activities and the focus and direction of most community groups in the Burnett Catchment within their respective geographic locations. This report is designed to assist in determining appropriate groups for local rivercare engagement and in aligning rivercare activities to compliment current group focus as well as local and regional priorities.

Freshwater biodiversity in the Burnett Mary Region (Stockwell et al., *2004)*

This technical paper provides a comprehensive overview of the current resource status, pressures and risks, current responses and legislative instruments, limitations and constraints, options for regional NRM planning response, cost-benefit and ecological risk assessment and monitoring and evaluation programs (Stockwell, *et al.,* 2004).

Several of the options for implementation within this report relate chiefly to Rivercare and include:

- Establishment of regional rivercare programs,
- Subcatchment rehabilitation/restoration pilot research projects,
- Riparian rehabilitation projects,

Within this report the authors emphasise the difficulty of establishing resource condition benchmarks in terms of aquatic biodiversity targets. They advise that management action targets be adopted for aquatic biodiversity attributes and that resource targets "simply reflect minimum targets set by state-wide or regional policy (EPA environmental values (EV's), Water Quality Objectives (WQO) and Reef WQ targets).

Metadata references

A metadata base is available that refers to technical information papers, journal articles and other sources of information relating to catchment management issues including water quality and rivercare for the entire Burnett Basin (NRM, 2004). There was a need for this information to be understandable at a local level – to determine where the current knowledge for respective areas lies (as the metadata set contains specific and general information at a local and/or species level (species habitat, studies within reaches or subcatchments of the Burnett), a regional level (catchment management, basin studies, reach and subcatchment similarity, geomorphic approaches to management etc) and a national level (similar studies overseas/ methodology corroboration and divergence). Information on relevant areas for each entry is available in the metadata; however, the size of the spreadsheet format complicates the ability to extract pertinent information.

Appendix 6 presents a list of the datasets and reports within the metadata set and indicates their relevance to streams and/or subcatchments within the Burnett Basin and their relevant metadata location. For example some studies relate only to individual streams, whereas other studies include sites across the catchment or among catchments.

Table 15: DPI State level activities (SIPS)

Key Areas	State level activities for capacity building - summary. Status - Current
Landscape management	AG01 Planning and implementation suport to landscape best practise through the Integrated Area Wide Management process in National Action Plan regions
	AG08 IAWM development in Condamine Alliance region
	AG11 IAWM development in Queensaldn Marray Darling Basin region
	AG12 IAWM development in the Fitzroy Bain region
Grazing lands management	AG02 Grazing lands management in the Budekin rangelands
	AG04 Grazing lands in the Fitzroy Basin
	AG06 Development of grazing lands management package for Queensland Murry Darling Basin region
	AG09 Develop and implement an environmenal monitoring program across grazing lands of the national action plan
	AG10 Modelling simulation to support the adoption of grazing
Industry capacity building for NRM	AG05 Benchmarking pesticide and nutrient movement in new cane and horticultura farming
	AG15 Building natural resource maangement capacity in irrigated cotton and grain industry
	AG16 Scoping and capacity building of natural resource mangement issues with the horticulture industry of dry tropics
	AG17 Developing and integrated small catchment approach to management of pesticides and nutrients for cane systems
Coordination and process support	AG03 The provision of coordination and process support to sustinable agricultural initiativs in National Action Plan for
	SE01 Institutionalising social/ economic considerations & assessments in reg. Arrangements. Status - Current
	AG07 Decision support to assess impact of land use change
	AG13 Resource economic assessment of costs/benefits involved in land use change an incentive mchanisms to support
	Ag14 Adoption of sustainable landscape design practices on small holdings
	Ag18 Developing effective engagement aproaches to work across different land users in densely populated areas

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