Stormwater Quality Management Plan for Mackay

McCreadys Creek Catchment Management Plan

Draft Report

April 2005

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Acronyms

ANZECC	Australian & New Zealand Environment & Conservation Council
ARQ	Australian Runoff Quality (Engineers Australia 2003)
ASS	Acid Sulfate Soils
BCC	Brisbane City Council
CMP	Catchment Management Plan
DPI&F	Department of Primary Industries & Fisheries
EMS	Environmental Management System
EPA	Environmental Protection Agency
EP Act	*Environmental Protection Act 1994*
EPP	Environmental Protection Policy
EV(s)	Environmental Value(s)
GBRMPA	Great Barrier Reef Marine Park Authority
MCC	Mackay City Council
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
MWNRM	Mackay Whitsunday Natural Resource Management Group
NAP	National Action Plan for Salinity and Water Quality
NHT	Natural Heritage Trust
NR&M	Department of Natural Resources & Mines
GPT	gross pollutant trap
ha	hectares
IP Act	*Integrated Planning Act 1997*
KPI	Key Performance Indicator
km	kilometre
L	litre
ML	megalitre
NHT	Natural Heritage Trust
pH	degree of acidity to alkalinity
SQID	Stormwater Quality Improvement Device
SWQMP	Stormwater Quality Management Plan

TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UDIA	Urban Development Institute of Australia
VMA	Vegetation Management Act 1999
WHMP	Waterway Health Monitoring Program
WQO	Water Quality Objective

Executive Summary

McCreadys Creek lies within the coastal region of Mackay City, discharging into the Coral Sea approximately 7 km north of the Mackay CBD. With an area of 3,112 ha, the catchment encompasses land from Eimeo in the north to Mt Pleasant in the south and from Nindaroo in the west to Andergrove and Blacks Beach in the east. The catchment encompasses four Council divisions; 2, 3, 4 & 6.

The catchment is highly developed with approximately 61 % of the catchment used for rural purposes such as sugarcane, grazing and rural residential development. Approximately 21 % of the catchment is used for residential purposes and 18 % of the catchment is open space (predominantly the estuarine areas of McCreadys Creek). The balance of the catchment is zoned commercial with this area located in Rural View. Development in the catchment, originally for sugarcane cultivation, has occurred since the 1860s.

In the next 5-10 years, residential development in the catchment is set to almost double. This development is largely at the expense of rural land used for either grazing or sugarcane cultivation.

A Catchment Management Plan (CMP) has been prepared for McCreadys Creek to assist with the provision of adequate stormwater quality management measures for existing and future developments within the catchment. The study examines existing water quality issues as well as riparian vegetation.

The principal goal of the CMP is *to maintain or enhance the McCreadys Creek Catchment and its waterways while achieving a state of balance among environmental, social and economic interests within the community*.

The objectives used to achieve the goal were to:

- assess the existing condition of the waterway corridor including flora and fauna;
- assess the changes in runoff quantity arising from urbanisation of the catchment;
- assess the impacts of development on water quality;
- propose measures to mitigate the impacts of urbanisation on water quality;
- assess costs associated with proposed measures;
- develop strategies and objectives for social, environmental, financial and integrated planning objectives; and
- develop action plans for communication, education, social, environmental, financial and integrated planning.

McCreadys Creek and its catchment is used for a variety of different activities including:

- fishing at the mouth and in tributaries;
- crabbing;
- fish nursery – permanent facility;
- revegetation – ongoing;
- walking and bushwalking;
- hunting and gathering (Traditional Owners);
- bird watching;
- golf;
- employment – farming (turf farm), construction, development, quarrying, fisheries, shopping, commercial, education, gardening; and
- residential activities.

The environmental values for the catchment, ranked in order of importance (high and medium values only) are:

- Aquatic ecosystem - plants, animals and their ecological interactions.
- Wildlife habitat - riparian wildlife and their habitat, food and drinking water.
- Human consumption - health of humans consuming produce (fish, crabs) from the ecosystem.
- Visual recreation – amenity of waterway for recreation (no contact with water) such as walking and picnicking adjacent to a waterway.
- Secondary recreation - health of humans during recreation that involves indirect contact with the water such as fishing, boating, rowing.
- Cultural heritage – indigenous and non-indigenous cultural heritage such as custodial, spiritual, hunting, gathering, ritual responsibilities and landmarks.
- Farm domestic supply, irrigation of crops and or stock watering.

McCreadys Creek has a highly valued aquatic ecosystem. It is a valued fish nursery and is also frequently used for recreational pursuits such as fishing, crabbing, walking and picnicking. The area also has high cultural heritage values for Traditional Owners.

A summary of the Environmental Values to be protected in the McCreadys Creek Catchment include:

Aquatic ecosystems	- Biological – primary productivity, species richness and diversity of the freshwater and estuarine ecosystems. - Physical – bed morphology, flow regimes, suspended solids. - Chemical – nutrients (nitrogen and phosphorus), pH, EC.
Riparian ecosystems	- Biological – vegetation and fauna. - Physical – bank morphology, flow regimes.
Terrestrial ecosystems	- Areas of ecological status.
Secondary contact recreation	- Fishing, boating, hunting and gathering.
Aesthetic values	- Scenic values and amenity.
Educational, scientific and cultural values	- Relating to flora and fauna, history, significant places.

The following objectives have been established to protect the environmental values

- Social – to ensure that Council's infrastructure and planning strategies within the catchment positively contribute to public health, safety, cultural values, recreational and aesthetic amenity of McCreadys Creek.
- Environmental:
  - To protect areas of ecological status within the catchment.
  - to maintain aquatic and riparian ecosystems where they meet objectives (eg water quality objectives, biological indicators) and enhance aquatic and riparian ecosystems where these are not met.
  - To collect the data necessary to confirm the requirements for maintaining or enhancing aquatic

and riparian ecosystems (eg WQO) in the McCreadys Creek catchment with a view to evaluating methods of control/rehabilitation.

- Financial – to ensure that maintenance and enhancement strategies are cost effective and that financial assistance is obtained from sources within Council, from developer contributions, industry and from State and Federal Government.
- Integrated Planning – to ensure that there is a planning and development control framework, which is consistent with regional plans and contributes to the protection of the agreed environmental values and objectives and supports ecologically sustainable development.

Interim water quality objectives have been established for the catchment. These are based on the Mackay Region WQOs contained in the Mackay Stormwater Quality Management Plan (SWQMP). At present, there is limited water quality data available to confirm these objectives. The nutrient values are similar to the ANZECC trigger values for tropical Australia's slightly disturbed ecosystems. A developer funded water quality monitoring program is presently being implemented in the western reach of McCreadys Creek.

Monitoring within the waterways of the catchment to assesses the ambient, stormwater flows and biological conditions is recommended to establish verifiable WQOs.

Ambient water quality samples are proposed to be collected at quarterly intervals from five sites with four stormwater events to be monitored (eight sites). Biological assessments every six months are proposed to assess the health of the ecosystem using sampling in accordance with the QLD AUSRIVAS Sampling and Processing Manual for the collection and processing (live-picking) of macroinvertebrate samples. Analysis of the biological sampling would be undertaken using Signal Invertebrate Grade Number – Average Level, SIGNAL2 (where macroinvertebrate are assigned a "grade number" between 1 and 10, with 1 indicating those organisms with a high tolerance of a range of environmental conditions).

Water quality modelling undertaken in the catchment revealed that the WQO for the catchment cannot be achieved with the existing landuses in the catchment. The modelling however was undertaken using values established for Brisbane's catchments in lieu of local Mackay data, which is not presently available. This may result in either under, or over estimation of pollutant exports from the catchment.

In relation to pollutant loads and current landuse, the rural catchment contributes approximately 94 % of the sediment load, 43% of the nitrogen load and 60% of the phosphorus load. Residential development contributes approximately 4% of the sediment load, the highest nitrogen load at 45% and 38% of the phosphorus load. The catchment contributes approximately 160.5 tonnes of sediment, 16.6 tonnes of nitrogen and 1.3 tonnes of phosphorus to the Coral Sea.

In the future, if measures are not taken to improve stormwater quality, nutrient loadings to the Coral Sea may increase by approximately 3.2 tonnes of nitrogen and 0.1 tonnes of phosphorus. Sediment loads may decrease through the conversion of agricultural land to residential land. This however is only in the operational phase of residential development once the disturbed areas are stabilised through vegetation cover etc. There is a high risk of sediment loads increasing during the construction phase if adequate measures are not taken to control erosion and sedimentation.

A number of water quality control measures involving gross pollutant traps, constructed wetlands, trash racks and revegetation/rehabilitation are proposed. These however are to be implemented together with non-structural improvement measures such as education and regulation eg development controls.

The proposed priority actions for the strategies previously identified are listed in Table ES1. These

actions are to be undertaken in 2004/2005.

Table ES1 Proposed Priority Actions for Implementation of the McCreadys Creek Catchment Management Plan in 2003/2004.

Action		Estimated Cost
COMMc1.1	Information sessions to communicate the contents of the draft CMP (once approved by Council) to stakeholders and the community. Invite written submissions and address in the final version prior to it being endorsed by Council.	$5,000
COMMc1.3	Liaise with the region's organisations involved in natural resource planning to ensure that improvement efforts in the catchment are consistent and effort is not duplicated,	Internal Council Process
EDMc1.4	Prepare guidelines (eg Water Quality Guidelines) as identified in the Mackay SWQMP to assist developers in improving stormwater quality management in future developments.	$30,000-$50,000
ENVMc2.1	Review and implement the McCreadys Creek Waterway Health Monitoring Program in consultation with other key stakeholders involved in waterway health monitoring programs such as the MWNRM Healthy Waterways program, MPA, EPA, DPI &F, GBRMPA.	$60,000 (year 1) $50,000 pa for minimum 4 years following
ENVMc2.1	Continue to participate in regional working groups/committees involved in Integrated Health Monitoring Systems eg MWNRM Healthy Waterways Committee.	Internal Council Process
FUNDMc1.1	Ensure funding allocated from Council's environment levy is used for implementation of stormwater quality improvement strategies in McCreadys Creek catchment.	Internal Council Process
FUNDMc2.1	Inform government funded groups, authorities and agencies such as MWNRM, GBRMPA and EPA of strategies specific to McCreadys Creek and which have regional benefits and seek assistance for funding of these projects.	Internal Council Process
FUND3.1	Prepare Infrastructure Charges Schedules for trunk stormwater quality infrastructure that involves both quantity and quality to apportion the costs associated with improving stormwater quality in the catchment.	Internal Council Process
IPMc1.2	Require, through the Development Approval process (as identified in the Stormwater Quality Management Policy for large, high-risk developments), the preparation of Stormwater Management Plans (SWMP) that apply the principles of water sensitive urban design (WSUD).	Internal Council Process

Additional actions of medium to lower priority for implementation in 2004/2005 are presented in Section 7.

1. Introduction

Catchment Management Plans (CMP) establish a framework for managing natural resources and the impact of development. Mackay City Council commissioned GHD Pty Ltd to prepare a CMP for the McCreadys Creek Catchment located in the developing suburbs of north Mackay (refer Figure 1-1 for Locality Plan). The CMP was prepared in conjunction with the Mackay Stormwater Quality Management Plan (SWQMP) and is the first CMP prepared for Council.

The vision for the CMP, which is consistent with Council's ecological sustainability objective, is to:

> *"improve management practices to maintain and enhance the McCreadys Creek catchment and waterways whilst achieving a state of balance among environmental, social and economic interests within our community"*

The McCreadys Creek Catchment Management Plan addresses a range of catchment based issues including:

- waterway assessment;
- environmental values and water quality objectives;
- managing existing and future development - key issues include stormwater management and riparian vegetation;
- objectives and action plans for the following catchment issues:
  - social issues such as public health and amenity;
  - environmental issues such as water quality/ waterway health, ecological corridors, loss of wetlands and Great Barrier Reef World Heritage Values;
  - financial issues such as cost recovery and economic assessment; and
  - integrated planning issues such as town planning, regional planning and natural resource management.

The above have been achieved through completion of tasks including a site inspection, review of existing data, stakeholder and community consultation, waterway assessment, hydrologic modelling and water quality modelling.

Catchment Management Plans typically address flooding. However in this instance, Council is addressing this catchment issue in a separate study – the McCreadys Creek Stormwater Drainage Study. Both studies will provide information on trunk stormwater infrastructure required for the catchment to meet required levels of service. This data is to be incorporated into Infrastructure Charges Schedules (ICS) and Priority Infrastructure Plans (PIP) under the *Integrated Planning Act 1997* to assist in the funding of such infrastructure.

McCreadys Creek Catchment Management Plan

FIGURE 1-1
McCreadys Creek Catchment Plan
(1998 Aerial Image)

Legend

McCreadys Creek Catchment Boundary

DRAFT

Scale: 1:30,000 (A3)

North

Source Information: Mackay City Council

GHD MANAGEMENT ENGINEERING ENVIRONMENT

G:\42\12379\MapInfo\GHD Data\McCreadysCatch_A3.wor

2. Catchment Description

A snapshot of the catchment is provided in Table 2-1 below.

Table 2-1 Snapshot of McCreadys Creek Catchment (2004)

Parameter	Details
◗ Catchment area	3,112 ha (approximately)
◗ Council divisions in catchment	2, 3, 4, 6
◗ Elevation range	0 m – 145 m AHD
◗ Major landuses in catchment	
– Rural (Agriculture, Grazing Residential)	1,894 ha or approximately (61% of catchment)
– Residential (Urban, Park)	657 ha (20.5 % of catchment)
– Open Space	561 ha (18 % of catchment)
– Commercial	1.7 ha (0.5% of catchment
◗ Receiving waters	Coral Sea – a 'Conservation Park Zone' of the Great Barrier Reef Marine Park (Mackay Capricorn Management Area).

2.1 Catchment

McCreadys Creek lies within the coastal region of Mackay City, discharging into the Coral Sea approximately 7 km north of the Mackay CBD. With an area of 3,112 ha, the catchment encompasses land from Eimeo in the north to Mt Pleasant in the south and from Nindaroo in the west to Andergrove and Blacks Beach in the east. A Plan of the catchment was shown in Figure 1-1.

The catchment is highly developed above the floodplain with the main landuses being agriculture (sugar cane) and urban development (predominantly residential). Based on land uses in 2004, approximately 61 % of the catchment was used for rural purposes with 20.5 % of the catchment comprising residential development and the remaining 18 % and 0.5 % comprised of open space and commercial development respectively. The McCreadys Creek estuary and adjoining low lying areas comprises the majority of the open space.

Major features within the catchment include:

- Sugar cane dominates the rural landscape in the northern and north-western parts of the catchment although there are some areas used for grazing.
- Urban development dominates the catchment in the southern and south western extents of the catchment.
- Future urban areas such as Palm Gardens (formerly Eulbertie Park), Shuttlewood property, and the Cain property are located in the northern and middle areas of the catchment.
- Mackay Bucasia Road - the main linkage between Mackay and the Northern Beaches suburbs.
- Mackay Golf Course; and

- McCreadys Creek Estuary.

The catchment topography consists mainly of relatively flat floodplain areas with elevated areas mostly located on the outer extremes of the catchment. The catchment topography ranges in elevation from around 1 m AHD to 145 m AHD, with the highest hill in the catchment forming part of the south-western boundary of the McCreadys Creek catchment. A hill situated in the middle of the catchment and located beside McCreadys Creek, which has been developed as “Golflinks Heights” has an elevation of 55 m AHD. Small dams are located in the catchment, which have been created by old quarrying works capturing stormwater runoff or for the collection of water for irrigation purposes eg golfcourse.

The main tributary of McCreadys Creek flows in an easterly direction from Nindaroo to its outlet just north of Slade Point. The lower reaches of the Creek are tidal, discharging into the Coral Sea.

It should be noted that the Digital Terrain Model (DTM) used for this project was generated in the early 1990s. A new DTM, created by Webmap Pty Ltd, is expected to be available by October 2004. This DTM will incorporate data from a new survey of the Mackay area, which encompassed the McCreadys Creek catchment, undertaken in mid 2004.

Note that the current aerial photography for the catchment is from 1998 (6 years old). Since this time, there has been further urbanisation in the catchment. This has predominantly occurred in the suburbs of Andergrove/Beaconsfield, Glenella, Mt Pleasant, Rural View and Golf Link Heights.

Development of the catchment (for agriculture) has occurred since the 1870s when sugarcane was established. This was initiated by the establishment of the Richmond Estate, which was selected in 1870 by Hugh McCready. The ruins of the Richmond Mill, which are listed on the Queensland Heritage Register, are located near the western tributary of McCreadys Creek.

The southern urbanised areas in the catchment have been increasingly developed since the 1970s with substantial developments occurring in the 1980s and 1990s.

2.2 Climate

The tropical climate of Mackay is characterised by:

- a mean annual rainfall of 1,600 mm with over 75% of the annual rainfall occurring during the cyclone season from December to April;
- high summer rainfalls associated with tropical cyclones and the southern edge of equatorial monsoon activity; and
- the months of July to September being the driest period of the year.

2.3 Geology & Soils

The soil types in the McCreadys Creek Catchment area are outlined below. These soil descriptions have been adopted from Holz, G.K. and Shields, P.G., (1985), *Mackay Sugar Cane Land Suitability Study, Part 1. Land Resource Inventory*, Queensland Department of Primary Industries.

The major soil types are:

- Mangroves and Saltmarsh;
- Sand;
- Acid bleached sand with a yellow B horizon on Quaternary sand deposits;

- Acid bleached, gravelly, mottled yellow duplex soil developed on acid tuffs of Campwyn Beds;
- Acid, cobbly yellow-brown gradational soil developed on intermediate to acid volcanics and tuffs of Carmila Beds and possibly Campwyn Beds;
- Neutral, brown gradational soil to non-cracking clay developed on intermediate Cretaceous dyke rocks;
- Alkaline, black, self-mulching, cracking clay developed on Quaternary alluvium;
- Alkaline, bleached, mottled dark to grey duplex soil developed on Quaternary alluvium; and
- Alkaline, grey non-cracking clay to duplex soil developed on alluvial-colluvial material from intermediate to basic volcanics of Carmila Beds, Cretaceous dykes and Lizzie Creek volcanics.

During the site visit to McCreadys Creek, the major types noted were:

- Mangroves and saltmarsh;
- Neutral, brown gradational soil to non-cracking clay developed on intermediate Cretaceous dyke rocks;
- Acid, cobbly yellow-brown gradational soil developed on intermediate to acid volcanics and tuffs of Carmila Beds and possibly Campwyn Beds; and
- Alkaline, grey non-cracking clay to duplex soil developed on alluvial-colluvial material from intermediate to basic volcanics of Carmila Beds, Cretaceous dykes and Lizzie Creek volcanics.

Acid sulfate soils exist the catchment and have been mapped by NRM. The location of ASS are shown on Figure 2-1. Actual Acid Sulfate Soils and strongly acidic soils are located near the surface in the northern low-lying areas of the McCreadys Creek catchment. ASS also occur within 5 m of the surface in most of the catchment at elevations below approximately 4-5 m AHD.

2.4 Areas of Documented Value in McCreadys Creek Catchment

The McCreadys Creek catchment borders, or contains areas which are of documented environmental value including:

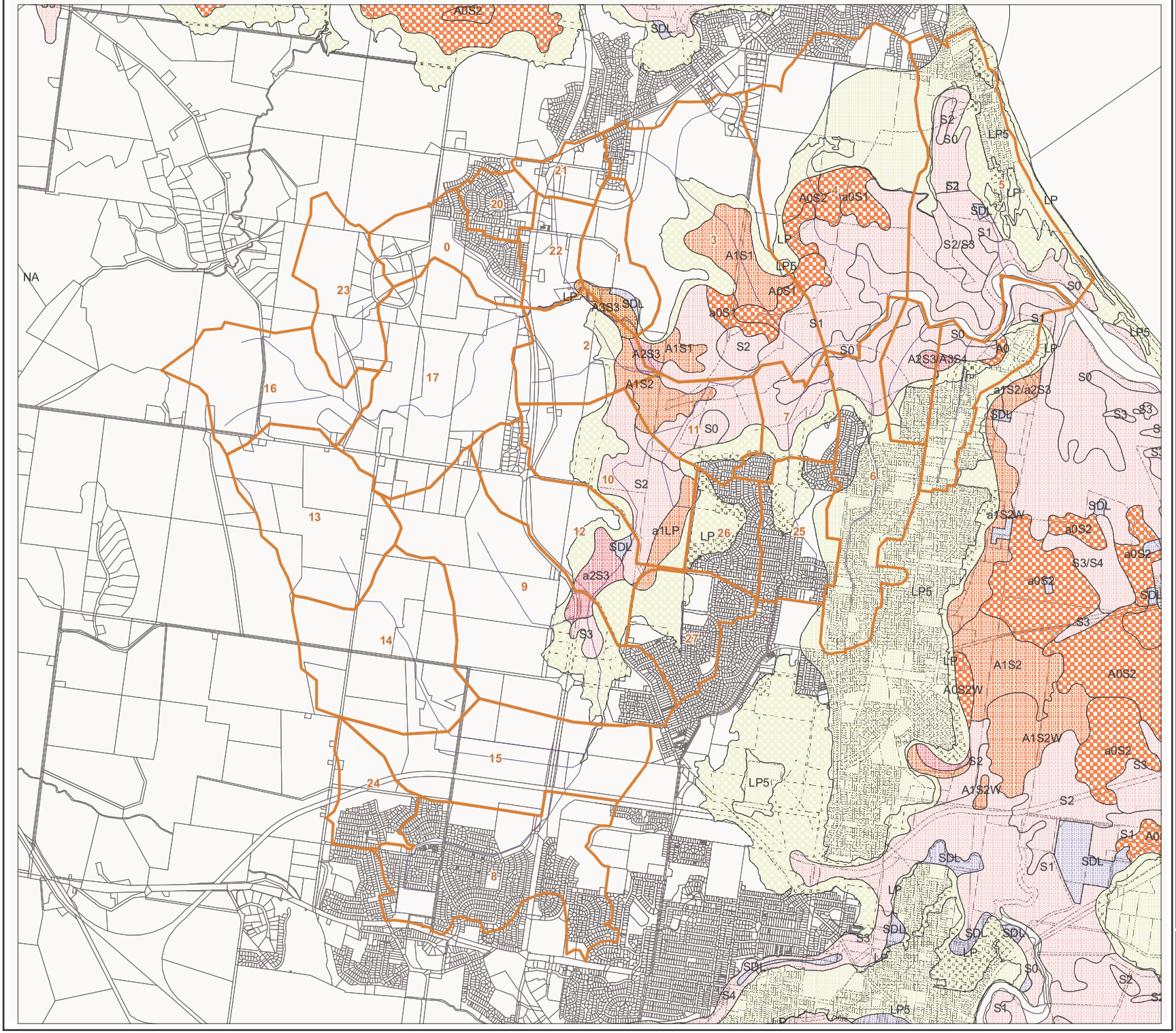
- Great Barrier Reef Marine Park.
- Shorebird intertidal roost areas.
- Blacks Beach Spit and McCreadys Reserve.
- Cultural Heritage Sites.
- Erosion Prone Areas.
- Several remnant perennial freshwater habitats.

2.4.1 Great Barrier Reef Marine Park

McCreadys Creek discharges into a conservation zone (yellow zone) of the Great Barrier Reef Marine Park. This zone extends from the low water mark (MLWS of 0.72m), out to sea. The Conservation Zone (yellow zone) allows for increased protection and conservation of areas of the Great Barrier Reef Marine Park, while providing opportunities for reasonable use and enjoyment, including limited extractive use. Currently, use restrictions due to GBRMPA Zoning apply to that area only.

McCreadys Creek Catchment Management Plan

FIGURE 2-1
Acid Sulfate Soils Map



Acid Sulfat Soils Code - NRM&E Ma

- A0
- a0S0
- A0S1
- A0S2
- A0S2W
- a0S4
- a1LP
- A1S1
- A1S2
- a1S2/a2S3
- A1S2W
- a1S3W
- A2S2
- A2S3
- A2S3/A3S4
- A3S3
- LP
- LP5
- NA
- S
- S0
- S1
- S2
- S2/S3
- S2/S4
- S2W
- S3
- S3/S4
- S4
- S4/S5
- S4/S5+
- S5
- S5+
- S5/S5+
- SDL

Scale: 1:30,000 (A3)

North

DRAFT

Source Information: Mackay City Council

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2.4.2 Shorebird Roosts

A study was undertaken in 2003 by the Queensland Wader Study Group (QWSG) to survey the shorebirds in the Mackay Region. The Mackay Shorebird Project was funded by the Natural Heritage Trust and administered by the World Wide Fund for Nature as part of the Australian Shorebird Conservation Project.

The Mackay Shorebird Project, Final Report (Harding S., et al, November 2003) indicates that two intertidal roosts were studied within/or in close proximity to the McCreadys Creek catchment eg. Blacks Beach (sandy shoreline along Blacks Beach) and Blacks Beach Spit (southern end of the beach at Blacks Beach). The Blacks Beach Spit was highlighted as a significant area for shorebirds as this roost has had up to 584 shorebirds. It was found to be an important roost for the shorebirds feeding on the northern beaches of Mackay. While the roost benefits from being at the end of an undeveloped beach, the proximity to the township of Blacks Beach still means that the roost is subject to considerable disturbance. Suggestions such as penalties for driving within the roost area, constructing a buffer of 200 m around the roost, enforcing speed limits for boats within McCreadys Creek and signage about not disturbing shorebirds were made in the report to limit this disturbance.

2.4.3 Blacks Beach Spit & McCreadys Reserve

The Coastal Planning Unit of the Environmental Protection Agency prepared an assessment of the coastal resources, values, issues and potential threats relating to Blacks Beach Spit in September 2002 (EPA 2002). The report was prepared to assist in assessing the relative priority of these lands for acquisition by the EPA. Econorth, the Mackay Northern Beaches conservation group lobbied for the area to be acquired under the Coastal Acquisition Fund so that it could be managed for its nature conservation values.

Blacks Beach Spit consists of 23.65 ha of freehold land, 10.6 ha of reserved land along the eastern seaward edge of the spit and approximately 17 ha of unallocated State Land. The landform consists of sandy beaches, beach ridges characterised by dunal vegetation, mixed forests and woodlands and a low lying area comprising coastal wetlands (mangroves, supratidal and tidal flats) associated with McCreadys Creek.

The report indicates that the area has value due to the following:

- It lies directly adjacent to the Great Barrier Reef World Heritage Area, which is only one of 15 sites that satisfy all four natural heritage World Heritage listing criteria;
- It is locally significant to residents and visitors as it provides a semi-remote destination for recreation;
- It contributes to the scenic coastal landscape values of the Mackay area; and
- It comprises coastal wetlands that are significant to marine and estuarine biodiversity and assist in stabilising the shoreline.

The report states that the land located on Blacks Beach Spit is of key concern from a coastal management perspective as it is considered to be particularly vulnerable to coastal processes. In terms of the future development threats to this land, it is considered that these are fairly low due to the land being constrained by:

- The erosion prone area which covers a large part of the property including all of the southern portion of the spit (land surrender of the erosion prone area would be sought as part of any subdivision

proposal); and

- Planning schemes provision, which effectively limit any future development potential to the area designated as "Tourism" under the Strategic Plan (which is located outside of the erosion prone area).

The *Mackay Coast, Vegetation, Floristics and Conservation: Inventory, Management and Recommendations*, (Batianoff et al 1997) identifies McCreadys Creek's riparian forest and saline flats and mangroves as part of the relatively small areas of high habitat diversity nominated for conservation of vegetation and flora within the Slade Bay "T-square" green corridor which also consists of coastal areas of Eimeo, Blacks Beach, Andergrove, Slade Bay, Slade Point (Including Slade Point Reserve), Harbour Beach and Mt Bassett. The diverse landscape elements of these areas are integrated as a large and connected conservation unit for the maintenance of indigenous species richness. This corridor is listed as one of the outstanding landscape features of Mackay City as it includes 675 plant species including 491 native and 184 introduced species, from nine major vegetation types present.

2.4.4 Cultural and Historical Significance

Aboriginal Cultural Significance

Traditional owners in Mackay maintain a strong connection to their land and waters through customary practices. The MWNRM Plan identifies that traditional owners in the region would like to increase their role in the management of the lands, coastal mangroves, rainforests and watercourses which have, and provide a valuable food source and cultural resource for the group.

All significant Aboriginal cultural heritage in Queensland is protected under the *Aboriginal Cultural Heritage Act 2003*. The Act defines Aboriginal cultural heritage as anything that is:

- A significant Aboriginal area in Queensland; or
- A significant Aboriginal object; or
- Evidence, of archaeological or historic significance, or Aboriginal occupation of an area of Queensland.

A Cultural Heritage Search for the McCreadys Creek catchment area identified the following recorded Aboriginal cultural sites:

- Site HH:A15 (Trap/Weir); and
- Site HH:A17 (Trap/Weir).

Under the legislation a person carrying out an activity must take all reasonable and practical measures to ensure the activity does not harm Aboriginal Cultural Heritage.

Previous studies in the catchment identified two Native title claims over the area, namely:

- A Wiri-Yuwiburra native title claim No QC98/11; and
- A Yuibera native title claim No. QC98/37.

Native title claims cannot encompass road reserves or freehold land.

Heritage Significance

The Queensland Heritage Register held by the Queensland Environmental Protection Agency and the Register of the National Estate held by the Australian Heritage Commission were checked to determine any sites of significance within the catchment. Sites located in close proximity or within the catchment

include:

- Old Richmond Mill (Ruins), Habana Rd, Mackay, QLD (indicative place).
- The Great Barrier Reef Region (registered).
- Slade Point Wetlands and Dune Association (registered).

2.4.5 Erosion Prone Areas

The Beach Protection Authority's Erosion Prone Areas Plan for Mackay City identify that erosion prone areas are 80 m to 140 m wide along Blacks Beach. This area adjoins the north-eastern boundary of the catchment. The erosion prone area extends for 400 m into McCreadys Creek. This coastal management district extends to either HAT (approx 3.5 m AHD) or 40 m beyond MHWS (2.34 m AHD) whichever is greater.

An erosion prone area is declared under Section 70(1) of the *Coastal Protection and Management Act 1995* to be an area within the coastal zone that may be subject to erosion or tidal inundation. Erosion prone areas are part of the active beach system and are normally subject to natural cycles of erosion and accretion of sand. Development in these areas may trap and prevent sand from being included in these natural beach movements and have adverse consequences on the adjacent beach.

2.5 Existing Conditions

2.5.1 Site Inspections

Site inspections were undertaken by various members of the project team including GHD's Robyn Birkett, senior ecologist Andrew Small and environmental scientist Nadine Flor. Key features identified during the site visits are:

- The alignment and form of tributaries of McCreadys Creek, particularly the southern branches have been modified in several locations including channel straightening. This is particularly evident from Mount Pleasant to Golflinks Road.
- The lowland catchment areas are impacted by grazing activities and exotic weeds.
- Channelised sections of McCreadys Creek are infested with paragrass.
- There are several man made ponds in the catchment. These are located in the vicinity of the golf course, in the northern catchment of McCreadys Creek to the east of Mackay Bucasia Road, at Northview Gardens, Glenella, at Kimberly Estate and to the south of Blacks Beach.
- Formal detention basins are constructed at Premier Gardens, just upstream of Mackay Bucasia Road at Rural View and at Broomdykes Road, Beaconsfield.

2.5.2 Current Landuse

A summary of current land uses in the catchment is provided in Table 2-2.

Table 2-2 McCreadys Creek Current Land Use

Zone	Area	% of Landuse
Rural (predominantly agriculture)	1894 ha	61%
Residential	592.3 ha	18.5%
Park Residential	63 ha	2.0%
Commercial	1.7 ha	0.5%
Open Space	561	18.0%
Total	**3,112 ha**	**100 %**

The total catchment area is 3,112 ha and the major landuse in the catchment is rural development, predominantly agriculture and sugarcane cultivation. Residential development encompasses approximately 21 % of the catchment area.

2.6 Future Conditions

2.6.1 Summary of Proposed Development

There are a number of developments proposed (or currently under construction) within the McCreadys Creek catchment. Development include:

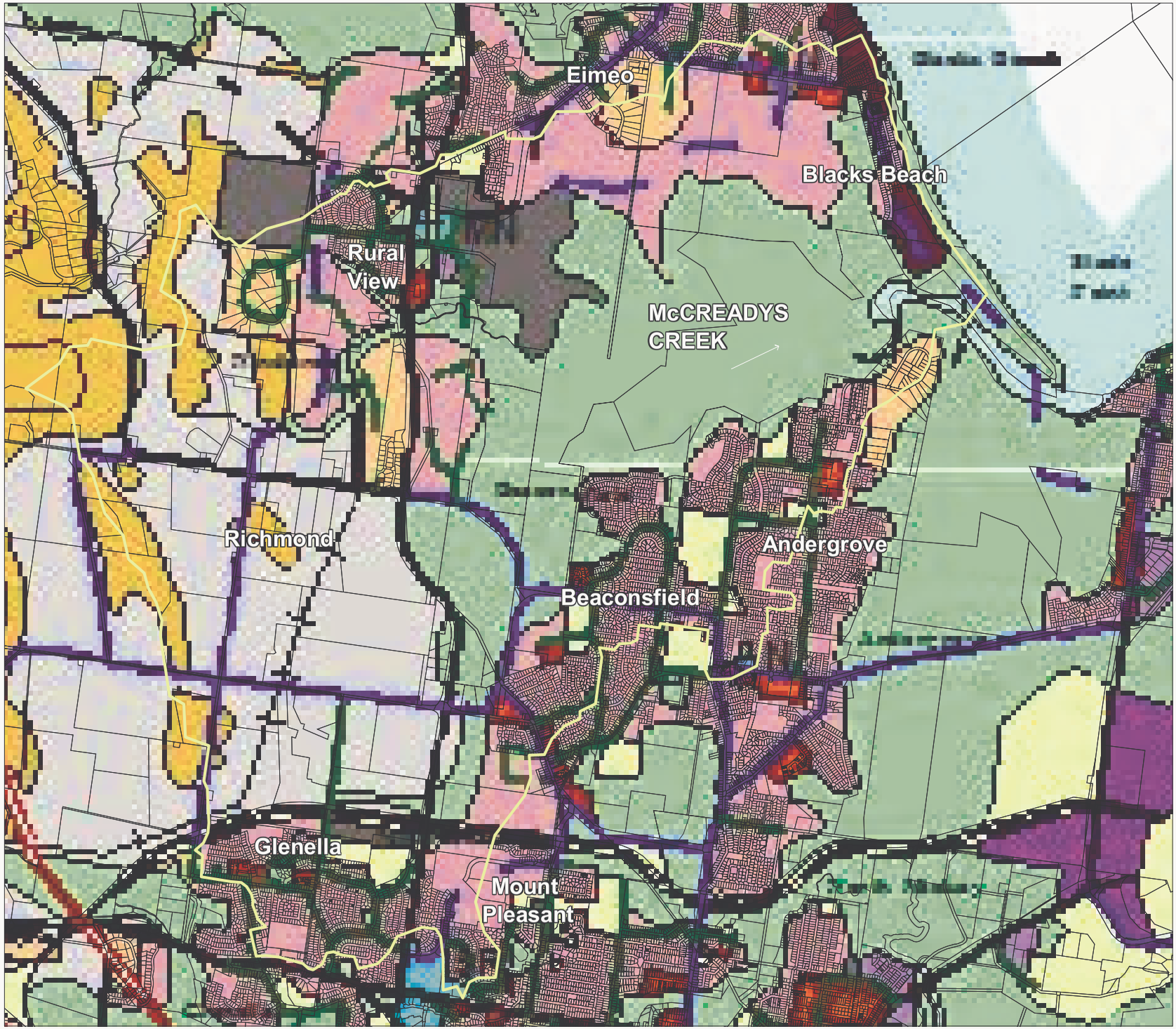
- Palm Gardens (Plantation Palms Properties Pty Ltd (formerly Eulbertie Park) – a residential estate.
- Eulcom Pty Ltd Commercial Development – a commercial district linking with the current commercial enterprises bounded by Mackay Bucasia Road and the Eimeo bypass road.
- Shuttlewood Land Development – a residential development bounded by Mackay Bucasia Road to the west, the eastern tributary of McCreadys Creek to the north and Golf Links Road to the south.
- Cain Development – a residential development bounded by Blacks Beach Road to the north and existing park residential development to the east.
- Mackay Bucasia Road – duplication of the arterial road (to four lanes) from Mackay Habana Road to Sologinkins Road.
- Sub-arterial road linking Blacks Beach Road with the Eimeo Bypass Road.

2.6.2 Strategic Plan

The Mackay Strategic Plan was overlain with a catchment plan to produce an estimate of the relative proportion of each of the future land use categories. Adjustments were then made to allow for open space contributions in urban land. The Strategic plan and catchments can be seen in Figure 2-2.

McCreadys Creek Catchment Management Plan

FIGURE 2-2
Catchment & Strategic Plan



- Urban Residential
- Higher Density Residential
- Future Urban
- Commercial
- Major Business/Industry
- Service and Commercial Industry
- Special Uses and Reserves
- Open Space and Recreation
- Rural
- Rural Agriculture
- Rural Residential
- Park Residential
- Village
- Tourism

DRAFT

North

Source Information: Mackay City Council.

GHD MANAGEMENT ENGINEERING ENVIRONMENT

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2.6.3 Changes to Catchment

A summary of the proposed changes to the existing catchment are described in Table 2-3.

Table 2-3 Summary of Changes to Catchment

Development Type	Existing Area	Increase in Area	Future Area	% Increase
Urban Residential Development	594 ha	557 ha	1,151	94 %
Park Residential Development	62.6 ha	84.6 ha	147.2	135 %

It is estimated that residential development in the catchment is likely to almost double in area within the next 5 to 10 years. The increase in urban and park residential developments is at the expense of rural land, mostly used for either sugar cane cultivation or grazing.

Table 2-4 identifies the landuse areas and proportion of the catchment for the future catchment. The table shows that residential development will comprise similar areas to rural developments in the catchment.

Table 2-4 McCreadys Creek Future Land Use

Landuse Type	Area	% of Landuse	% Change
Rural (predominantly agriculture)	1,251.1 ha	40.2%	-34%
Residential	1151 ha	37.0%	94%
Park Residential	147.2 ha	4.7%	134%
Commercial	1.7 ha	0.1%	0 %
Open Space	561	18.0%	0 %
Total	**3,112 ha**	**100 %**	

Given the significant changes in the catchment and the potential for adverse impacts if sufficient controls are not in place, McCreadys Creek is a “high risk” catchment. The development and implementation of actions from this catchment management plan will reduce the potential for adverse impacts.

3. Waterway Assessment

An inspection was undertaken of McCreadys Creek and its tributaries, with the main point of emphasis being the riparian vegetation of McCreadys Creek, its ecological significance and the presence of any rare or threatened species. A desktop analysis was then undertaken to assess the likely impacts of further development and to identify possible mitigation measures.

3.1 Aquatic Fauna

3.1.1 State of Aquatic Fauna Associated with the Waterways

The findings from previous investigations in McCreadys Creek and the site visits were used to identify the state of aquatic fauna in the Creek.

The more natural reaches of McCreadys Creek, such as the western tributary, provide good habitat for a wide variety of fish species as they provide natural variation in habitat, good riparian vegetation, good water quality and adequate depth of water for fish to survive a drought. The channelised reaches of the Creek however lack such features and do not provide much habitat for fish. Despite this, discussions with local fisherman indicated that large fish such as Mullet have been caught in the channels near Golflinks Road.

A fisheries assessment of McCreadys Creek was undertaken as part of the *Rehabilitation of Freshwater Drains Project* (DPI&F 2003). The McCreadys Creek site was located just downstream from Mackay Bucasia Road. The site was used along with a site in Reliance Creek, to assess natural variability over the period of study and as a benchmark to compare the effect of the works on the rehabilitated Vines Creek site. The site was sampled using an electrofisher and the following fish identified in McCreadys Creek:

- Oxeye herring (3);
- Empire gudgeon (382);
- Mosquitofish (11);
- Rainbowfish (9);
- Snakeheaded gudgeon (6);
- Marbled eel (20);
- Guppy (15);
- Pacific short-finned eel (1); and
- Spangled perch (8).

McCreadys Creek is a popular recreational fishing destination in Mackay with whiting, flathead, bream, and juvenile barramundi reported to inhabit the McCreadys Creek estuary (*Mackay Fishing & Boating 2000 Edition).*

3.1.2 Impacts of further development and mitigation

Reaches at Risk

The lower tidal and middle freshwater reaches are most at risk from ongoing development. These areas of the catchment are where the Strategic Plan shows Future Urban development. The upper catchment is mostly used for sugar cane production and is not likely to be developed within the next 15 years.

Development may impact upon the aquatic fauna through:

- Altered flow regimes such as from the increased volume and peak flows from increased impervious areas associated with urbanised catchments.
- Water quality through the introduction of stormwater runoff, direct contamination, litter and loss of riparian and instream vegetation.
- Habitat complexity, through increased channelisation, clearing of riparian vegetation and modified bed and bank morphology from altered flow regimes.

Mitigating Development Impacts

Measures to mitigate or minimise the impacts of further development should include:

- Reduce contamination in stormwater runoff through the installation of water control measures such as GPTs, constructed wetlands, vegetated swales, bioretention systems.
- Reduce stormwater flows to pre-development conditions through use of on-site detention, regional detention basins and infiltration devices.
- Enhance (rehabilitate) habitat complexity and quality through replanting emergent and riparian vegetation.
- Eradicate exotic weeds such as para grass.
- Enhance habitat complexity through the addition of physical features such as wetlands, varied water depths and snags.
- Foster Water Sensitive Urban Design within the catchment.

3.1.3 Recommendations for Protection of Aquatic Fauna

Responsible management of stormwater inflow and the incorporation of adequate buffers between development and waterways are recommended as the two measures most critical to protecting the health and biological diversity of the waterways of McCreadys Creek.

Rehabilitation of waterways involves reconnecting the watercourses to its floodplain, and specifically re-creating particular types of habitat that would boost fisheries production (as well as a wider range of aquatic organisms).

The DPI&F was involved with the Whitsunday Natural Resource Management Group (MWNRMG) on the *Rehabilitation of Freshwater Drains Project* (DPI& F 2003). The project rehabilitated fish habitat along a 200m section of Vines Creek in North Mackay, potentially a significant freshwater nursery habitat in the Lower Pioneer River System. The project also provided an educational focus for freshwater fish habitat rehabilitation in the Mackay Whitsunday Region. The project was a success from both a fish habitat rehabilitation and educational point of view, with hundreds of fish successfully utilizing the modified habitat and numerous community and local authority groups visiting the rehabilitation site to see the

implementation of freshwater fish habitat rehabilitation technology.

Photo 3-1 Vines Creek Rehabilitation of Drains Project (Source: DPI&F 2003)

3.2 Flora

3.2.1 Introduction

This section of the report provides details of waterway riparian vegetation and component flora. Field surveys and aerial photographic interpretation combined with a literature search revealed the current status of the various stream elements, which comprise the waterways of McCreadys Creek.

These studies were utilised to develop a series of strategies designed to maintain and enhance or rehabilitate noteworthy or otherwise significant segments of the stream with respect to future development.

Vegetation and the ecological status of such areas in the McCreadys Creek Catchment are shown on Figure 3-1, and Figure 3-2 (respectively).

3.2.2 Site Descriptions

Descriptions of the sites visited are provided below. Field sheets and photos are contained in Appendix A.

Site 1: Lower end of catchment, estuary mouth

High integrity estuarine mangroves dominated by Rhizophora and Brugiera on estuary side. Moderate integrity woodland on dunes on landward side. Evidence of fire, rubbish (vehicle bodies) extensive clearing associated with tracks and weeds are present. Woodland dominated by *Corymbia tessellaris* with Acacia and Melaleuca associates in swales. Understorey predominantly grassy.

Site 2: Swale behind subdivision.

Melaleuca leucadendra dominated swale community. Evidence of dieback along swale edge probably owing to modified drainage regimes. Swale tidally influenced. Surrounding sclerophyll woodland affected by fire, rubbish and recreational use.

Site 3: Overview of McCreadys Creek lower estuary wetland

Mosaic of vegetation types. Rhizophora/Brugiera dominated verges to tidal creek areas. Low Ceriops, Osbornia, Avicennia shrubland is the major vegetation on landward side of vegetation with extensive areas of saltpan and samphire flats (*Sporobolus virginicus*). Where there is freshwater influence, swales are lined with Melaleuca leucadendra. On the outermost fringe of the wetlands there are areas of alluvium with Eucalyptus tereticornis. Some minor woodland associated with Melaleuca swales with *Corymbia tessellaris* and Acacia. Integrity of overall system moderate to high, excepting in *E. tereticornis* remnants (highly fragmented and disturbed), and along edges abutting urban development areas (sedimentation and weed issues).

Site 4: Mid reaches of McCreadys creek

Riparian vegetation restricted to less than 5 m wide in total. Limited canopy cover, most common species *Terminalia sericocarpa, Syzygium tierneyanum* and *Mangifera indica*. Some other vine forest species including palms (Livistonia) and figs (Ficus spp). Highly disturbed environment, weeds are dominant, notably Tithonia diversifolia (Japanese sunflower), *Urochloa mutica, Sphagneticola trilobata*. Adjacent landuse is sugar cane, with regular spraying encroaching into riparian areas.

Site 5: Upper reaches of McCreadys Creek

No continuous native riparian vegetation. Creek is a drainage line, with only isolated examples of *Nauclea orientalis*. Drainage line is dominated by *Tithonia diversifolia* (Japanese sunflower), and *Panicum maximum* (guinea grass).

Site 6: Overflow from detention basin near golf course

Constructed drain. Natural drainage channel straightened. Low lying flood plain on silt and alluvium, no native vegetation present. Surrounding landuse grazing. Common weed species *Urochloa mutica* (para grass), choking upstream section.

Site 7: Open cane drain, highly modified drainage line

Entirely choked with *Ipomea aquatica, Persicaria attenuata and Urochloa mutica*. Native trees restricted to isolated examples of *Syzygium tierneyanum*, otherwise no tree cover at all. Downstream of road the channel has recently been excavated.

Site 8: Open urban drain near High School

Grassed and concreted spoon drain, emptying directly into McCreadys Creek wetland. Sediment deposited from drain into Avicennia, Melaleuca, samphire wetland. Sediment deposition at end of drain into wetland has resulted in dense infestation of *Urochloa mutica* in this area. No gross pollutant traps on drain. Litter (abandoned bikes, plastics – bottles and bags,) abundant. Established urban area catchment.

Site 9: Open drain, end Emperor Drive

Partially concreted open spoon drain emptying into drainage channel. Drain dominated by introduced *Urochloa mutica*, rubbish present. Silts are deposited directly into low Ceriops/Avicennia shrubland mangrove communities from the drain. Developing urban area catchment.

Site 10: Informal boat ramp, near Apsley Way, southern side of estuary

Estuarine environment, high integrity Rhizophora/Brugiera vegetation community along estuary.

Site 11: Upstream McCready Ck, Mackay Bucasia Road

Moderate integrity riparian vegetation with mixed riparian vine forest and sclerophyll elements. Riparian verge varies from 7 to 12 m in width, however vegetation confined to within high points of the bank. Some evidence of fire. Canopy broken with weeds including guinea grass, Singapore daisy and Japanese sunflower established along edges. Some woodland elements on outmost riparian verge include pandanus and *Eucalyptus platyphylla*. Soils are generally more clay in composition than downstream.

Site 12: McCreadys Creek upstream of Mackay Bucasia Road

Moderate to high integrity notophyll vine forest with tall (to 25m) emergents of *Terminalia sericocarpa* diagnostic of the vegetation. Riparian vegetation is original remnant vegetation, with a number of large trees present. Vegetation varies in width from 10 to 20 metres, however does not extend beyond the high point of the bank. Weeds are restricted to the margins of the vegetation, limited to the ecotone only. Either side of the creek is maintained as a headland for agricultural purposes, and weeds are generally controlled. Diversity of riparian vegetation is high, and constitutes a moderately effectively buffer zone for water quality purposes.

Site 13: Open urban drain into wetland areas

No native vegetation, drain densely infested with introduced species, notably *Urochloa mutica*, and rubbish is evident. No gross pollutants traps observed and high levels of silt deposition evident. Drain empties directly into samphire and low mangrove shrubland. Developing urban area catchment.

Site 14: Closed urban drain

Drain is subterranean beneath existing developed urban catchment area, empties directly into mangrove wetland community adjacent park. Evidence of minor siltation and minor weed infestation, however drain outlet is shaded by large trees, mitigating weed impact. No pollutant traps, plastic bags and bottles directly carried into mangrove wetlands.

3.2.3 State of the Flora of the Study Area

A narrow strip of riparian vegetation exists along some of the western tributaries of McCreadys Creek; this can be distinguished from the aerial photography. The southern tributary of McCreadys Creek is a channel infested with weeds and primarily provides a drainage function. Drains discharging from the urbanised areas in the suburbs of Beaconsfield, Kimberly Estate and Andergrove have contributed to the introduction of weeds such as paragrass into the wetland areas.

The vegetation within the McCreadys Creek Catchment area is sparse, with the majority of the catchment being used for sugarcane or residential development. Most of the existing vegetation within the catchment is noted as having an Ecological Status of Regionally Significant Natural Areas of High Conservation Status, which is an area that is poorly conserved and/or has a major functional role in the landscape and has a Regional Vegetation Status of ‘endangered’ or ‘of concern’.

The Ecological Status of the remaining vegetation within the catchment is:

- Regionally Significant Natural Areas (Habitat Maintenance) – large areas that are either poorly conserved and/or have a major functional role in the landscape;
- Core Ecological Areas and Corridors (High Conservation Status) – areas that are either poorly conserved and/or have a major functional role in the landscape (smaller areas that Regionally

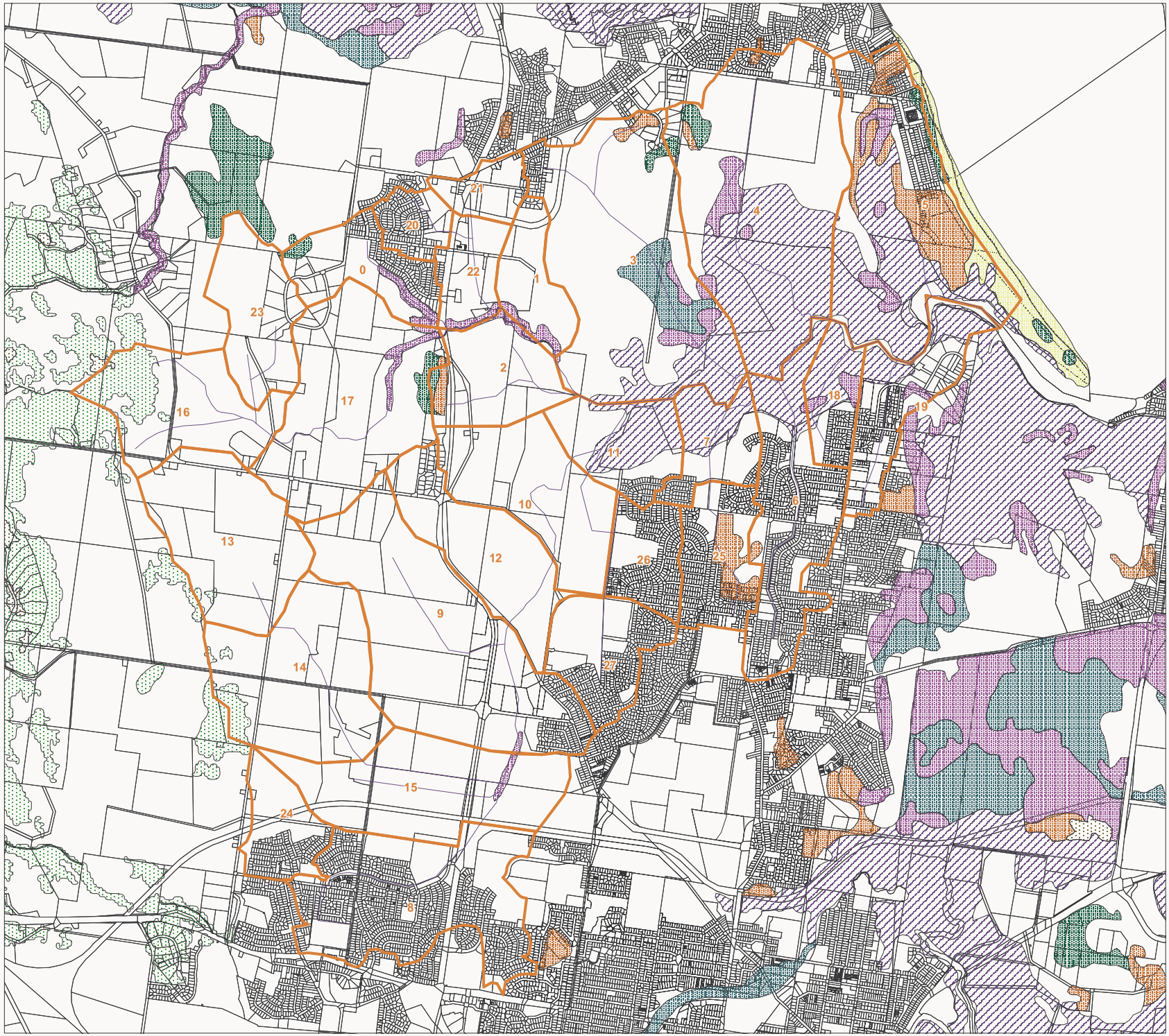
Significant Natural Areas);

- Isolated Small Remnants and other Highly Modified Areas – has a remnant size of < 5 ha and does not fit into other categories;
- Other Significant Remnants (including disturbed Riparian areas) – identifies those areas with fewer of the spatial characteristics identified for the above categories. These areas however, may be quite significant at a local level, and contain areas that can make a significant contribution to the overall ecological values.

These vegetation descriptions have been adopted from the *Natural Environment Plan* for Mackay City Council (2001).

The Mackay area also has various vegetation species that are significant to the area. *Acacia dietrichiana* is a small shrub listed as “Locally Very Rare” and found near McCreadys Creek.

Mangrove dieback, restricted predominantly to *Avicennia marina* (Grey Mangrove) is present in the McCreadys Creek estuary.



McCreadys Creek Catchment Management Plan

FIGURE 3-1
Vegetation Map

Vegetation - Broadtype

- Estuarine Complexes
- Eucalypt and Related Forests / Woodlands
- Foredune Complex
- Heathland / Shrubland
- Highly Modified / Disturbed
- Highly Modified / Disturbed (Clearings within bush
- Melaleuca Forests
- Other remnant vegetation outside study areas
- Rainforest Communities
- Rocky Seashore
- Sedgelands and Related Communities

McCreadys Subcatchment

Boundary

McReadys Creek

Main Waterways

DRAFT

Scale: 1:30,000 (A3)

North

Source Information: Mackay City Council

GHD MANAGEMENT ENGINEERING ENVIRONMENT

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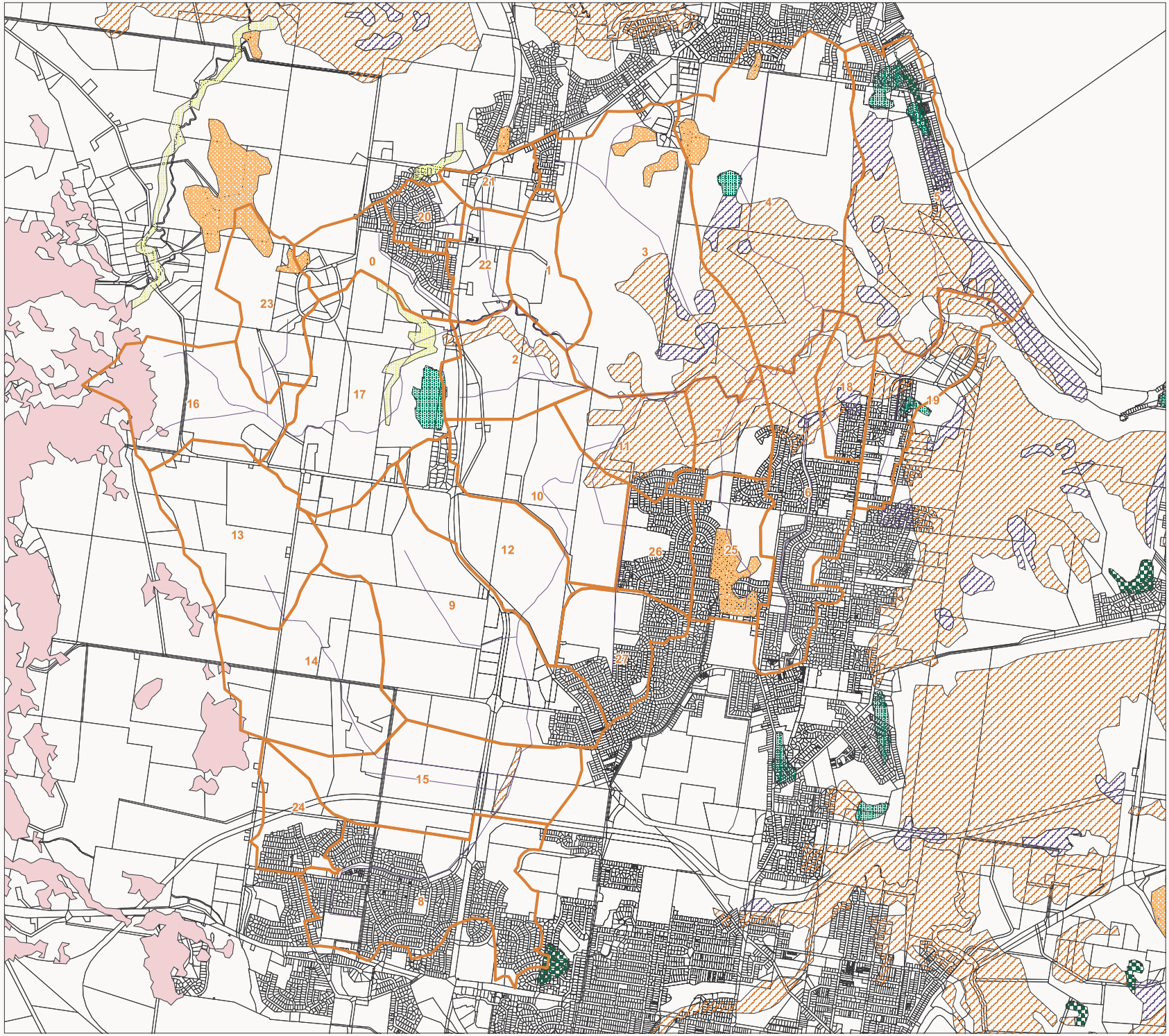

McCreadys Creek Catchment Management Plan

FIGURE 3-2
Ecological Status Map

Ecological Status

- Core Ecological Areas and Corridors (Habitat Maintenance)
- Core Ecological Areas and Corridors (High Conservation Status)
- Isolated Small Remnants and other Highly Modified Areas
- Not Assessed (Vegetation outside study areas)
- Other Significant Remnants (Including disturbed Riparian areas)
- Regionally Significant Natural Areas (Habitat Maintenance)
- Regionally Significant Natural Areas (High Conservation Status)

McCreadys Catchment

Sub Catchment Boundaries

DRAFT

Scale: 1:30,000 (A3)

North

Source Information: Mackay City Council

GHD MANAGEMENT ENGINEERING ENVIRONMENT

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3.2.4 Current Threatening Processes

The most obvious threat to the natural values of the study area is the loss of remnant riparian vegetation, with chronic threats of weeds, altered hydrological regimes and increased nutrient and sediment loads in the waterways. These processes contribute to long term degradation and loss of natural values.

The disturbance of the soil profile and sediment mobilisation during development activities can increase the nutrient and sediment loads in the waterways during the construction phase of a development. These impacts diminish with the sealing of roads, housing and landscape works. The new surfaces however are either more impervious or provide on-going sources of nutrient inputs (eg. nutrient leaching from gardens and lawns). This alters the biophysical relationships within the waterways. Combined with waterway eutrophication, invasive weed species exacerbate the depletion of natural values and lead to the inevitable loss of native biota.

These threatening processes are similar to most, if not all other coastal lowland areas of Queensland.

3.2.5 Future Management Issues and Options

Chanelled sections of the waterways in the urbanised, middle sections of the catchments are not sites, which could be feasibly rehabilitated with native vegetation. This is because they have been designed for drainage and to do so would affect the hydraulic efficiencies of the channel and potentially cause flooding. As such these reaches are not suggested for rehabilitation and are not dealt with further in the future, however rehabilitation works should be encouraged if development occurs in these areas, or funding is allocated for rehabilitation of these types of drainage systems.

The sections of waterways downstream of developed areas and within future development areas can be rehabilitated if appropriate measures are undertaken to encourage or enhance natural recruitment of the native biota. A major impediment to natural regeneration processes is the invasive weed species. The weed species must be eradicated or controlled and the area maintained weed free to allow seedlings to grow unhindered and provide more suitable conditions for further germinations and establishment of native flora to occur along the modified banks.

Waterway corridors, which consider the hydraulic effects of a more natural system, (eg increased hydraulic roughness) could be incorporated into development conditions to ensure that the waterways provide for the two desired functions, namely hydraulic capacity/regime and water quality. For this to occur, the width of the waterways is likely to be wider than those in the channelised reaches of already developed catchments.

Channels in a highly degraded state are presently stabilised by weed infestations, which prevents erosion and slumping. A feasible option is to commence a series of dense trial planting and rely on shade from their developing canopy to reduce weed management needs and allow for colonisation. Weed maintenance however will be required on a continual basis due to the numerous sources of weed propagules in the contiguous landscapes. Trials would be required to determine the most efficacious means of rehabilitating these areas, as no examples are available for formulation of a plan.

The most appropriate catchment wide strategy to adopt to maintain and enhance the environmental values in the catchment is to build on the viable remnants requiring minimal inputs to restore their self sustaining ecology and then direct efforts towards more problematic areas requiring longer term rehabilitation needs.

Riparian management of fresh and tidal waterways needs to balance a range of issues in a sustainable

way, including:

- native vegetation, weeds, ecological processes, habitat and shading;
- recreational use/access;
- bank stability, erosion, vegetation and cattle access;
- best practice land use management, stormwater runoff, buffers and filter strips; and
- flooding.

Stormwater runoff is water that flows from the land into waterways during or after rainfall. Stormwater carries sediment, nutrients, organic matter, metals, pesticides, hydrocarbons and rubbish into water ways. While waterways need a certain amount (sometimes called a “benchmark”) of sediment, nutrients and organic matter to maintain their ecosystems, they are degraded by:

- excess sediment, nutrients and organic matter; and
- other pollutants, such as pesticides, hydrocarbons and rubbish.

3.3 Water Quality

There is limited water quality data available for waterways within the McCreadys Creek Catchment. Data available has been identified in the following reports:

- Mackay Mangrove Dieback Study (Duke et al,. 2003); and
- McCreadys Creek Mackay Water Quality Monitoring Program and Baseline Survey (Connell Wagner 2004)

The Mackay Mangrove Dieback Study undertook surface water measurements in 2002 at five sites located in the tidal reaches of Mcreadys Creek and from water that seeped into holes (4 sites) that were dug into mangrove sediment.

A summary of the findings on water quality within McCreadys Creek is presented in Table 3-1.

Table 3-1 Summary of findings on water quality within McCready’s Creek from Duke et al., 2003

Water Quality Parameter	Discussion
Surface Water	
Total Suspended Solids	◗ Sechi depth, which indicates the level of total suspended solids in the water column was reported to be lower, upstream in Mcreadys Creek. This result was consistent with other creeks in the area indicating increased turbidity in upstream sites.
Temperature	◗ Temperature ranged between 24°C and 26°C.
Salinity	◗ Surface water salinity ranged between 25% to 37%, which increased towards the mouth of the river.
pH	◗ pH levels were within ANZECC (2000) guideline values of 7 to 8.5.
Dissolved Oxygen	◗ Dissolved oxygen levels were below the guideline levels for slightly disturbed ecosystmens in tropical Australi (80-120%) in all McCreadys Creek water sampling sites. One site, MCW2 was 54.9% compared to the guideline value of 80-120%.

Water Quality Parameter	Discussion
Chlorphyll a	◗ Three of the five water samples analysed for chlorophyll a exceeded the values for tropical Australian for slightly disturbed ecosystems (0.002 mg/L). ◗ Chlorophyll a levels in McCreadys Creek were lower than Pioneer River and Bakers Creek levels however these both had higher DO levels than McCreadys. These low values indicate some water quality problems which need to be investigated further.
Core Water	
Phosphorus	◗ All samples exceeded the ANZECC (2000) guidelines for Total P. The three samples tested ranged in value from 3.4 to 3.7 mg/L for Total P.
Nitrogen	◗ All samples exceeded the ANZECC (2000) guidelines for Total N. The three samples tested ranged in value from 0.51 to 1.1 mg/L for Total N. Levels of nutrients are high for healthy tropical estuarine ecosystems.
Herbicides	◗ Diuron was detected at all four core water sampling sites. Diuron concentrations ranged from 3.32 to 8.36 ng/L. Ametryn, Hexazinone, Tebuthiuron and Simazine were also detected at some of the sites.

Duke et al. (2003) recommended that steps be taken to reduce the amount of nutrients reaching these waters (ie waters of Pioneer, Bakers and McCreadys Creeks) as levels of nutrients were high for healthy tropical estuarine ecosystems.

Connell Wagner Pty Ltd was presently undertaking a baseline survey of water quality in McCreadys Creek in 2004 on behalf of adjoining land developments. Three sites were assessed and were located in the western reach of McCreadys Creek in the vicinity of Mackay Bucasia Road. The program was required as part of the conditions of the environmental authority issued by the EPA for proposed development works around the area, and for MCC Development Approval. Baseline sampling was to occur on a monthly basis for six months prior to construction activity. The report discussed sampling undertaken in May 2004, which analysed parameters for:

- Temperature;
- Dissolved Oxygen;
- pH;
- Electrical Conductivity;
- Turbidity;
- Total Dissolved Solids;
- Suspended Solids; and
- Total Recoverable Hydocarbon.

The results were compared to the *Australian and New Zealand Conservation Council 2000* (ANZECC 2000) and indicated that the water quality parameters were generally within the expected ranges for tropical Australia. Of significance were the low dissolved oxygen levels at the three sites (around 2 mg/L) and these are well below the ANZECC 2000 trigger values. These levels could be attributed to time of day, solar radiation, turbidity, macrophytes and riparian vegetation. No petroleum hydrocarbons were identified above detectable limits at any of the three sample locations.

4. Environmental Values & Water Quality Objectives

4.1 Introduction

Environmental Values (EV) represent what stakeholders want, or value, in their waterways. EVs are not determined by scientific method, but by community preference and reasonable judgement. They are qualities or characteristics of a waterway that support healthy ecosystems and the community's livelihoods and lifestyles.

The five main categories of environmental values to be protected under section 7 of the EPP Water are identified in Table 4-1.

Table 4-1 Environmental Values

Aquatic Ecosystems
◗ Aquatic Ecosystem - plants, animals and their ecological interactions
◗ Wildlife Habitat - riparian wildlife and their habitat, food and drinking water
◗ Human Consumption - health of humans consuming produce (fish etc) from the ecosystem
Recreational water quality and aesthetics
◗ Primary Recreation - health of humans during recreation that involves direct contact with the water such as swimming
◗ Secondary Recreation - health of humans during recreation that involves indirect contact with the water such as fishing, boating, rowing.
◗ Visual Recreation – amenity of waterway for recreation (no contact with water) such as walking and picnicking adjacent to a waterway
◗ Cultural Heritage – indigenous and non-indigenous cultural heritage such as custodial, spiritual, hunting, gathering, ritual responsibilities, landmarks etc
Agricultural water use
◗ Farm domestic supply; ◗ Irrigation of crops; and/or
◗ Stock watering.
Industrial water use
◗ Water that is used for industrial purposes.
Drinking water
◗ Water requiring minimal treatment before supply as drinking water.

The EVs for McCreadys Creek were derived by views of community and stakeholder groups and observation. These are discussed in the sections below.

4.2 Consultation

4.2.1 Stakeholder Consultation

The stakeholders were consulted to identify information available for use in the Catchment Management Plan (eg water quality monitoring data, other environment studies). Stakeholders included:

- Mackay City Council;
- The Department of Natural Resources, Mines and Energy;
- MWNRM Healthy Waterways Program;
- Department of Primary Industries and Fisheries;
- Environmental Protection Agency;
- Pioneer Integrated Catchment Management Association (PICMA);
- Urban Development Institute of Australia (UDIA);
- Canegrowers;
- Sunfish; and
- Yuibera Aboriginal Group.

4.2.2 Community Consultation

A Public Meeting was held on Wednesday, 21 July 2004 at the Northern Beaches Bowls Club to discuss the USWQMP and the McCreadys Creek Catchment Management Plan. The community was informed of the event by a variety of different measures such as:

- A public notice and article in the Mackay Daily Mercury.
- Advertisement as part of the Mackay City Communique in The Mackay Midweek paper and on radio.
- An email invitation to a targeted list of individuals and groups with an interest in the plan, such as:
  - planners, engineers, surveyors and developers;
  - government departments/agencies;
  - environmental/natural resource management groups and organisations; and
  - recreational waterway users.

The meeting was attended by 48 persons. The agenda for the meeting consisted of:

- Project Overview.
- How Stormwater Quality is Managed in the Mackay Urban Areas.
- Workshop 1 - Identification of Urban Stormwater Quality Issues in Mackay.
- Catchment Management Plans - McCreadys Creek Case Study.
- Workshop 2 - McCreadys Creek Environmental Values.

- Closing Session - Sum Up Outcomes, Your View, Study Team's View, Where to From Here.

The outcomes from the workshops, specifically in relation to McCreadys Creek were as follows:

Table 4-2 Uses associated with the McCreadys Creek Catchment

Uses	Responses	
Identified uses of the catchment and waterways	• Fishing (creek and mouth) • Crabbing • Fish nursery – permanent facility • Revegetation – ongoing • Walking and bushwalking	• Golf • Employment – farming (turf farm), construction, development, quarrying, fisheries, shopping, commercial, education, gardening • Residential

Table 4-3 Environmental Value rankings for McCreadys Creek Catchment

Environmental Value	Ranking of Value
• Aquatic Ecosystem - plants, animals and their ecological interactions	High
• Wildlife Habitat - riparian wildlife and their habitat, food and drinking water	High
• Human Consumption - health of humans consuming produce (fish etc) from the ecosystem	High
• Visual Recreation – amenity of waterway for recreation (no contact with water) such as walking and picnicking adjacent to a waterway	Medium/high
• Secondary Recreation - health of humans during recreation that involves indirect contact with the water such as fishing, boating, rowing.	Medium
• Cultural Heritage – indigenous and non-indigenous cultural heritage such as custodial, spiritual, hunting, gathering, ritual responsibilities, landmarks etc	Medium
• Farm domestic supply; • Irrigation of crops; and/or	Medium
• Stock watering.	Medium
• Water requiring minimal treatment before supply as drinking water.	Low/medium
• Primary Recreation - health of humans during recreation that involves direct contact with the water such as swimming	Low
• Water that is used for industrial purposes.	Low

Table 4-4 Threats to Aquatic Ecosystems and Ameliorative Measures

Threats	Solutions / Ameliorative Measures^
◗ Development ◗ Inappropriate development ◗ Salinity ◗ Riparian vegetation ◗ Urban encroachment = development ◗ Recreational use ◗ Pollutants	◗ Improved buffers ◗ Management of amount/quality of stormwater ◗ WSUD (Water Sensitive Urban Design) ◗ Controls on development ◗ Enforcement (particularly for ESC)

^ Note that not all groups were able to contribute due to time constraints on this question.

In summary, the outcomes from the public meeting were:

- Aquatic ecosystems were identified as being the highest environmental value for the McCreadys Creek Catchment.
- Encroachment from urbanisation and infrastructure was identified as the major threat to McCreadys Creek's aquatic ecosystem; and
- Suggestions to alleviate this threat include increased buffer zones around waterways, management of the amount and quantity of stormwater and WSUD (Water Sensitive Urban Design).

The public consultation meeting did not highlight much in regards to the cultural heritage values of the catchment. Further investigation into the cultural heritage values of the catchment was therefore completed as discussed in the section below.

Cultural Heritage

Discussions were held with Gary Mooney, a local representative from the Yuibera group to discuss the cultural heritage values of McCreadys Creek. Mr Mooney identified:

- Traditional owners use the McCreadys Creek catchment for fishing, hunting and gathering and the catchment has high cultural heritage values.
- The major pressure/threat to the high environmental values is wash-off from the catchment areas.
- Traditional owners have strong linkages with the regions's waterways and beaches. Sites of cultural significance are concentrated in these areas as the watercourses and beaches provide a source of food, bush medicine and recreation/amenity. Items of cultural significance that may be found in Mackay's waterways, catchments and beaches include fish traps/weirs, burials (eg.bones), hunting tools, shell middens etc. There are also places of cultural significance such as ceremonial places, burial sites, occupations sites and contact sites in the region.
- Traditional owners desire to be consulted regarding development/implementation of measures in catchment areas.

Individual Submissions

Individual submissions on the SWQMP and the McCreadys Creek Catchment Management Plan were also received from:

- Chris Cook;
- H Smith;
- Sunfish; and
- Noel Whitehead Snr.

Chris Cook's submission highlighted pollution as being a major threat to the highest environmental value in McCreadys Creek and the need for adequate planning to preserve what is important in the catchment.

H Smith and Sunfish submissions highlighted:

- The importance of McCreadys Creek to our fisheries and habitats.
- The need to protect the diminishing number of fish nurseries and where possible, rehabilitate them to their previous function.
- The need for natural connectivity strips of a minimum 100 m wide.
- No topsoil removal.
- The need for detention to prevent excessive fresh water entering the marine environment.
- No disturbance of ASS.
- Protection of groundwater and surface water ecosystems.
- The need for water quality sampling and event monitoring.
- No development within 100 m (minimum) of HAT and this area to be left in a natural condition or rehabilitated.
- The need for trash racks and gross pollutant traps and artificial wetlands to prevent pollutants entering waterways.
- The need to think 50 years ahead and of the legacy that we leave for future generations.
- Wetlands, both natural and artificial; - under no circumstances will wetland be allowed to be destroyed or disrupted. Wetlands to be brought back, even if means not continuing present activity.
- All wetlands to have a 100 m buffer beyond extremities of wetlands, or wider if experts consider necessary. To give encouragement to land owners this total area to be calculated and deducted from rateable area, then to have an economic value placed on the area for the land-holder.

Noel Whitehead advised that McCreadys Creek and it's tributaries are very important nurseries for local fish and aquatic stocks. Mr Whitehead highlighted the importance of the tributary of McCreadys, which adjoins the eastern boundary of the Golfcourse. The tributary still supports aquatic fauna despite water being extracted for irrigation and the drain straightened. It was recommended that the drain be rehabilitated with holes and meanders and the riparian zone replanted. This is also suggested for the main McCreadys Creek tributary.

4.3 Environmental Values to be Protected

Based on the review of the existing catchment and input from stakeholder and community consultation,

the following environmental values need to be protected in the McCreadys Creek Catchment:

Table 4-5 Summary of Environmental Values to be protected in McCreadys Creek Catchment

Environmental Values	Indicators
Aquatic ecosystems	Biological – primary productivity, species richness and diversity of the freshwater and estuarine ecosystems.
	Physical – bed morphology, flow regimes.
	Chemical – nutrients (nitrogen and phosphorus), pH, EC.
Riparian ecosystems	Biological – vegetation and fauna.
	Physical – bank morphology, flow regimes.
Terrestrial ecosystems	Vegetation and fauna in the balance of areas of ecological status.
Secondary contact recreation	Fishing, boating, hunting and gathering.
Aesthetic values	Scenic values and amenity.
Educational, scientific and cultural values	Relating to flora and fauna, history, significant places.

4.4 Environmental Objectives

The following objectives have been established to assist in the protection of identified environmental values

- Social
  - To ensure that Council's infrastructure and planning strategies within the catchment positively contribute to public health, safety, cultural values, recreational and aesthetic amenity of McCreadys Creek.
- Environmental
  - To maintain areas of ecological status within the catchment.
  - To maintain aquatic and riparian ecosystems where they meet objectives (eg water quality objectives, biological indicators) and enhance aquatic and riparian ecosystems where these are not met.
  - To collect the data necessary to confirm the requirements for maintaining or enhancing aquatic and riparian ecosystems (eg WQO) in the McCreadys Creek catchment with a view to evaluating methods of control/rehabilitation
- Financial
  - To ensure that maintenance and enhancement strategies are cost effective and that financial assistance is obtained from sources within Council, from developer contributions, industry and from State and Federal Government where appropriate.

- Integrated Planning
  - To ensure that there is a planning and development control framework that contributes to the protection of the agreed environmental values and objectives and supports ecologically sustainable development.
  - To integrate the plan into other regional plans.

4.4.1 Water Quality Objectives

Water Quality Objectives (WQO) as identified in the SWQMP are best derived from site-specific data collected from waterways of interest. There is limited data available in McCreadys Creek, hence the interim Mackay Region Water Quality Objectives are to be adopted until sufficient data can be collected. These interim values are detailed in Table 4-6.

Table 4-6 Interim Water Quality Objectives for Mackay Region

Indicator	Unit	Statistic	Level
Total Nitrogen	mg/L	Mean Range	Less than 0.2 to 0.5 mg/L.
Total Phosphorus	mg/L	Mean Range	Less than 0.01 to 0.05 mg/L.
Dissolved Oxygen	% saturation	Mean	Greater than 80% saturation during daytime.
Chlorophyll-a	µg/L	Mean Range	Ambient conditions less than 3µg/L.
pH		Mean Range	pH between 7 to 8
Faecal Coliforms	cfu/100 mL	Median	Bacterial content less than 150 faecal coliform organisms per 100 mL.
		80%ile	Bacterial content less than 600 faecal coliform organisms per 100 mL.
Enterocci	cfu/100 mL	Median	Bacterial content less than 150 faecal coliform organisms per 100 mL.
		Max	Bacterial content less than 150 faecal coliform organisms per 100 mL.
Nuisance algae		Max	Direct contact should be discouraged if cell counts exceed 15,000-20,000 cells/mL depending on Species.
Turbidity/Clarity	-		Changes in euphotic depth of <10% Mean less than 10 NTU.
Litter/debris	-		Retention of litter greater than 50 mm for flows up to the 3 month ARI peak flow.
Oil and grease			No visible oils for flows up to the 3-month.
Coarse sediment			Retention of sediment coarser than 0.125 mm* for flows up to the 3-month ARI peak flow.

As an alternative to achieving the water quality objectives specified in Table 4-5 for SS, TN and TP, an acceptable solution for urban developments is to achieve the stormwater treatment objectives outlined in Table 4-7. These objectives have been defined in Victoria and New South Wales to represent achievable targets using current best practice (Engineers Australia 2003). These treatment objectives for stormwater

are expressed in mean annual reductions of pollutant loads from typical urban areas with no stormwater treatments installed. Achieving these objectives does not necessarily suggest that the ultimate receiving water quality outcomes for aquatic ecosystem health protection have been attained.

Table 4-7 Alternative Stormwater Treatment Objectives

Indicator	Stormwater Treatment Objective
Suspended Solids (SS)	80% retention of the average annual load
Total Phosphorous (TP)	Total Phosphorous (TP) 45% retention of the average annual load
Total Nitrogen (TN)	Total Nitrogen (TN) 45% retention of the average annual load

5. Hydrology

Hydrological analysis for the McCreadys Creek catchment has been undertaken using the RAFTS (Version 5.1) software.

Design flows for the catchment have been calculated for the 5, 50 and 100 year average recurrence interval (ARI) events. Flows have been determined for both “existing” and “future” catchment conditions.

The “existing” catchment scenario represents the modelling of the catchment in its existing state of urban development. The “ultimate” catchment scenario is defined to be the modelling of the catchment in accordance with the Mackay City Council Strategic Plan (refer Figure 5-1).

Estimated flows have been used to calibrate the water quality “MUSIC” model.

5.1 Source Data

The data used for the hydrology assessment is detailed Table 5-1.

Table 5-1 Source Data used for the Hydrological Assessment

Item	Source	Details
Drawings	Mackay City Council	◗ Paper copies of as constructed detention basins/lagoons in the catchment (eg. Premier Gardens, Northview, Eaglemount, Kimberly). ◗ Electronic copies of AutoCAD drawings showing Council defined catchments and trunk drainage in the McCreadys Creek catchment. Drawings contained details eg size of pipes, lengths and general remarks on channels.
GIS Data	Mackay City Council	◗ ASS – contains the Acid Sulfate_dnr_mar04.tab (ASS Map). ◗ Cadastral Data – McCreadys.tab contains the Cadastral and Zoning Plan (the planning scheme zone areas to be used are those defined Current_Zo; current zoning). ◗ Ecosystem Data– Vegetation Protection Zones. ◗ Contour Data – Contains contour_merge. tab which is a DTM from early 1990s.
Aerial Photography	Mackay City Council	◗ 1998 Aerial Image (jpeg) files (1:25,000).
Drainage Reports	Mackay City Council	◗ Eaglemount Report. ◗ Beaconsfield. ◗ Andergrove Main Drain.

5.2 Probabilistic Rational Method (PRM)

The Probabilistic Rational Method (PRM) flows were estimated from the methodology described in Section 5 of QUDM. Rainfall Intensities were taken from Australian Rainfall and Runoff (AR&R 1987). Fraction impervious was gained by dividing the catchment in ArcGIS into 4 divisions listed as Urban Residential, Undeveloped (Open Space and Rural), Park Residential and Rural Residential. The fraction impervious used in the assessment were:

- Urban Residential 0.40

- Undeveloped 0.00
- Park Residential 0.03
- Rural Residential 0.02

These values were used in conjunction with the area of each landuse type to get a fraction impervious for each catchment. The PRM was then applied at 9 points within the catchment. These locations are shown in Figure 5-2.

5.3 Rafts Model

A RAFTS model was established using the same subcatchment divisions and landuse characteristics as the PRM. Rainfall intensities were calculated using AR&R with temporal patterns in RAFTS for Zone 3. As RAFTS only allows for two subcatchment types in a catchment node, generally where more than two landuse types were represented in a subcatchment, Subcatchment A included the Urban Residential and Park Residential Components, while Subcatchment B included the Rural Residential and Undeveloped components. Two subcatchment types were only represented in a couple of catchments and these were always Rural Residential and Undeveloped. In these situations Subcatchment A was Rural Residential and B was Undeveloped.

5.3.1 Impervious Values

The proportion of each landuse type in the sub catchment was used to give impervious area and weighted values for Mannings n. Mannings n values adopted are shown below:

- Urban Residential 0.025
- Park Residential 0.050
- Rural Residential 0.050
- Undeveloped 0.070

5.3.2 Storage

A storage coefficient was determined using the Direct Storage Coefficient (B) in each catchment where B = 2Kc. Kc is related to the catchment area, Kc = 0.6 x Area ^ 0.66 . n (the non standard storage exponent) values have also been set to -0.2 in accordance with this method. These values correspond relatively well with the PRM values with differences being in alignment with generally accepted tolerances.

5.3.3 Losses

The initial losses and continuing losses for rural/parkland were:

- 100, 50 Year ARIs IL = 10 mm
  CL = 2.5 mm
- 5 Year ARI IL = 25 mm
  CL = 2.5 mm

In urban areas, both continuing and initial losses were set to a value of zero.

5.3.4 Detention Basins

The RAFTS models were run both with and without Detention Basins. The basin at Eaglemount Heights Stage 17 was not included in the analysis owing to the lack of adequate data and the apparent small volume being detained. Stage storage data for the Nindaroo Estate Basin (Premier Gardens) was estimated from data previously attained. Stage Discharge was calculated using the CulvertW program for the outlets indicated on the drawings. Spillway levels and widths were also estimated from the drawings. No additional detention storage was provided for the ultimate development case.

5.4 Results

The results of the PRM and RAFTS models for the 5 year, 50 year and 100 year ARI are shown in Table Table 5-2, Table 5-3, and Table 5-4 respectively.

Table 5-2 5 Year ARI Comparison of Flow Estimates

Node	Development Scenario	5 Yr ARI		
		PRM	Rafts No Detention	Rafts Detention
1	Existing	116	98	96
1	Ultimate	129	118	115
2	Existing	106	86	85
2	Ultimate	119	107	104
3	Existing	33	24	24
3	Ultimate	39	33	33
4	Existing	13	9	9
4	Ultimate	16	11	10
5	Existing	20	12	12
5	Ultimate	22	15	15
6	Existing	61	40	39
6	Ultimate	64	43	41
7	Existing	53	32	32
7	Ultimate	55	33	33
8	Existing	37	20	20
8	Ultimate	39	21	21
9	Existing	21	9	9

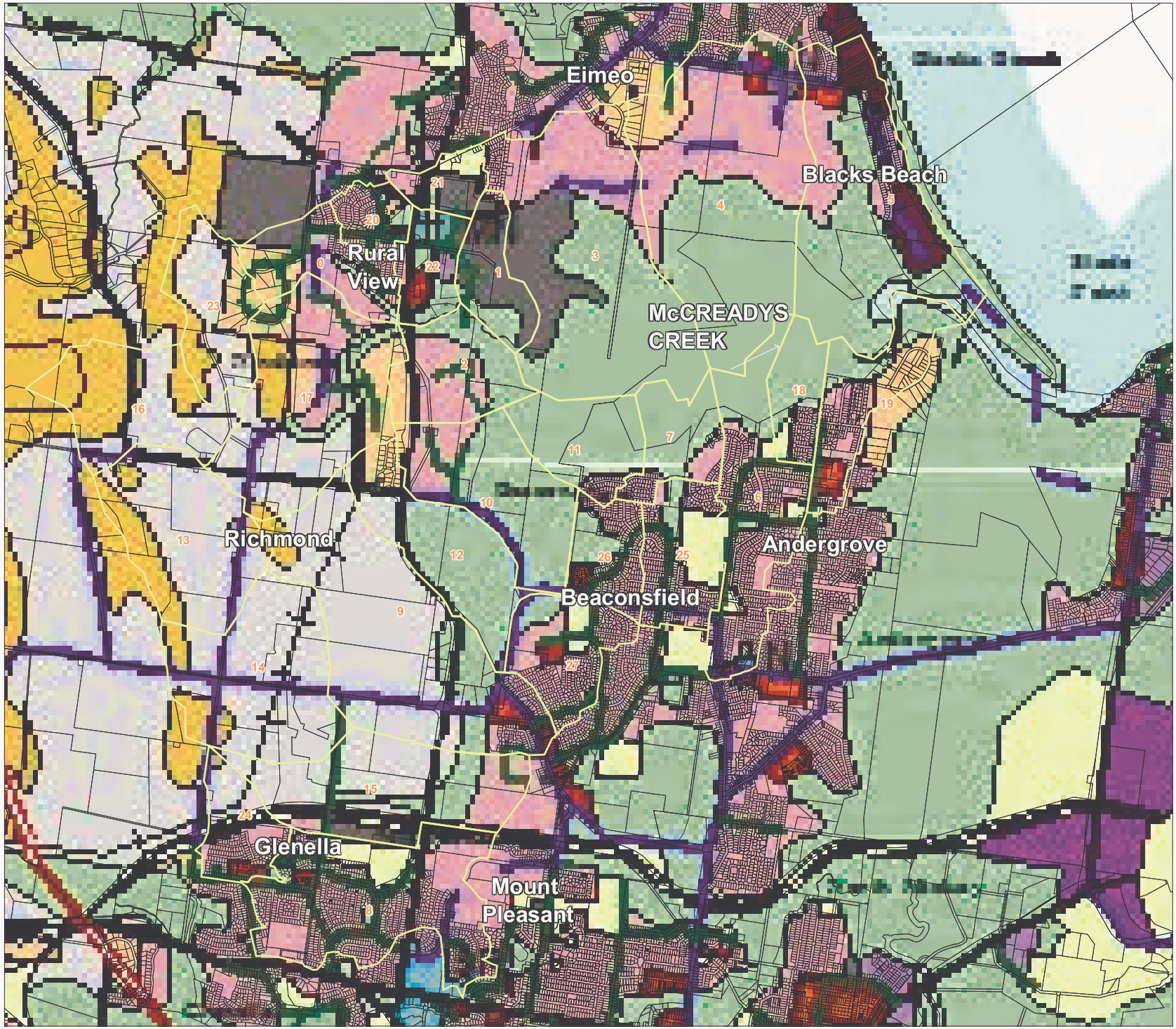
Table 5-3 50 Year ARI Results Comparison

Node	Development Scenario	50 Yr ARI		
		PRM	Rafts No Detention	Rafts Detention
1	Existing	210	209	206
1	Ultimate	234	234	231
2	Existing	191	186	183
2	Ultimate	215	209	206
3	Existing	59	52	52

Node	Development Scenario	50 Yr ARI		
		PRM	Rafts No Detention	Rafts Detention
3	Ultimate	69	62	61
4	Existing	23	18	18
4	Ultimate	27	20	19
5	Existing	35	26	26
5	Ultimate	38	29	29
6	Existing	108	87	85
6	Ultimate	114	60	87
7	Existing	93	70	70
7	Ultimate	98	71	71
8	Existing	65	44	44
8	Ultimate	69	45	45
9	Existing	36	17	17

Table 5-4 100 Year ARI Results Comparison

Node	Development Scenario	100 Yr ARI		
		PRM	Rafts No Detention	Rafts Detention
1	Existing	272	247	244
1	Ultimate	304	275	271
2	Existing	248	220	216
2	Ultimate	278	246	242
3	Existing	76	61	61
3	Ultimate	89	73	71
4	Existing	29	21	20
4	Ultimate	35	23	22
5	Existing	45	31	31
5	Ultimate	48	34	34
6	Existing	140	103	100
6	Ultimate	147	106	103
7	Existing	121	83	83
7	Ultimate	126	84	82
8	Existing	84	53	53
8	Ultimate	89	53	53
9	Existing	46	20	20



McCreadys Creek Catchment Management Plan

FIGURE 5-1
RAFTS Catchments & Strategic Plan

Legend

Subcatchment Boundary

- Urban Residential
- Higher Density Residential
- Future Urban
- Commercial
- Major Business/Industry
- Service and Commercial Industry
- Special Uses and Reserves
- Open Space and Recreation
- Rural
- Rural Agriculture
- Rural Residential
- Park Residential
- Village
- Tourism

DRAFT

North

Source Information: Mackay City Council.

GHD MANAGEMENT ENGINEERING ENVIRONMENT

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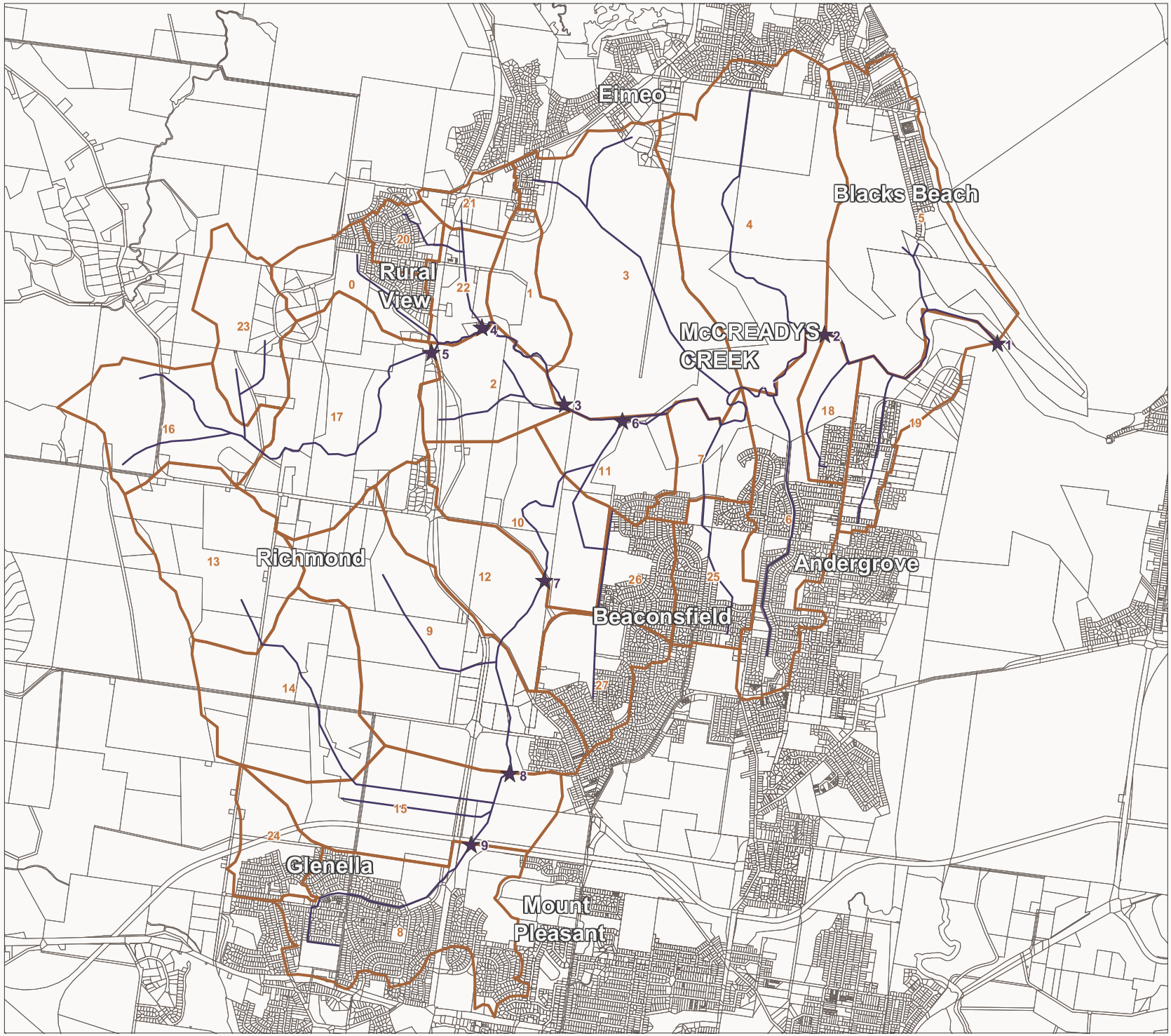

McCreadys Creek Catchment Management Plan

FIGURE 5-2
RAFTS Catchments and Flow Points

Legend

Flow Point

Subcatchment Boundary

DRAFT

Scale: 1:30,000 (A3)

North

Source Information: Aerial Image, Cadastre and Catchment Plan from MCC

GHD MANAGEMENT ENGINEERING ENVIRONMENT

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6. Water Quality Assessment

Water quality modelling of the McCreadys Creek waterways was undertaken using the water quality simulation program MUSIC (Model for Urban Stormwater Improvement Conceptualisation). The water quality model is based on the hydrological catchments defined for the RAFTS model.

MUSIC is a decision-support-system first released in 2001 and developed by the CRC for Catchment Hydrology based at Monash University in Victoria. The model enables users to evaluate conceptual designs of stormwater management systems to determine their suitability in the catchments.

The overall aims of this water quality assessment are to:

- Determine the existing state of water quality in the catchment considering there is limited water quality improvement measures in the catchment; and
- Evaluate the effectiveness of proposed SQIDs;

Analysis was performed for suspended sediment, total nitrogen (N) and total phosphorus (P) with the aim of maximising the pollutant removal efficiency within the constraints of available land and site suitability.

Three MUSIC models were established for McCreadys Creek:

- Existing - current situation;
- Future - proposed situation eg. development in accordance with Strategic Plan; and
- Mitigated - proposed situation with mitigation eg SQIDs and development in accordance with Strategic Plan.

6.1 Landuse and Water Quality

At present, there is no data specific to the Mackay region that relates landuse to pollutant generation concentrations. The MUSIC modeling and general pollutant loadings for the catchment were undertaken using parameters defined for Brisbane Catchments as shown below in Table 6-1.

Table 6-1 Pollutant concentration parameters for various landuses

Landuse Type	Suspended Solids (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
MUSIC Base Concentration Parameters for Brisbane Catchments (BCC 2003)			
Urban Residential	1.25	1.58	0.107
Rural Residential	3.4	0.30	0.03
Commercial	6.0	2.09	0.25
Agriculture (MCC assumed Rural -Sugarcane, Grazing)	25	1.19	0.13
Forest (MCC assumed Open space)	3.2	0.26	0.016

The pollutant concentration values for 'Agriculture' were compared to pollutant concentrations for sugarcane areas in North Queensland. Pollutant concentrations reported in the Mackay Whitsunday Region State of the Waterways Report 2004 (Brodie et al 2004) identified levels in streams draining from sugar cane areas in the Herbert region at 32 mg/L, 1 mg/L and 0.08 mg/L for suspended solids, nitrogen and phosphorus concentrations respectively. As these values seem consistent with the Brisbane data, it

was decided to use the Brisbane values until pollutant concentrations from Mackay landuses are obtained.

A basic assessment of average annual pollutant loads from the catchment was made by applying pollutant concentrations to the average annual runoff volumes. As can be seen in the tables below, agricultural land and residential development contribute the most to pollutant loads exported from the catchment.

Table 6-2 Average Annual Pollutant Loadings (Existing Condition)

Landuse Type	Volumetric Runoff Coefficient	Existing Annual Runoff Volume (ML)	Sediment		Nitrogen		Phosphorus	
			kg	%	kg	%	kg	%
Rural - Sugarcane/Grazing	20%	6,061	151,520	94%	7,212	43%	788	60%
Residential	45%	4,718	5,897	4%	7,454	45%	505	38%
Commercial	100%	27	164	0%	57	0%	7	1%
Open Space	10%	898	2,872	2%	1,875	11%	14	1%
	Totals	**11,704**	**160,454**		**16,599**		**1,314**	

Table 6-3 Average Annual Pollutant Loadings (Future Condition - Unmitigated)

Landuse	Volumetric Runoff Coefficient	Existing Annual Runoff Volume (ML)	Sediment		Nitrogen		Phosphorus	
			kg	%	kg	%	kg	%
Rural Sugarcane/Grazing	20%	4,004	100,088	88%	4,764	24%	521	36%
Residential	45%	8,287	10,359	9%	13,094	66%	887	62%
Commercial	100%	27	164	0%	57	0%	7	0%
Open Space	10%	898	2,872	3%	1,875	9%	14	1%
	Totals	**13,216**	**113,483**		**19,790**		**1,428**	

An assessment of the average annual pollutant loads from the basic assessment reveals the following:

Existing Condition

- The rural catchment contributes approximately 94 % of the sediment load, 43% of the nitrogen load and 60% of the phosphorus load.
- Residential development contributes approximately 4% of the sediment load, the highest nitrogen load at 45% and 38% of the phosphorus load.
- The catchment contributes approximately 160.5 tonnes of sediment, 16.6 tonnes of nitrogen and 1.3 tonnes of phosphorus per year to the Coral Sea.

Future Condition (unmitigated)

- The rural catchment contributes approximately 88% of the sediment load, 24% of the nitrogen load and 36% of the phosphorus load.
- Residential development contributes approximately 9% of the sediment load, and the highest percentage of nutrient loads at 66% for nitrogen and 62% for phosphorus.
- The catchment contributes approximately 113.5 tonnes of sediment, 19.8 tonnes of nitrogen and 1.4 tonnes of phosphorus to the Coral Sea.
- Comparing the existing scenario to the unmitigated future development scenario:
  - nutrient loadings to the Coral Sea increase by 3.2 tonnes of nitrogen (19% increase) and 0.1 tonnes of phosphorus (9% increase).
  - Sediment loadings decrease by approximately 47 tonnes through the conversion of agricultural land to residential land. Note however that this is only in the operational phase of residential development once the disturbed areas are stabilised through vegetation cover etc. There is a high risk of sediment loads increasing during the construction phase if adequate measures are not taken to control erosion and sedimentation.

For comparative purposes, the *Great Barrier Reef Catchment Water Quality Action Plan* (2001) identifies 10-year targets (2011) for the entire Great Barrier Reef catchment. These targets are:

- Sediment – a 38 % reduction from 11,700,000 tonnes per year to 7,300,000 tonnes per year;
- Nitrogen – a 39% reduction from 39,300 tonnes per year to 24,000 tonnes per year; and
- Phosphorus – a 47% reduction from 7,400 tonnes per year to 3,900 tonnes per year.

6.2 MUSIC Model Establishment

Input data for the MUSIC model was derived from several different sources. An outline of the source of data used in the model is listed below:

- Climate data for Mackay was supplied with the MUSIC software (sourced from the Bureau of Meteorology) and provided rainfall data for Mackay at 6 min time intervals. Average monthly evapo-transpiration data was also supplied for Mackay. The data was configured in a form suitable for use in MUSIC.
- The same subcatchment layout as that determined for the RAFTS model was used; however in MUSIC, there can only be one node per land use. Hence each subcatchment has been divided into a number of nodes, each node representing a unique land use.
- The same land use information for each subcatchment used in the RAFTS model was used to obtain the area of each land use node.

The following actions were necessary as part of the model establishment process.

- Brisbane City Council's "*Guidelines for Pollutant Export Modelling in Brisbane Version 7 – Draft*" (BCC 2003) were used to determine the values of the rainfall / runoff parameters eg. fraction impervious, soil storage, infiltration capacity and recharge to groundwater.
- Pollutant export parameters were based on Brisbane City Council's Guidelines which have been derived from BCC's Stormwater Quality Monitoring Programme (Peljo and Fletcher, 2002).
- The MUSIC model was set up with hydrological connections, for each node, along with physical and

pollutant export characteristics.

6.3 Limitations of MUSIC

6.3.1 Pollutant Removal Efficiency – Nitrogen and Phosphorus

The developers of MUSIC have attempted to use established science in deriving pollutant removal efficiencies for the mitigation measures. However due to a lack of accepted data, MUSIC does not model biological nutrient removal processes. The primary pollutant represented in MUSIC is purely a result of sediment settlement. For phosphorus, this should still provide a reasonable estimate of pollutant removal as this nutrient in stormwater is absorbed onto the sediment particles whereas the relative proportion of dissolved phase phosphorus is typically quite low. However, the proportion of dissolved phase nitrogen is usually significantly higher. *As a result, MUSIC is likely to underestimate nitrogen removal.*

The performance of the mitigation measures is primarily determined by the specification of C* and k values C* values represent the lowest possible concentration to which a nutrient will decay with time in a particular mitigation measure. The k values are related to the hydraulic loading and treatment capacity of a mitigation measure. The higher the k value, the faster and more efficiently a measure can remove pollutants. MUSIC will therefore not predict concentrations lower than C*, even if no pollutants are present.

Table 6-4, Table 6-5, and Table 6-3 present the C* and k values for the removal of TSS, TP and TN for a range of mitigation measures.

Table 6-4 Total Suspended Sediment (TSS) Removal Rates

Treatment Measure	K (m/yr)	C* (mg/L)
Sedimentation Ponds	15000	30
Ponds	1000	12
Swales	15000	30
Wetlands	5000	6
Biofilters	1000	12

Table 6-5 Total Phosphorus (TP) Removal Rates

Treatment Measure	K (m/yr)	C* (mg/L)
Sedimentation Ponds	12000	0.18
Ponds	500	0.13
Swales	12000	0.18
Wetlands	2800	0.09
Biofilters	500	0.13

Table 6-6 Total Nitrogen (TN) Removal Rates

Treatment Measure	K (m/yr)	C* (mg/L)
Sedimentation Ponds	1000	1.7
Ponds	500	1.3
Swales	1000	1.7
Wetlands	500	1.3
Biofilters	500	1.3

6.4 Results

A visual of the MUSIC model layout is shown in Figure 6-1. The results for the three MUSIC models are contained in Table 6-8.

6.4.1 Proposed Stormwater Quality Improvement Devices (SQID)

The SQIDs proposed and tested in the mitigated MUSIC model are shown on Figure 6-1 and listed in Table 6-7. They include gross pollutant traps (GPT), constructed wetlands (including detention functions), and trash racks. The constructed wetlands proposed incorporate a number of functions including the trapping of gross pollutants and sediment, detention and polishing of water (N&P removal).

Table 6-7 Stormwater Quality Improvement Devices (SQID) Proposed for McCreadys Creek Catchment

ID	Sub catchment	Location	Site Details	Estimated Cost^	Priority (MCC)
Gross Pollutant Traps					
McGPT1	19	Apsley Road, Andergrove	Discharge point of 2/1200 RCPs	$60,000	4
McGPT2	18	Carbeen Street, Andergrove (east of Mackillop Catholic Primary School)	Open drain, 20 m wide, grass base	$50,000	5
McGPT3	6	Nadarmi Drive, Andergrove (west of Mackillop Catholic Primary School)	Open drain, 30 m wide, 7 m wide concrete base.	$120,000	1
McGPT5	10	Broomdykes Drive, Beaconsfield	Open drain, 20, wide, downstream of detention basin	$100,000	3
McGPT6	8	Multimodal Corridor, Mt Pleasant	Open drain, 8.5 m wide, grassed	$100,000	6
McGPT7	20	Mackay Bucasia Road, Rural View	Detention Basin to be retrofitted to capture Gross Pollutants	$50,000	8
McGPT8	5	Pacific Drive, Blacks Beach	Prior to discharge into natural detention basin	$50,000	7
Constructed Wetlands					
McCWet1	7	Caledonian Drive, Kimberley	Open drain, 20 m wide, downstream of 4/2400x1200 RCBCs	$250,000	2
McCWet2	3	Symons Property	Downstream of future urban area	$150,000	N/A
McCWet3	3	Symons Property	Downstream of future urban area	$120,000	N/A
McCWet4	1	Symons Property	Downstream of future urban area	$120,000	N/A

ID	Sub catchment	Location	Site Details	Estimated Cost^	Priority (MCC)
McCWet5	22	Symons Property	Downstream of future urban area	$150,000	N/A
McCWet6	4	Cain Property	Downstream of future urban area	$170,000	N/A
McCWet7	2	Shuttlewood Property	Downstream of future urban area	$150,000	N/A
Trash Racks					
McTR1	0	George Fordyce Drive, Rural View	Discharge point of drainage system	$8,000	11
McTR2	0	George Fordyce Drive, Rural View	Discharge point of drainage system	$8,000	12
McTR3	0	George Fordyce Drive, Rural View	Discharge point of drainage system	$8,000	13
McTR4	9	Beaconsfield Road, Beaconsfield	Road Table Drain	$12,000	9
McTR5	9	Holts Road, Beaconsfield	Road Table Drain	$ 12,000	10

^ Cost includes estimated planning, design and construction costs.

The estimated total cost for the trunk stormwater quality improvement devices in the McCreadys Creek catchment is approximately $1,700,000. Of this figure, controls required for existing developments total $ 840,000. Future trunk stormwater quality infrastructure likely to be required in the next 10 years is estimated to be in the order of $860,000.

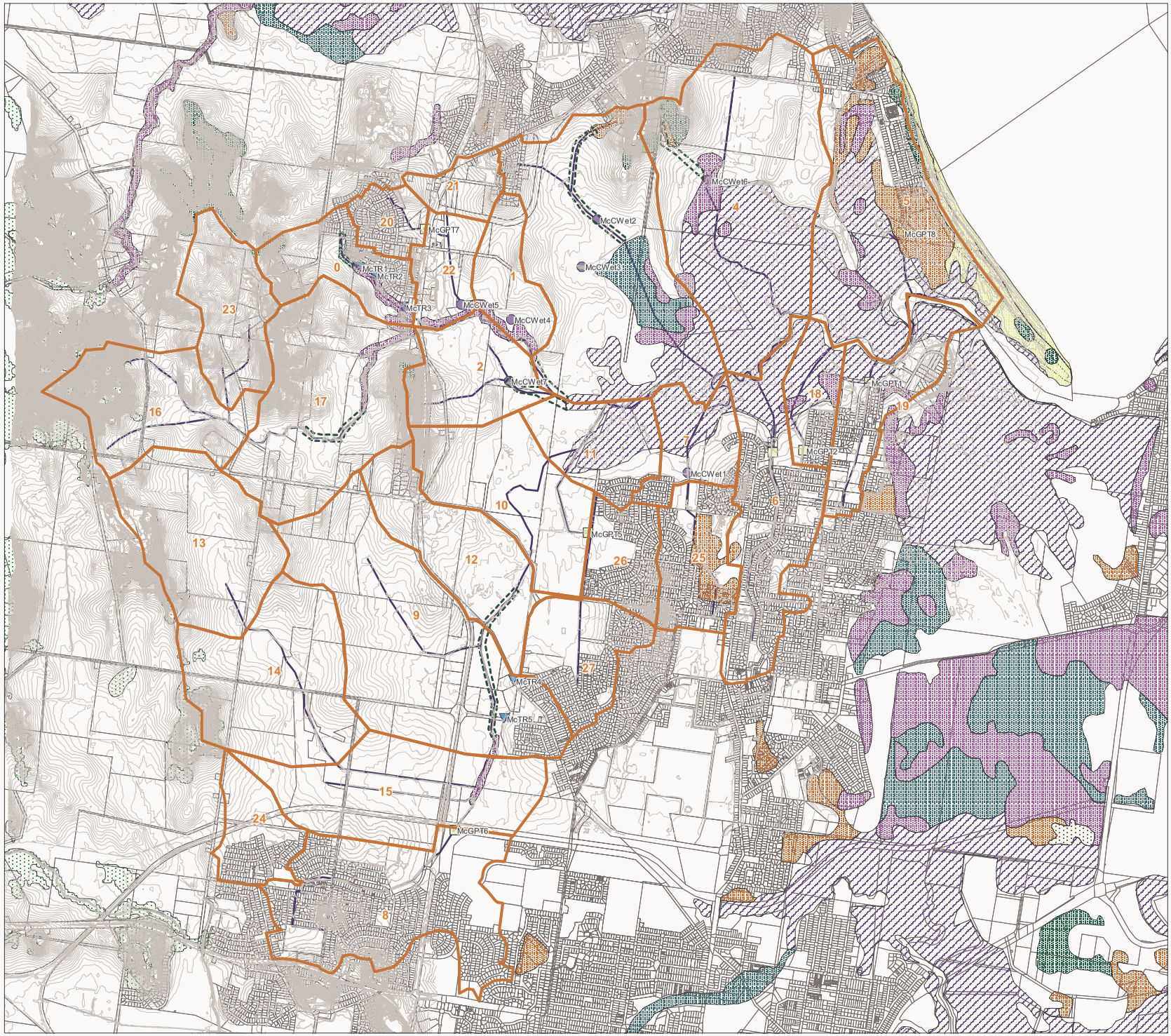
The area benefiting from the SQIDs in approximately 930.2 ha. This area represents mostly urban residential development. The total cost divided by the benefiting area is approximately $1,830/ha.

6.4.2 Constraints

Potential constraints with respect to the implementation of stormwater management controls include:

- Council budget.
- Extensively developed subcatchments where retro fitting stormwater quality control measures might not be possible in many areas.
- Flat topography, lack of hydraulic gradient.
- Potential acid sulphate soils, which may preclude excavation of vegetated swales or infiltration trenches without appropriate management strategies;
- Poorly drained soils, which may limit application of water treatment measures relying on infiltration; and
- Tidally affected downstream waterways.

Therefore, it will be important for feasibility investigations or concept designs to investigate each proposed site.



McCreadys Creek Catchment Management Plan

FIGURE 6-1
Proposed Water Quality Controls

Legend

Area of Proposed Rehabilitation/Revegetation

Proposed SQIDs

- Proposed Trash Rack
- Proposed Gross Pollutant Trap
- Proposed Constructed Wetland

Vegetation - Broadtype

- Estuarine Complexes
- Eucalypt and Related Forests / Woodlands
- Foredune Complex
- Heathland / Shrubland
- Highly Modified / Disturbed
- Highly Modified / Disturbed (Clearings within bushland)
- Melaleuca Forests
- Other remnant vegetation outside study areas
- Rainforest Communities
- Rocky Seashore
- Sedgelands and Related Communities
- all others

DRAFT

Scale: 1:30,000 (A3)

North

Source Information: Aerial Image, Cadastre and Catchment Plan from MCC

GHD MANAGEMENT ENGINEERING ENVIRONMENT

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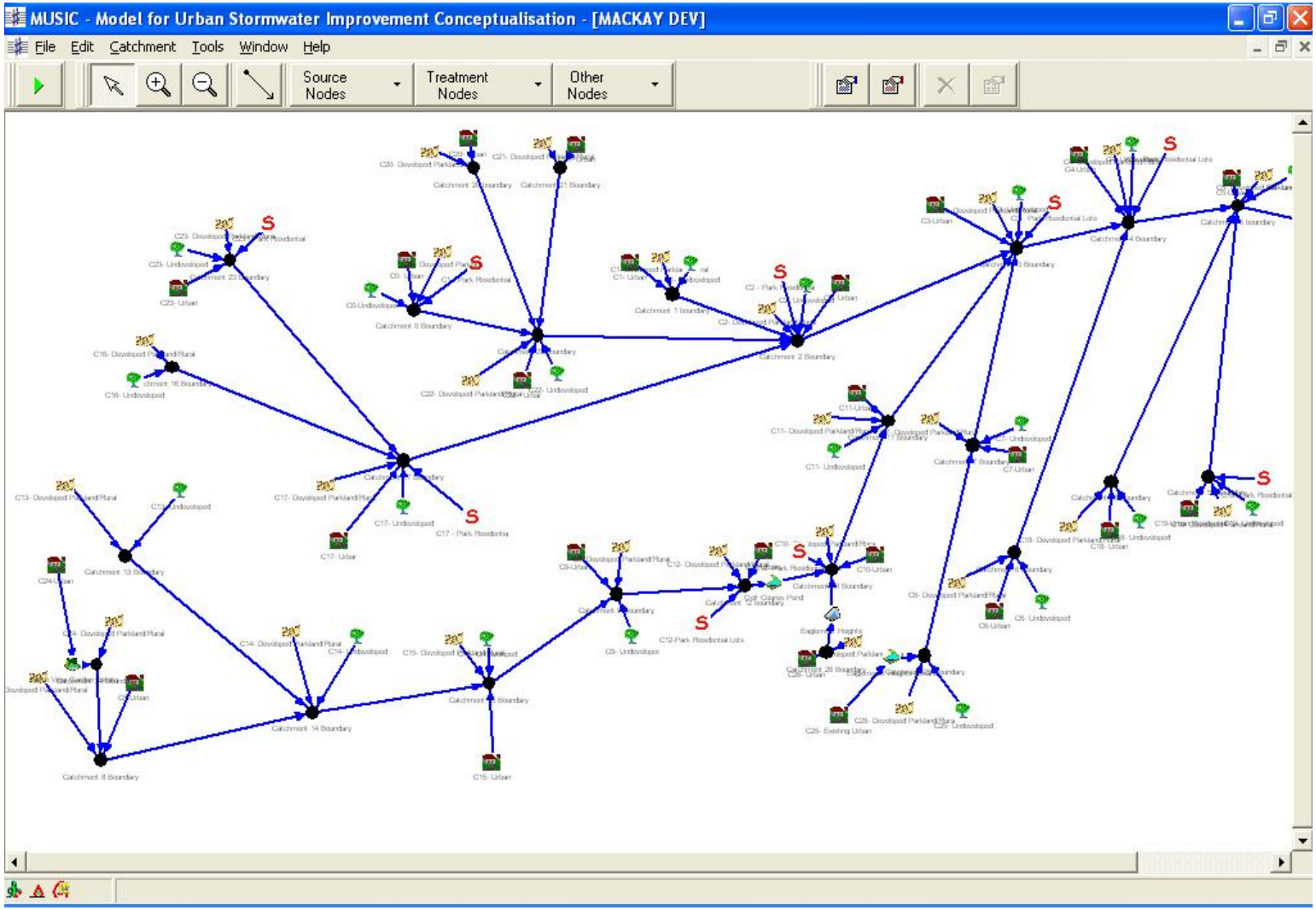


Figure 6-2 MUSIC Layout for McCreadys Creek Catchment (Unmitigated)

Table 6-8 MUSIC Results (Mean Concentrations)

Catchment (refer to Figure 6-1)	Current			Proposed			Proposed with Treatment Measures		
	Total Suspended Solids (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
0	55.9	0.901	0.137	57.4	0.761	0.128	57.4	0.752	0.127
1	54.9	1.260	0.170	59.7	0.859	0.141	59.3	0.862	0.141
2	58.3	1.200	0.166	62.0	1.060	0.159	40.4	1.050	0.142
3	43.3	1.200	0.147	47.3	1.130	0.144	34.3	1.090	0.130
4	45.9	1.150	0.146	49.3	1.080	0.142	32.9	1.030	0.124
5	46.6	1.100	0.142	49.6	1.040	0.140	32.1	0.996	0.124
6	57.1	0.766	0.129	56.0	0.677	0.119	36.1	0.652	0.111
7	29.9	0.771	0.099	28.4	0.726	0.093	21.9	0.733	0.098
8	64.1	1.100	0.169	67.0	1.080	0.172	46.6	1.050	0.165
9	60.9	1.210	0.174	62.8	1.180	0.175	48.6	1.160	0.171
10	39.2	1.310	0.147	38.4	1.260	0.143	39.7	1.260	0.144
11	38.9	1.250	0.141	38.1	1.200	0.137	38.0	1.200	0.137
12	61.0	1.210	0.175	62.6	1.180	0.174	48.7	1.160	0.170
13	56.0	1.480	0.190	57..4	1.480	0.192	57.0	1.480	0.192
14	61.7	1.170	0.172	62.8	1.160	0.174	47.4	1.130	0.169
15	61.1	1.190	0.173	63.2	1.170	0.173	46.2	1.140	0.169
16	52.2	1.300	0.169	51.5	1.310	0.168	51.4	1.310	0.167
17	58.1	1.380	0.177	61.3	1.510	0.161	45.2	1.130	0.155
18	48.5	0.664	0.108	48.8	0.610	0.104	24.9	0.579	0.097
19	53.2	0.719	0.188	53.2	0.678	0.116	28.9	0.645	0.107
20	64.4	1.060	0.166	65.2	1.040	0.166	37.3	1.000	0.155
21	57.0	1.240	0.172	62.9	1.060	0.165	34.8	1.020	0.156
22	59.6	1.040	0.156	61.9	0.932	0.151	45.1	0.904	0.143
23	61.4	1.330	0.167	61.4	1.270	0.165	55.5	1.260	0.164
24	61.7	1.120	0.169	63.2	1.100	0.168	65.4	1.100	0.170
25	22.7	0.853	0.098	22.9	0.982	0.113	22.2	0.985	0.111
26	66.7	1.080	0.171	64.8	1.070	0.167	38.3	1.040	0.159
27	62.6	1.110	0.169	64.1	1.090	0.169	65.4	1.090	0.169

6.5 Discussion

6.5.1 Existing case model

Modelling of the McCreadys Creek catchment reveals that the levels of TSS, and nutrients (TP and TN) are greater than the specified Water Quality Objectives (WQO).

6.5.2 Pollutant Export

The pollutant export modelling undertaken by MUSIC for different land use types has been based on parameters provided by the BCC and default MUSIC values. These parameters are derived with data from Brisbane and Melbourne respectively, as shown in Table 6-1.

It is recognised that using pollutant export rates derived in Melbourne and Brisbane may not accurately represent all export processes occurring in Mackay. As Mackay has higher rainfall than Melbourne and Brisbane (refer Table 6-9), this is likely to have an impact on pollution export. However, the adopted method was deemed acceptable as:

- There is no locally calibrated pollutant runoff data available for Mackay; and
- There is not easy way of calibrating the hyetrograph / pollutograph for different areas.

To assess the applicability of this methodology, further research on the rainfall pollutant export parameter has been conducted.

Table 6-9 Annual Rainfall Comparisons

	Mackay Annual Rainfall (mm)	Brisbane Annual Rainfall (mm)	Melbourne Annual Rainfall (mm)	Increase in Mackay's rainfall over Brisbane (%)	Increase in Mackay's rainfall over Melbourne (%)
Mean	1600	1185	560.6	35	185
Years of Data		50	30	-	-

From Table 6-9, it can be seen that Mackay's rainfall is 35% greater than Brisbane and about 3 times greater than Melbourne. In *An Overview of Urban Stormwater Quality*, (Duncan, H.P. 1997) concentrations of pollutants are statistically compared to characteristics likely to affect urban runoff quality. These characteristics were:

- Area;
- Population density;
- Traffic density;
- Mean annual rainfall; and
- Percentage land use.

These were compared for the pollutants:

- Suspended Solids (SS);
- Total Nitrogen (TN);

- Total Phosphorus (TP).

The importance of mean annual rainfall is of interest to this study. The results of comparing annual rainfall with the concentration of pollutants are summarised below:

Suspended Solids

- With respect to SS from roads, "Increasing the annual rainfall by 500 mm approximately halves the most likely concentration of suspended soils";
- This was mirrored in the high urban (industrial, commercial and high density urban) catchments. The low urban catchments (agriculture, forest and other low urban) exhibit "A very wide range of values", however, there is a tendency for concentrations to increase with increasing annual rainfall;
- For the McCreadys Creek catchment this means that the model may be overestimating the amount of SS from urban land uses. This is due to the fact that Mackay's rainfall is nearly 500 mm greater than Brisbane where the pollutant export rates were derived.

Total Nitrogen

- In high urban areas: "Total nitrogen concentrations from high urban areas are significantly correlated with mean annual rainfall. The regression line is almost identical to that for the roads group. Increasing the annual rainfall from 500-1000 mm reduces the most likely concentration by about 30%;
- The low urban results depict a similar relationship. This led to the question that "Perhaps the relationship with annual rainfall reflects an atmospheric process rather than a runoff process, since it is so similar for all land uses";
- The concentration of nitrogen for the McCreadys Creek catchment could be overestimated by 30%.

Total Phosphorus

- Phosphorus pollutant generation has been summarised as "A barely significant negative relationship between total phosphorus concentration and mean annual rainfall. However this is no longer significant when agricultural development is simultaneously accounted for";
- Therefore there is little correlation between annual rainfall and the concentration of total phosphorus;
- Hence, phosphorus concentrations identified in the McCreadys Creek MUSIC models are likely to be reasonable.

Conclusions

The CRCCH state that "the use of local values, where there are good quality local data to support these".

Even though there is qualitative evidence that pollutant export may be influenced by rainfall, it is not encouraged to quantify this until local data sets are available. Therefore without the benefit of local monitoring data to calibrate the model, changing pollutant export parameters is not recommended.

A study of the pollutant generation rates for different land use types is recommended if a more accurate estimate of pollutant export rates is required to calibrate the MUSIC models.

6.5.3 Removal Efficiencies

Pollutant removal in MUSIC uses a kinetic model characterised by k, the exponential decay rate constant and C*, the background concentration. The k and C* values for various removal devices are presented in

Table 26, Table 27 and Table 28. Due to the default values of C* being currently above the WQO that we are aiming to achieve, it is theoretically impossible to remove pollutants to below the C* value. As with pollutant export data, the CRCCH only encourages the modification of the USTM parameters (k and C*) , where there is good reliable local data to support such modifications.

6.5.4 Recommended Strategy

Based on MUSIC modelling results and the discussion sections above, it can be concluded that:

- MUSIC predicts a reduction of pollutant loads for proposed measures; and
- Nutrient removal rates in MUSIC make it difficult to assess the success of proposed scenarios when measured against water quality objectives. However, a relative assessment can be made using our current understanding of load removal rates for the various proposed measures.

To help decide on a recommended strategy, the overall efficiency of the various modelled treatment trains were estimated based upon typical pollutant removal efficiencies of the measures – sourced from BCC (2000a) and CRC (1997), as well as from various manufacturers – which are summarised in Table 6-10.

Treatment trains are a combination of single measures with the overall pollutant removal efficiency calculated as:

$$\textbf{Treatment train efficiency} = (1-(1-B_1)(1-B_2)(1-B_3)\ldots)$$

Where; B_1, B_2…= Pollutant removal efficiency of individual measures.

Table 6-10 Estimated Pollutant Removal Efficiency of Proposed Treatment Trains

Measure		TSS Removal (%)	TP Removal (%)	TN Removal (%)
Individual Measure Efficiency	Wetland	70	40	40
	Lake / Pond	60	40	40
	GPT / Trash / CDS	30	20	20
	Swale	50	35	35
	Sand Filter	80	55	55
Treatment Train Measures Overall Efficiency	Biofilter (swale + sand fitter)	90	71	71
	Lake + GPT	72	52	52
	Lake + Wetland	88	64	64
	GPT + Lake + Wetland	92	71	71
	Lake + Biofilter	96	83	83
	GPT + Lake + Wetland + Biofilter	99	92	92

Note: Data derived from a number of sources, including: BCC, 2000a; CRCCH, 1997; and Manufacturers.

6.6 Conclusions

- It has been shown that due to the modelling methodology undertaken in MUSIC, it is theoretically impossible to reach WQOs by implementing industry standard SQID methodologies within the MUSIC model. It is therefore suggested that a treatment train approach is used.
- MUSIC underestimates TN removal from mitigation measures.
- Data is not currently available to calibrate MUSIC pollutant export parameters, which could mean that TSS and TN concentrations are overestimated.
- Both the unmitigated and mitigated cases do not achieve the WQO for Total Suspended Solids and nutrients. This may mean that the WQO are too high for the catchment.
- Data specific to Mackay is required to adequately model the water quality in the catchments using MUSIC. This data can only be obtained by monitoring pollutant concentrations in runoff from different landuses in the Mackay region.
- WQOs for McCreadys Creek need to be amended following a review of water quality monitoring undertaken in the catchment.
- New developments in McCreadys Catchment need to adopt a treatment train approach to achieve WQO. This needs to be assessed in Stormwater Management Plans (SWMP) prepared at the planning stage of the development (High Risk Developments) to ensure that sufficient areas are allocated for the measures (eg areas dedicated for waterways need to consider quality and quantity requirements). The treatment trains are likely to comprise SQIDs such as grassed swales, unlined channels, gross pollutant traps, constructed wetlands etc.
- Feasibility investigations or concept design reports need to firstly be prepared to address the various site constraints that exist in each catchment.
- The estimated total cost for the trunk stormwater quality improvement devices in the McCreadys Creek catchment is approximately $1,700,000. Of this figure, controls required for existing developments total $ 840,000. Future trunk stormwater quality infrastructure likely to be required in the next 10 years is estimated to be in the order of $860,000.
- The area benefiting from the SQIDs in approximately 930.2 ha. This area represents mostly urban residential development. The total cost divided by the benefiting area is approximately $1,830/ha.

7. Strategies and Action Plans

Strategies identified in Scoping Study prepared by SKM in 2000 that need to be addressed in the CMPs are provided below:

- Social – to ensure that Council's infrastructure and planning strategies within the catchment positively contribute to public health, safety, cultural values, and recreational and aesthetic amenity of McCreadys Creek.
- Environmental:
  - To protect areas of ecological status within the catchment.
  - To maintain aquatic and riparian ecosystems where they meet objectives (eg water quality objectives, biological indicators) and enhance aquatic and riparian ecosystems where these are not met.
  - To collect the data necessary to confirm the requirements for maintaining or enhancing aquatic and riparian ecosystems (eg WQO) in the McCreadys Creek catchment with a view to evaluating methods of control/rehabilitation.
- Financial – to ensure that maintenance and enhancement strategies are cost effective and that financial assistance is obtained from sources within Council, from developer contributions, industry and from State and Federal Government.
- Integrated Planning – to ensure that there is a planning and development control framework, which is consistent with regional plans and contributes to the protection of the agreed environmental values and objectives and supports ecologically sustainable development.

The objectives, rationale and actions for these strategies are detailed below.

7.1 Social Issues

7.1.1 Objective

To ensure that Council's infrastructure and planning strategies within the catchment positively contribute to public health, safety, cultural values, and the recreational and aesthetic amenity of the McCreadys Creek catchment.

7.1.2 Rationale

Council's infrastructure and planning controls within the McCreadys Creek catchment need to consider social issues such as:

- Pest control/management and human safety regarding the ponding of water for detention and wetland functions including sufficient buffering infrastructure (distance from ponded water or tidal lands);
- Recreational use of waterway corridors; and
- Visual amenity and cultural values in regards to the location and design of infrastructure.

It is recommended that these requirements be contained in Water Quality Guidelines. The guidelines may recommend acceptable solutions such as risk assessments to ensure that the social issues have been managed appropriately. The guidelines may also recommend specific documents such as:

- *Guidelines to minimize mosquito and biting midge problems in new development areas* (Queensland Health 2002) to minimise mosquito and biting midge problems in new development areas. This document provides advice on how to prevent or minimise the impact of mosquitos and other biting insects in new development areas.
- *The Australian Mosquito Control Manual* (Mosquito Control Association of Australia 2002) to minimise mosquito breeding in the design of constructed wetlands, water impoundments, grass swales and open earth drains.

The cultural values of the catchment also need to be considered when improvement measures are implemented as the catchment is of high value to Traditional owners. The involvement of traditional owners can provide enrichment and a better understanding of natural resource issues pre-development.

7.1.3 Actions

- Ensure that guidelines prepared for developers to support WSUD initiatives address social issues such as performing risk assessments to ensure that public safety, pest control/management, maintenance and amenity issues are considered and managed appropriately.
- Consult with local Aboriginal representatives of Traditional owners when planning infrastructure in the catchment to ensure that cultural heritage values will not be compromised by the proposed works.
- Consult with adjoining landholders and the community when planning stormwater quality infrastructure to ensure that social and recreational values will be maintained or enhanced by the proposed works.

7.2 Environmental

7.2.1 Objective

- To maintain areas of ecological significance within the catchment.
- To maintain aquatic and riparian ecosystems where they meet objectives (eg water quality objectives, biological indicators) and enhance aquatic and riparian ecosystems where these are not met.
- To collect the data necessary to confirm the requirements for maintaining or enhancing ecosystems (eg WQO) with a view to evaluating methods of control.

This strategy is divided into general environmental and monitoring rationale and actions.

7.2.2 Environmental

Rationale

Stormwater runoff is water that runs off the land into waterways during or after rainfall. Stormwater carries sediment, nutrients, organic matter, metals, pesticides, hydrocarbons and rubbish into waterways. Waterways need a certain amount of sediment, nutrients and organic matter to maintain their

ecosystems, however stormwater runoff from urban areas has contributed to deteriorating water quality in local waterways by:

- Increasing nutrient concentrations, sediment loads and organic matter;
- The presence of toxins and contaminants and elevated pathogen levels;
- Altering salinity regimes;
- Creating acid water drainage associated with disturbance of acid sulphate soils.

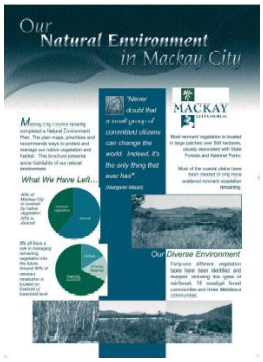
Urban development has also adversely affected:

- Water quality in our waterways through poor riparian management in fresh and tidal waterways.
- Waterway ecosystems through altering hydrologic patterns.

Mackay City Council has a Natural Environment Plan that recommends ways to protect and manage native vegetation and habitat in the Mackay region. The Plan addresses the need for riparian vegetation and identifies that rehabilitation of riparian areas as an important activity (including weed management during the early stages of rehabilitation).

Actions

- Continue to maintain and improve the riparian vegetation within the McCreadys Creek Catchment through revegetation projects, and work with landholders and developers to improve the natural environment and wildlife habitat. An example of Council's brochure, which promotes the preservation and improvement of riparian vegetation is shown beside.



- Prepare a program to implement the SQIDs specified in Table 6-7 to maintain and enhance the identified environmental values for the McCreadys Creek catchment.
- Action priorities 1 to 7 specified in Table 6-7 1 by 2010.
- Prepare a program to implement revegetation/rehabilitation of areas identified on Figure 6-1 by 2010.

7.2.3 Environmental Monitoring

Objective

To collect the data necessary to quantify the stormwater pollutants entering McCreadys Creek waterways and wetlands with a view to evaluating methods of control and amending water quality objective.

Rationale

Stormwater quality monitoring and modelling undertaken in Australian and overseas has confirmed that urban stormwater is a significant contributor to deterioration in receiving water quality. However, the variability in these results indicates the need for the collection of local data before making changes to stormwater management, which may be an unnecessary expense.

Stormwater quality monitoring cannot be undertaken independently to waterway ecosystem health monitoring as stream ecosystems are governed by complex biological, chemical and physical processes.

It is therefore suggested that a Waterway Health Monitoring Program be established which includes the following types of monitoring:

- Ambient Monitoring (baseflow, low or no flow conditions) - The monitoring of background levels of various parameters such as pH, salinity, heavy metals, to assess the impact on the health of in-stream ecosystems.
- Stormwater Quality Monitoring (event flow conditions) – The monitoring of stormwater runoff in waterways to collect samples during rainfall events. The results of the analysis of these samples are then used to develop pollutant export relationships for particular types of catchments or land uses;
- Biological Monitoring – The monitoring of biological parameters in, or adjacent to a waterway to measure the ecological viability of the stream. Biological parameters include riparian vegetation (the trees, grasses, shrubs and other plants which live on the banks of waterways) and benthic macroinvertebrates (insects, insect larvae, crustaceans, snails, worms etc, which inhabit the "benthos" or bottom sediments of a waterway). Both of these parameters can provide a more effective long-term indication of the health of a waterway than traditional physiochemical water quality measurements, as the numbers and types of inhabitants will fluctuate over time depending on the impacts affecting them. This monitoring can be directly linked to ecological health monitoring;

The McCreadys Creek Waterway Health Monitoring Program (WHMP) is proposed to be undertaken in association with the broader Mackay City WHMP, which also looks at other sites in the Mackay urban areas (including the McCreadys Creek Sites).

It is anticipated that the data collected will be transferable to other catchments with similar land use types.

The objectives of the McCreadys Creek WHMP are to provide local data on Mackay's waterways to:

- Confirm and justify the WQO that have been set in development approval conditions;
- Compare whether the WQO are being achieved and therefore, if the environmental values are being protected or not;
- Calibrate water quality modelling programs such as MUSIC eg land use base flow and storm flow pollutant concentrations; and
- Contribute data to regional initiatives such as MWNRM Health Waterways Program, the Reef Protection Plan etc.

The draft McCreadys Creek Waterway Health Monitoring Program is contained within Appendix B. In order for the program to provide sufficient data to meet the above objectives, the program should be undertaken over a long term eg. minimum of 5 years. Reviews should however be undertaken annually to and included in an Annual Report, which should also report and provide analysis of the data collected for the year.

The Program should be discussed with other key stakeholders involved in waterway health monitoring programs eg. the MWNRM Healthy Waterways program, EPA, DPI&F and GBRMPA to ensure that there is no duplication of effort and that the program is consistent with the region's Integrated Health Monitoring System as described in Mackay Whitsunday Region State of the Waterways Report 2004.

Actions

- Review and implement the McCreadys Creek Waterway Health Monitoring Program in consultation with other key stakeholders involved in waterway health monitoring programs eg. the MWNRM Healthy Waterways program, MPA, EPA, DPI &F, GBRMPA.
- Revise WQO considering water quality data and MUSIC model calibrated specifically to the Mackay region.

7.3 Financial

This strategy comprises initiatives for funding activities associated with the SWQMP. The objectives, rationale and actions have been divided into the following three categories:

- Internal Funding;
- Government and Industry Funding; and
- Funding through Infrastructure Charges Schedules.

7.3.1 Internal Funding

Objective

To obtain funding for stormwater quality improvement projects from Council's internal funding source eg rates.

Rationale

Council has introduced an environment levy ($20 per year) as part of Council's rates to fund environmental initiatives. Recommendations for the funding of projects from this levy are determined by Council's Natural Environment Advisory Committee, which is comprised of Councillors, Council Staff and community representatives. The recommendations are forwarded to Council for approval.

Actions

- Ensure funding allocated from Council's environment levy is used for implementation of projects within McCreadys Creek, which cannot be funded through developer contributions or by other government and industry funding.
- Ensure a portion of funds allocated for Council's capital drainage improvements include stormwater quality improvement measures.

7.3.2 Government & Industry Funding

Objective

To receive funding for stormwater quality improvement projects from government and industry groups where mutual benefits can be achieved in the McCreadys Creek Catchment.

Rationale

Various government agencies, departments and groups such as MWNRM, GBRMPA, and EPA provide opportunities to receive funding that would assist implementation of stormwater quality improvement measures in McCreadys Creek.

In particular, strategies from the McCreadys Creek CMP that have regional benefits and may attract funding include:

- The McCreadys Creek Waterway Health Monitoring Program;
- Retrofitting existing stormwater infrastructure in residential areas to remove urban pollutants as a demonstration project with educational and water quality benefits.

Industry bodies may also assist in funding by providing price reductions for use of their equipment if mutual benefits can be obtained.

Other Council's have also provided incentives for developers to encourage the adoption of water sensitive urban design in their developments.

Actions

- Inform government funded groups, authorities and agencies such as MWNRM, GBRMPA and EPA of initiatives to improve stormwater quality and riparian management and apply for assistance for funding of these projects where there are regional benefits from the initiatives.
- Seek expressions of interest from companies involved in the supply of stormwater quality improvement devices to see if mutual benefits could be exchanged for the supply/installation of devices eg Council receive a discounted price and monitor and report on effectiveness & companies receive promotional benefits and field results in return.
- Seek expressions of interest from developers in the McCreadys Creek catchment to nominate a showcase project where Best Practice Stormwater Quality Management is to be implemented and Council and the Developer contribute and benefit.
- Investigate incentives to encourage all developers to adopt water sensitive urban design features in their developments.

7.3.3 Funding Through Infrastructure Charges Schedules

Objective

To obtain funding for trunk stormwater quality management infrastructure through Infrastructure Charges Schedules contained in Priority Infrastructure Plans. *Note: The Government has not yet finalised its arrangements for PIPs and infrastructure charging under the IPA. Until such time as this occurs, the existing approach to collecting headworks contributions from developers via conditions placed on development approvals in accord with planning scheme headworks policies will continue.*

Rationale

The *Integrated Planning Act 1997* (IPA) allows Councils to prepare priority infrastructure plans (PIP) to be incorporated in their Planning Schemes to provide for the funding of trunk infrastructure including stormwater quality management infrastructure.

Council has indicated that they will be preparing Infrastructure Charges Schedules (ICS) for stormwater infrastructure. An infrastructure charges schedule (ICS) is a mechanism for funding the supply of the trunk infrastructure identified in the PIP. These are in preference to Infrastructure Payments Schedules (IPS), which can only be applied as conditions of development approvals and not levied on existing users.

Development infrastructure is divided into two categories under IPA. These categories, and their relevance to stormwater quality management infrastructure is as follows:

- Trunk infrastructure - shared infrastructure eg. gross pollutant traps and regional wetlands; and
- Non-trunk infrastructure – individual user benefits eg. an on-site stormwater detention basin.

The Guidelines (Consultation Draft of June 2004) for PIPs indicate that:

- Infrastructure charges can only be levied for trunk infrastructure; and
- The supply of non trunk infrastructure can be conditioned if:
  - networks are internal to the premises;
  - connecting the premises to external infrastructure networks;
  - protecting or maintaining the safety or efficiency of the infrastructure network of which the non-trunk infrastructure is a component (DLGPS&R).

For stormwater quality, the trunk infrastructure servicing or providing benefits to the catchment includes all works associated with high frequency / low volume events (ie first flush). Infrastructure that treats and removes pollutants from first flush run off events includes gross pollutant traps, trash racks, interception devices, wetlands etc.

Water Quality Infrastructure items to be funded using infrastructure charges are the works required to achieve Council's water quality objectives in each catchment.

The stormwater quality component is to be based upon an assessment of the ultimate development of an individual catchment in accordance with the Mackay City Plan and an identification of works required to achieve Council's water quality objectives and, in particular, its specific objectives of maintaining and enhancing natural drainage lines within the catchment.

Costs are apportioned across a particular catchment so that all development is included in apportioning the cost of water quality management works.

$$Infrastructure\ Charge\ Rate = \frac{Cost\ of\ Stormwater\ Quality\ Management\ Works}{Total\ Equivalent\ Contributing\ Area}$$

Different land uses have different effects on stormwater quality. The Draft Guidelines for Infrastructure Charges Schedules (November 2003) indicate that an acceptable method for apportioning costs based on providing stormwater quality control devices is to attribute a factor to different land use types based on their effects on stormwater quality eg light industry would be expected to have a smaller water quality factor than heavy industry.

The relative contribution from each land use is identified as an impermeability factor, which is a measure of the potential runoff from each land use in comparison to urban residential, for example, 2.5 x QUDM Fraction Impervious. The calculation behind the Stormwater Quality Factor is shown in Table 7-1.

Table 7-1 Apportionment Factor for Landuse Types for Stormwater Quality Charges

Land Use	Mackay City Strategic Plan	QUDM Fraction Impervious	SWQ Factor
Central Business District	CBD Commercial	1.0	2.25
Commercial & Industrial Commercial	Major Business/Industry	0.9	2.25
Urban Res High Density	Higher Density Residential	0.75	1.88
Urban Res Low Density	Urban Residential	0.4	1
Rural Res	Park Residential	0.3	0.675
Rural Res	Rural Residential	0.2	0.45
Open Space	Open Space	0	0
Other	Special Uses, Village, Tourism	Dependant on Use	

The infrastructure charge is determined by multiplying the area by the SWQ Factor by the Infrastructure Schedule Rate.

As detailed in Section 6, the infrastructure charge rate for stormwater quality in the McCreadys Creek catchment is approximately $1,830/ha. This figure however does not conclude that the proposed measures will achieve the WQO for the catchment as the water quality objectives for the catchment are interim values and not specific to the McCreadys Creek catchment. This can only be done once there is sufficient local data obtained.

Actions

- Prepare Infrastructure Charges Schedules for trunk stormwater infrastructure that involves both quantity and quality to apportion the costs associated with improving stormwater quality in the catchment.

7.4 Integrated Planning Issues

7.4.1 Objective

- To ensure that there is a planning and development control framework that contributes to the protection of the agreed environmental values and objectives and supports ecologically sustainable development.
- To integrate the plan into other regional plans.

7.4.2 Rationale

Planning and Development Framework

The preparation of Stormwater Management Plans (SWMP) for high-risk developments (as identified in the Stormwater Quality Management Policy) provides an opportunity for an integrated planning approach to be taken to ensure that the McCreadys Creek environmental values are maintained or enhanced. It is

recommended that developers consider WSUD in larger developments (high risk) by addressing the following in their SWMP:

- Storage rather than conveyance of stormwater;
- Maintenance and enhancement of water quality;
- Water conserving landscaping;
- Conservation of water related environments;
- Use of vegetation for stormwater treatment;
- Localised water supply for irrigation;
- The preparation of Erosion and Sediment Control Plans for building works; and
- The preparation of Soil and Water Management Strategies for operational works.

Regional Planning

Proposed measures to maintain and enhance McCreadys Creek's ecosystems need to be consistent with regional plans and discussed with regional bodies such as MWNRM as such groups may assist Council in:

- Coordinating and implementing work programs to implement the measures eg rehabilitation of riparian vegetation, weed management etc.
- Providing incentives and support for groups; and
- Providing mechanisms for community involvement in natural resource management.

7.4.3 Actions

- Discuss proposed improvement measures in the catchment with Regional groups such as MWNRM to ensure that an integrated approach is taken to integrated management in the catchment.
- Require, through the Development Approval process (as identified in the Stormwater Quality Management Policy for large, high-risk developments), the preparation of Stormwater Management Plans (SWMP) that apply the principles of water sensitive urban design.
- Review the effectiveness of the development approval process in achieving implementation of WSUD in new developments within McCreadys Creek eg. proportion of new developments adopting WSUD features in new developments.
- Modify planning codes (and acceptable solutions) if WSUD is not being adopted in new developments.

7.5 Implementation

Table 7-2 summarises the necessary actions, which have been derived from the strategies to improve stormwater quality in Mackay. The actions are focussed on delivering outcomes for:

- Communication;
- Education;
- Social;
- Environmental;
- Financial; and
- Integrated Planning.

Table 7-2 Action Plan for McCreadys Creek Catchment

No.	Initiative	Estimated Cost	Priority	Planning & Environmenta Services	Infrastructure Services				Financial & Info Systems	Community & Customer Service
					Works Operations	Technical Services	Parks & Recreation	Mackay Water		
Communication Strategy										
COMMc1.1	Communicate the contents of the draft CMP once approved by Council to stakeholders and the community through information sessions. Invite written submissions on the draft and ensure these issues are addressed in the final version prior to it being endorsed by Council.	$5,000	04/05 a	I		L				I
COMMc1.2	Prepare media releases/public coverage of McCreadys Creek projects on a regular basis. Examples of projects include water quality monitoring, SQIDs, revegetation etc.	$5,000	04/05 c	C		L				I
COMMc1.3	Liaise with the region's organisations involved in natural resource planning to ensure that improvement efforts in the catchment are consistent and effort is not duplicated,	Internal Council Process	04/05 a	L		I				
Education Strategy										
EDMc1.1	Actively involve the community and stakeholders in the development and implementation of stormwater quality improvement projects in the McCreadys Creek catchment.	Internal Council Process	05/06	I		L				C
EDMc1.2	Continue to promote activities such as 'Clean Up Australia', which have both litter reduction and stormwater quality improvement benefits in McCreadys Creek.	Internal Council Process	04/05 c	L		I				C
EDMc1.3	Investigate implementing an educational programs in schools such as "Adopt a waterway" in consultation with MWNRM's Heathy Waterways Education Officer.	$10,000	04/05 b	L		I				C
EDMc1.4	Prepare guidelines (eg Water Quality guidelines) as identified in the Mackay SWQMP to assist developers in improving stormwater quality management.	$30,000 - $50,000	04/05 a	I	I	L	I			C
Social Strategy										
SOCMc1.1	Ensure that guidelines prepared for developers to support WSUD initiatives address social issues such as performing risk assessments to ensure that public safety, pest control/management, maintenance and amenity issues are assessed and managed appropriately.	Internal Council Process	04/05 a	I	C	L	C	C		I

No.	Initiative	Estimated Cost	Priority	Planning & Environmenta Services	Infrastructure Services				Financial & Info Systems	Community & Customer Service
					Works Operations	Technical Services	Parks & Recreation	Mackay Water		
SOCMc1.2	Consult with adjoining landholders and the community when planning stormwater quality infrastructure to ensure that recreational values will be maintained or enhanced by the proposed works.	Internal Council Process	04/05 b	I	I	L	I			
SOCMc1.3	Consult with representatives of Traditional Owners when planning infrastructure in the catchment to ensure that cultural heritage values will not be compromised by the proposed works.	Internal Council Process	04/05 b	I	I	L	I			C
Environment Strategy										
Environmental										
EnvMc1.1	Continue to maintain and improve the riparian vegetation within the McCreadys Creek Catchment through revegetation projects, and work with landholders and developers to improve the natural environment and wildlife habitat. An example of Council's brochure, which promotes the preservation and improvement of riparian vegetation is shown beside. Note: All revegetation works should be done in conjunction with the Natural Environment Program.	Internal Council Process	04/05 b							
EnvMc1.2	Prepare a program to implement the SQIDs specified in Table 6-7 to maintain and enhance the identified environmental values for the McCreadys Creek catchment.	$5,000	04/05 b							
EnvMc1.3	Action priorities 1 to 7 specified in Table 6-7 1 by 2010.	$740,000	Ongoing		I	L				
EnvMc1.4	Prepare a program to implement revegetation/rehabilitation of areas identified on Figure 6-7.	$5,000	04/05 b	L		I				
Monitoring										
ENVMc2.1	Review and implement the McCreadys Creek Waterway Health Monitoring Program in consultation with other key stakeholders involved in waterway health monitoring programs eg. the MWNRM Healthy Waterways program, MPA, EPA, DPI &F, GBRMPA.	$60,000 (year 1) $50,000 pa after for 4 years (min)	04/05 a	I		L		I		
ENVMc2.1	Prepare Annual Reports on the Waterway Health Monitoring Program and provide these to other key stakeholders involved in waterway health monitoring programs.	Internal Council Process	05/06 a	C		L				
ENVMc2.1	Revise WQO for McCreadys Creek considering water quality data and MUSIC model calibrated specifically to the Mackay region.	$15,000	05/06	I		L				

No.	Initiative	Estimated Cost	Priority	Planning & Environmenta Services	Infrastructure Services				Financial & Info Systems	Community & Customer Service
					Works Operations	Technical Services	Parks & Recreation	Mackay Water		
ENVMc2.1	Continue to participate in regional working groups/committees involved in Integrated Health Monitoring Systems eg MWNRM Healthy Waterways Committee.	Internal Council Process	04/05 a	C		L				
Financial										
Internal Funding										
FUNDMc1.1	Ensure funding allocated from Council's environment levy is used for implementation of stormwater quality improvement strategies in McCreadys Creek catchment.	Internal Council Process	04/05 a			L				
FUNDMc1.2	Ensure a portion of funds allocated for Council's works within the McCreadys Creek Catchment adopt WSUD features.	Internal Council Process	05/06 a			L				
Government & Industry Funding										
FUNDMc2.1	Inform government funded groups, authorities and agencies such as MWNRM, GBRMPA and EPA of strategies specific to McCreadys Creek and seek assistance for funding of these projects.	Internal Council Process	04/05 a			L				
FUNDMc2.2	Seek expressions of interest from companies involved in the supply of stormwater quality improvement devices to see if mutual benefits could be exchanged for the supply/installation of devices eg Council receive a discounted price and monitor and report on effectiveness & companies receive promotional benefits and field results in return.	Internal Council Process	05/06			L				
FUNDMc2.3	Seek expressions of interest from the development industry to nominate a showcase project where Best Practice Stormwater Quality Management is to be implemented and Council and the Developer contribute and benefit.	Internal Council Process	05/06			L				
Funding from Infrastructure Charges Schedules										
FUND3.1	Prepare Infrastructure Charges Schedules for trunk stormwater quality infrastructure that involves both quantity and quality to apportion the costs associated with improving stormwater quality in the catchment.	Internal Council Process	04/05 a			L				
Integrated Planning										
IPMc1.1	Discuss proposed improvement measures in the catchment with Regional groups such as MWNRM to ensure that an integrated approach is taken to integrated management in the catchment.	Internal Council Process	04/05 a	L		C				

No.	Initiative	Estimated Cost	Priority	Planning & Environmenta Services	Infrastructure Services				Financial & Info Systems	Community & Customer Service
					Works Operations	Technical Services	Parks & Recreation	Mackay Water		
IPMc1.2	Require, through the Development Approval process (as identified in the Stormwater Quality Management Policy for large, high-risk developments), the preparation of Stormwater Management Plans (SWMP) that apply the principles of water sensitive urban design.	Internal Council Process	04/05 a	L		C				
IPMc1.3	Review the effectiveness of the development approval process in achieving implementation of WSUD in new developments within McCreadys Creek eg. proportion of new developments adopting WSUD features in new developments.	Internal Council Process	05/06 & 06/07	C		L				
IPMc1.4	Modify planning codes (and acceptable solutions) if WSUD is not being adopted in new developments.	$10,000	05/06 & 06/07	C		L				

Key:

04/05 2004/2005 Financial Year
05/06 2005/2006 Financial Year
06/07 2006/2007 Financial Year
a High Priority
b Medium Priority
c Low Priority
L Leader of the process
I Provides input to the process
C Consulted during the process

8. Conclusions and Recommendations

The following conclusions and recommendations are made for the McCreadys Creek Catchment Management Plan:

8.1 Conclusions

- McCreadys Creek is a highly developed catchment, which discharges into the Coral Sea approximately 7 km north of the Mackay CBD. The catchment encompasses an area of 3,112 ha from Blacks Beach in the north to Mt Pleasant in the south.
- Agricultural development is likely to have commenced in the catchment in the 1860s (Richmond Estate).
- Existing Landuse:
  - Approximately 61 % of the catchment is used for rural purposes such as sugarcane, grazing and rural residential development.
  - Approximately 21 % of the catchment is used for residential purposes; and
  - 18 % of the catchment is open space (predominantly the estuarine areas of McCreadys Creek). The balance of the catchment is zoned commercial with this area located in Rural View. Development in the catchment, originally for sugarcane cultivation, has occurred since the 1860s.
- In the next 5-10 years, residential development in the catchment is set to almost double. This development is largely at a loss of rural land used for either grazing or sugarcane cultivation.

The environmental values for the catchment, ranked in order of importance (high and medium values only) are:

- Aquatic ecosystem - plants, animals and their ecological interactions.
- Wildlife habitat - riparian wildlife and their habitat, food and drinking water.
- Human consumption - health of humans consuming produce (fish etc) from the ecosystem.
- Visual recreation – amenity of waterway for recreation (no contact with water) such as walking and picnicking adjacent to a waterway.
- Secondary recreation - health of humans during recreation that involves indirect contact with the water such as fishing, boating, rowing.
- Cultural heritage – indigenous and non-indigenous cultural heritage such as custodial, spiritual, hunting, gathering, ritual responsibilities, landmarks etc.
- Farm domestic supply, irrigation of crops and or stock watering.

McCreadys Creek has a highly valued aquatic ecosystem. It is a valued fish nursery and is also frequently used for recreational pursuits such as fishing, crabbing, walking and picnicking. The area has high cultural heritage values for Traditional owners.

There is limited water quality or aquatic ecosystem health data available in the catchment. Developer funded water quality monitoring programs are presently being implemented in the western reach of McCreadys Creek.

In the future, if measures are not taken to improve stormwater quality, nutrient loadings to the Coral Sea will increase by 3.2 tonnes of nitrogen and 0.1 tonnes of phosphorus. Sediment loads may decrease through the conversion of agricultural land to residential land. This however is only in the operational phase of residential development once the disturbed areas are stabilised through vegetation cover etc. There is a high risk of sediment loads increasing during the construction phase if adequate measures are not taken to control erosion and sedimentation.

In addition to water quality impacts, further loss of valued aquatic and terrestrial ecosystems may occur without improved management in the catchment.

8.2 Recommendations

It is recommended that the following priority actions, as identified in Section 7, are undertaken in 2004/2005:

- Communicate the contents of the draft McCreadys Creek CMP (once approved by Council) to stakeholders and the community. Estimated cost of $5,000.
- Liaise with the region's organisations involved in natural resource planning to ensure that improvement efforts in the catchment are consistent and effort is not duplicated.
- Prepare guidelines (eg Water Quality Guidelines as part of the AUSPEC Development Manual) as identified in the Mackay SWQMP to assist developers in improving stormwater quality management in future developments. Estimated cost of $30,000 - $50,000.
- Amend Codes in the Draft IPA Planning scheme as identified in the SWQMP (estimated cost of $10,000 to $20,000). Relevant changes that will benefit the McCreadys Creek catchment include:
  - Amend Planning Codes such as the Infrastructure Code to require "maximising WSUD principles in planning and design", preparation of "Site Based Stormwater Management Plans (SBSWMP) to be prepared in accordance with the Water Quality Guidelines referenced by the Development Manual".
  - Consider separate codes, such as: a "Stormwater Management Code" to integrate planning, design and implementation of water quality and quantity; a "Natural Wetland Areas and Waterway Code" to provide acceptable solutions such as "development to be set back 100 m from the HAT line of a tidal wetland"; a "Parkland and Open Space Code" to integrate public open space with conservation corridors, stormwater management systems and recreational facilities (these 'Greenways' may have a minimum width of 50-80 m if linkages are of ecological importance); and an "Erosion and Sediment Control Code" to detail requirements for erosion and sediment control at the construction and operational stages.
- Review and implement the McCreadys Creek Waterway Health Monitoring Program in consultation with other key stakeholders involved in waterway health monitoring programs such as the MWRNRM Healthy Waterways program, MPA, EPA, DPI &F, GBRMPA. Estimated cost of $60k for first year, subsequent years estimated to cost $50,000. Seek funding assistance from other stakeholders to implement the program.
- Continue to participate in regional working groups/committees involved in Integrated Health Monitoring Systems eg MWRNRM Healthy Waterways Committee.
- Ensure funding allocated from Council's environment levy is used for implementation of stormwater quality improvement strategies in McCreadys Creek catchment.

- Prepare Infrastructure Charges Schedules for trunk stormwater quality infrastructure that involves both quantity and quality to apportion the costs associated with improving stormwater quality in the catchment.
- Require, through the Development Approval process (as identified in the Stormwater Quality Management Policy for large, high-risk developments), the preparation of Stormwater Management Plans (SBSWMP) that apply the principles of water sensitive urban design (WSUD).
- Prepare a program for implementation of recommended water quality control measures eg. Gross pollutant traps, trash racks, constructed wetlands, revegetation etc based on Council's budget and likely contributions from stakeholders.
- Investigate implementing an educational programs in schools such as "Adopt a waterway" in consultation with MWNRM's Heathy Waterways Education Officer.
- Actively involve the community and stakeholders in the development and implementation of stormwater quality improvement projects in the McCreadys Creek catchment.
- Continue to maintain and improve the riparian vegetation within the McCreadys Creek Catchment through revegetation projects. In conjunction with the National Environment Program.
- Implement the balance of actions as identified in Section 7 in 2005/2006.

9. References

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Appendix A

Waterway Assessment

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 1				
SITE DESCRIPTION: Lower end of catchment, estuary mouth (end of Pacific Drive)				
DATE: 12/07/04		TIME: 11:00 am		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: Sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals:	No			
Any Human Activity: Evidence of fire, rubbish (vehicle bodies), extensive clearing, tracks				
Animal Life: Birds, fish				
Flow level: No flow [ ] (dry/isolated)	Low [ ] (< water mark)	Moderate [X] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 0 %	Right bank: 0 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [ ]	Lowland [X]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 90 %				
Width of Riparian Zone:	Left Bank: 10 m		Right Bank: 10 m	
Composition of Riparian Zone:	Native: 80%		Exotic: 20%	
Riparian Vegetation:	Grass: 10 %		Trees <10 m high: 35 %	
	Shrubs: 20 %		Trees > 10 m high: 35 %	
Major Vegetation Type: Native: *Corymbia tessellaris, Acacia sp., Melaleuca sp.* Exotic: *Panicum maximum* (Guinea grass)				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Lower end of catchment, catchment mouth.

Weeds situated at site.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 2				
SITE DESCRIPTION: Swale behind subdivision (end of Cowrie St)				
DATE: 12/07/04		TIME: 11:15 am		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: Sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Evidence of fire, rubbish, recreational use				
Animal Life: birds, fish				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 0 %	Right bank: 10 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [ ]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [X]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [ ]	Lowland [X]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 90 %				
Width of Riparian Zone:	Left Bank: 10m		Right Bank: 10 m	
Composition of Riparian Zone:	Native: 80%		Exotic: 20 %	
Riparian Vegetation:	Grass: 10 %		Trees <10 m high: 80 %	
	Shrubs: 5 %		Trees > 10 m high: 5 %	
Major Vegetation Type: Native: *Melaleuca leucadendra* (evidence of dieback), sclerophyll woodland surrounding Exotic: *Panicum maximum (*guinea grass)				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Melaleuca leucadendra dominated swale.

Evidence of dieback along bank.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 3				
SITE DESCRIPTION: Overview of lower estuary wetlands (from Eulbertie Avenue)				
DATE: 12/07/04		TIME: 11:30 am		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS: (N/A as just an overview of estuary)				
Weather: sunny, calm				
Water Odour:	None [ ]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [ ]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [ ]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [ ]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals:				
Any Human Activity:				
Animal Life:				
Flow level: No flow [ ] (dry/isolated)	Low [ ] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank …..%	Right bank …..%		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [ ]	None [ ]
Sediment Deposits:	None [ ]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [ ]	
Local point source pollution:	No evidence [ ]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [ ]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [ ]	Lowland [ ]	
Adjacent landuse:	Urban [ ]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: %				
Width of Riparian Zone:	Left Bank:		Right Bank:	
Composition of Riparian Zone:	Native:		Exotic:	
Riparian Vegetation:	Grass: %		Trees <10 m high: %	
	Shrubs: %		Trees > 10 m high: %	
Major Vegetation Type: Native: *Rizophora/Brugiera* mangroves, *Ceriops*, *Osbornia, Avicennia, Sporobolus virginicus, Melaleuca leucadendra, Eucalyptus tereticornis, Corymbia tessellaris, Acacia sp.* Exotic:				
MACROPHYTES:				
Emergent:	None [ ]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [ ]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [ ]	Little [ ]	Moderate [ ]	Lot [ ]

Overview of McCready Creek lower estuary wetland.

Overview of McCready Creek lower estuary wetland.

Overview of McCready Creek lower estuary wetland.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 4				
SITE DESCRIPTION: Mid McCready Creek (end of Bovey Road)				
DATE: 12/07/04		TIME: 12:15 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Sugar cane farming adjacent to site				
Animal Life: Birds				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 5%	Right bank: 5 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [X]	Midland [ ]	Lowland [ ]	
Adjacent landuse:	Urban [ ]	Semi-urban [ ]	Irrigated cropping [X]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 10 %				
Width of Riparian Zone:	Left Bank: < 5 m		Right Bank: < 5 m	
Composition of Riparian Zone:	Native: 50 %		Exotic: 50 %	
Riparian Vegetation:	Grass: 40 %		Trees <10 m high: 10 %	
	Shrubs: 40 %		Trees > 10 m high: 10 %	
Major Vegetation Type: Native: *Terminalia sericocarpa, Syzygium tierneyanum, Mangifera indica, Livistonia sp, Ficus sp.* Exotic: *Tithonia diversifola* (Japanese sunflower), *Urochloa mutica, Sphagneticola trilobata*				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Riparian vegetation along McCready Creek.

Weed infestation within McCready Creek.

Riparian vegetation along McCready Creek.

Tithonia diversifolia (Japanese sunflower) dominates McCreadys Creek.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 5				
SITE DESCRIPTION: Upper McCready Creek (where creek crosses Mackay-Habana Road)				
DATE: 12/07/04		TIME: 12:30 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Sugar cane adjacent to creek				
Animal Life: no				
Flow level: No flow [X] (dry/isolated)	Low [ ] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 0 %	Right bank: 0 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [X]	Midland [ ]	Lowland [ ]	
Adjacent landuse:	Urban [ ]	Semi-urban [ ]	Irrigated cropping [X]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 1 %				
Width of Riparian Zone:	Left Bank: < 5 m		Right Bank: < 5 m	
Composition of Riparian Zone:	Native: 5 %		Exotic: 95 %	
Riparian Vegetation:	Grass: 60 %		Trees <10 m high: 5 %	
	Shrubs: 30 %		Trees > 10 m high: 5 %	
Major Vegetation Type: Native: *Nauclea orientalis* Exotic: *Tithonia diversifolia* (Japanese sunflower), *Panicum maximum* (guinea grass)				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Tithonia diversifolia (Japanese sunflower) dominates McCreadys Creek.

Vegetation along McCreadys Creek.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 6				
SITE DESCRIPTION: Overflow from detention basin near golf course (Golflinks Road)				
DATE: 12/07/04		TIME: 12:40 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: Yes				
Any Human Activity: Constructed drain. Surrounding landuse is golf course and grazing.				
Animal Life: Birds				
Flow level: No flow [ ] (dry/isolated)	Low [ ] (< water mark)	Moderate [X] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 100 %		Right bank: 100 %	
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [X]	Limited [ ]	None [ ]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Local point source pollution:	No evidence [ ]	Potential [X]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [ ]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [X]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other: Golf course	
RIPARIAN VEGETATION:				
Canopy Cover: 0 %				
Width of Riparian Zone:	Left Bank: 0 m		Right Bank: 0 m	
Composition of Riparian Zone:	Native: 0 %		Exotic: 100 %	
Riparian Vegetation:	Grass: 100 %		Trees <10 m high: 0 %	
	Shrubs: 0 %		Trees > 10 m high: 0 %	
Major Vegetation Type: Native: Nil Exotic: *Urochloa mutica* (para grass)				
MACROPHYTES:				
Emergent:	None [ ]	Little [X]	Moderate [ ]	Lot [ ]
Submerged:	None [ ]	Little [X]	Moderate [ ]	Lot [ ]
Floating:	None [ ]	Little [ ]	Moderate [X]	Lot [ ]

Constructed drain.

Detention Basin near Mackay Golf Course.

Detention Basin near Mackay Golf Course.

Constructed Drain.

Birds at site.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 7				
SITE DESCRIPTION: Open cane drain (crosses Beaconsfield Road)				
DATE: 12/07/04		TIME: 1:15 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Surrounding landuse is canefields, channel has recently been excavated downstream				
Animal Life: No				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 0 %	Right bank: 0 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [X]	Limited [ ]	None [ ]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [ ]	Semi-urban [ ]	Irrigated cropping [X]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: < 5%				
Width of Riparian Zone:	Left Bank: < 5 m		Right Bank: < 5 m	
Composition of Riparian Zone:	Native: 5 %		Exotic: 95 %	
Riparian Vegetation:	Grass: 90 %		Trees <10 m high: 0 %	
	Shrubs: 5 %		Trees > 10 m high: 5 %	
Major Vegetation Type: Native: Isolated *Syzygium tierneyanum* Exotic: *Ipomea aquatica, Persicaria attenuata, Urochloa mutica*				
MACROPHYTES:				
Emergent:	None [ ]	Little [X]	Moderate [ ]	Lot [ ]
Submerged:	None [ ]	Little [X]	Moderate [ ]	Lot [ ]
Floating:	None [ ]	Little [X]	Moderate [ ]	Lot [ ]

Weed infestation in open cane drain.

Weed infestation in open cane drain.

Open cane drain.

Recently excavated channel.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 8				
SITE DESCRIPTION: Open Urban Drain along Nadarmi Drive				
DATE: 12/07/04		TIME: 2:00 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [ ]	Little [ ]	Moderate [X]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Surrounding landuse is residential houses, school, day care centre. Rubbish abundant in drain.				
Animal Life: Birds				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 90 %	Right bank: 90 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [ ]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [X]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [X]	Obvious [ ]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 0 %				
Width of Riparian Zone:	Left Bank: 0 m		Right Bank: 0 m	
Composition of Riparian Zone:	Native: 0 %		Exotic: 100 %	
Riparian Vegetation:	Grass: 100 %		Trees <10 m high: %	
	Shrubs: %		Trees > 10 m high: %	
Major Vegetation Type: Native: No vegetation along drain, *Avicennia, Melaleuca, samphire* wetland at end of drain Exotic: *Urochloa mutica* infestation along sediment deposition at end of drain				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Open urban drain.

Evidence of rubbish and weeds within drain.

Open urban drain.

Evidence of rubbish within drain.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 9				
SITE DESCRIPTION: Open drain at end of Emperor Drive				
DATE: 12/07/04		TIME: 2:15 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Urban development being constructed around drain				
Animal Life: No				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 10 %	Right bank: 10 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [ ]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other: Silts	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 0 %				
Width of Riparian Zone:	Left Bank: 5 m		Right Bank: 5 m	
Composition of Riparian Zone:	Native: 5 %		Exotic: 95 %	
Riparian Vegetation:	Grass: 100 %		Trees <10 m high: 0 %	
	Shrubs: 0 %		Trees > 10 m high: 0 %	
Major Vegetation Type: Native: No native vegetation surrounding drain, low *Ceriops/Avicennia* shrubland at end of drain Exotic: *Urochloa mutica*				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Weed infestation within drain.

Weed infestation within drain.

Open drain.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 10				
SITE DESCRIPTION: Informal Boat Ramp along Aspley Way				
DATE: 12/07/04		TIME: 2:35 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: Yes				
Any Human Activity: Site surrounded by semi-urban residential houses, site used as informal boat ramp				
Animal Life: No				
Flow level: No flow [ ] (dry/isolated)	Low [ ] (< water mark)	Moderate [X] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 0 %	Right bank: 0 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [ ]	None [X]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [X]	Obvious [ ]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [ ]	Lowland [X]	
Adjacent landuse:	Urban [ ]	Semi-urban [X]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [X]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 100 %				
Width of Riparian Zone:	Left Bank: > 10 m		Right Bank: > 10 m	
Composition of Riparian Zone:	Native: 100 %		Exotic: 0 %	
Riparian Vegetation:	Grass: 0 %		Trees <10 m high: 0 %	
	Shrubs: 100 %		Trees > 10 m high: 0 %	
Major Vegetation Type: Native: high integrity *Rhizophora/Brugiera* vegetation community Exotic: Nil				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Informal boat ramp. Estuarine environment.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 11				
SITE DESCRIPTION: Upstream of McCreadys Creek, along Mackay-Bucasia Road				
DATE: 12/07/04		TIME: 11:50 am		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Site is surrounded by canefarm, major road and residential houses				
Animal Life: Birds, dogs				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 5 %	Right bank: 5 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [X]	Limited [ ]	None [ ]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [X]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 90 %				
Width of Riparian Zone:	Left Bank: 7 – 12 m		Right Bank: 7 – 12 m	
Composition of Riparian Zone:	Native: 70%		Exotic: 30 %	
Riparian Vegetation:	Grass: 15 %		Trees <10 m high: 40 %	
	Shrubs: 5 %		Trees > 10 m high: 40 %	
Major Vegetation Type: Native: Mixed riparian vine forest and sclerophyll, *Pandanus* sp, *Eucalyptus platypylla* Exotic: *Tithonia diversifolia* (Japanese sunflower), *Panicum maximum* (guinea grass), *Sphagneticola trilobata* (Singapore daisy)				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Riparian vegetation upstream McCreadys Creek.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 12				
SITE DESCRIPTION: Downstream of McCreadys Creek, along Mackay-Bucasia Road				
DATE: 12/07/04		TIME: 11:45 am		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Site is adjacent to cane farms, major road and residential houses				
Animal Life: Birds				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank : 0 %	Right bank: 0 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [X]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other……	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [X]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 95 %				
Width of Riparian Zone:	Left Bank: 10 – 20 m		Right Bank: 10 – 20 m	
Composition of Riparian Zone:	Native: 95 %		Exotic: 5 %	
Riparian Vegetation:	Grass: 5 %		Trees <10 m high: 45 %	
	Shrubs: 0 %		Trees > 10 m high: 45 %	
Major Vegetation Type: Native: Moderate to high integrity notophyll vine forest with tall emergents of *Terminalia sericocarpa* Exotic: restricted weeds				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Photos:

Riparian vegetation downstream McCreadys Creek.

Riparian vegetation downstream McCreadys Creek.

Evidence of original remnant vegetation.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 13				
SITE DESCRIPTION: Open urban drain along Emperor Drive				
DATE: 12/07/04		TIME: 2:25 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals: No				
Any Human Activity: Site surrounded by residential houses. Rubbish is evident in drains.				
Animal Life: Birds				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 0 %	Right bank: 0 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [ ]	Limited [X]	None [ ]
Sediment Deposits:	None [ ]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other: silt	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 0 %				
Width of Riparian Zone:	Left Bank: 5 m		Right Bank: 5 m	
Composition of Riparian Zone:	Native: 0 %		Exotic: 100 %	
Riparian Vegetation:	Grass: 100 %		Trees <10 m high: 0 %	
	Shrubs: 0 %		Trees > 10 m high: 0 %	
Major Vegetation Type: Native: No native vegetation surrounding drain. Samphire and low mangrove shrubland at end of drain. Exotic: *Urochloa mutica*				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Weed infestation within open urban drain.

Samphire and low mangrove shrubland at end of drain.

McCREADYS CREEK CATCHMENT MANAGEMENT PLAN INFORMATION SHEET

SITE NUMBER: 14				
SITE DESCRIPTION: Closed urban drain, end of Banksia Avenue				
DATE: 12/07/04		TIME: 2:00 pm		
COLLECTED BY: Andrew Small and Nadine Flor				
LATITUDE:		LONGITUDE:		
ELEVATION (m):				
OBSERVATIONS:				
Weather: Sunny, calm				
Water Odour:	None [X]	Effluent [ ]	Anoxic [ ]	Algae [ ]
Water Foaming:	None [X]	Detergent [ ]	Surf. Spot [ ]	Scum [ ]
Algae (on substrate):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Algae (in water column):	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Presence of Pastoral Animals:	No			
Any Human Activity: Site is surrounded by residential houses and park				
Animal Life: Birds, dog				
Flow level: No flow [ ] (dry/isolated)	Low [X] (< water mark)	Moderate [ ] (= water mark)	High [ ] (> water mark)	Flood [ ]
Bare ground above water mark:	Left bank: 0 %	Right bank: 0 %		
Bank Erosion: Extreme [ ]	Extensive [ ]	Moderate [X]	Limited [ ]	None [ ]
Sediment Deposits:	None [ ]	Sludge [ ]	Sawdust [ ]	Paper fibre [ ]
	Sand [ ]	Relict shells [ ]	Other: Silt	
Local non-point source pollution:	No evidence [ ]	Potential [ ]	Obvious [X]	
Local point source pollution:	No evidence [X]	Potential [ ]	Obvious [ ]	
Dams/barriers:	Absent [X]	Present [ ]		
Site position in catchment:	Upland [ ]	Midland [X]	Lowland [ ]	
Adjacent landuse:	Urban [X]	Semi-urban [ ]	Irrigated cropping [ ]	
	Non-irrigated cropping [ ]	Light grazing [ ]	Mod grazing [ ]	Heavy grazing [ ]
	Forestry [ ]	Native forest [ ]	Other……	
RIPARIAN VEGETATION:				
Canopy Cover: 80 %				
Width of Riparian Zone:	Left Bank: 5 m		Right Bank: 5 m	
Composition of Riparian Zone:	Native: 80%		Exotic: 20%	
Riparian Vegetation:	Grass: 10 %		Trees <10 m high: 35 %	
	Shrubs: 20 %		Trees > 10 m high: 35 %	
Major Vegetation Type: Native: Exotic:				
MACROPHYTES:				
Emergent:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Submerged:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]
Floating:	None [X]	Little [ ]	Moderate [ ]	Lot [ ]

Weed infestation within drain.

Appendix B

McCreadys Creek Waterway Health Monitoring Program (WHMP)

1. McCreadys Creek Waterway Health Monitoring Program (WHMP

1.1 Overview

The collection method and in-situ field testing of water quality conditions is to be undertaken in accordance with the '*Water Quality Sampling Manual'* (Qld EPA, 1999), which is used to test compliance with the *Environmental Protection Act 1994*. The laboratory analysis is to be undertaken by a National Association of Testing Authority (NATA) registered facility. The sampling methodologies for macroinvertebrates would be undertaken in accordance with the "*QLD AUSRIVAS Sampling and Processing Manual*" (Queensland Department of Natural Resources and Mines, 2001) for the collection and processing (live-picking) of macroinvertebrate samples.

The proposed sites, parameters to be tested and the testing frequencies are detailed in Table B-1. The sites have been chosen to determine links between the varying landuses in the catchment eg unimpacted, urban, agricultural etc. The sites are shown on Figure B1-1.

Table B-1-1 McCreadys Creek Water Quality Sampling Program

Site Details	Field Analysis	Laboratory Analysis	Monitoring Type/ Frequency
McWQ1- Freshwater			
Western reach of McCreadys Creek upstream of culvert crossing on Mackay-Habana Road. To represent an unimpacted site.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids	Ambient Monitoring (baseflow, low or no flow conditions) Quarterly eg. January, April, July, October.
	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Stormwater Quality Monitoring (event flow conditions) 4 events per year in months of December, January, February & March 4 events in Event flow
	- Riparian vegetation health	- Macroinvertebrate identification to either family or species level - Counting of individuals of each family (or species).	Biological Six monthly for the first year (eg January & July), then annually

Site Details	Field Analysis	Laboratory Analysis	Monitoring Type/ Frequency
McWQ2 – Freshwater			
Western reach of McCreadys Creek upstream of culvert crossing on Mackay Bucasia Road. To represent a site impacted by rural and urban development.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids	Ambient Monitoring (baseflow, low or no flow conditions) Quarterly eg. January, April, July, October.
	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Stormwater Quality Monitoring (event flow conditions) 4 events per year in months of December, January, February & March 4 events in Event flow
	- Riparian vegetation health	- Macroinvertebrate identification to either family or species level - Counting of individuals of each family (or species).	Biological Six monthly for the first year (eg January & July), then annually
MCWQ3 – Freshwater			
South western drain of McCreadys Creek upstream of multimodal corridor. To represent a site impacted by predominantly urban development.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Stormwater Quality Monitoring (event flow conditions) 4 events per year in months of December, January, February & March 4 events in Event flow
MCWQ4 – Freshwater			
South western drain of McCreadys Creek downstream of Golflinks Road. To represent a site impacted by rural and some urban development.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Stormwater Quality Monitoring (event flow conditions) 4 events per year in months of December, January, February & March 4 events in Event flow

Site Details	Field Analysis	Laboratory Analysis	Monitoring Type/ Frequency
MCWQ5 – Freshwater			
Northern reach of McCreadys Creek. To represent a site impacted by predominantly rural development (grazing) with a high likelihood of development in the next 5-10 years.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids	Ambient Monitoring (baseflow, low or no flow conditions) Quarterly eg. January, April, July, October.
	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Stormwater Quality Monitoring (event flow conditions) 4 events per year in months of December, January, February & March 4 events in Event flow
MCWQ6 – Estuarine			
Main estuarine reach of McCreadys Creek. To represent the estuarine reaches of McCreadys Creek.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids	Ambient Monitoring (baseflow, low or no flow conditions) Quarterly eg. January, April, July, October.
	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Stormwater Quality Monitoring (event flow conditions) 4 events per year in months of December, January, February & March 4 events in Event flow
MCWQ7 – Freshwater			
South eastern drain of McCreadys Creek downstream Nadarmi Drive. To represent a site impacted by urban development.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Event
MCWQ8 – Estuarine			
Main estuarine reach of McCreadys Creek.	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids	Ambient Monitoring (baseflow, low or no flow conditions) Quarterly eg. January, April, July, October.

Site Details	Field Analysis	Laboratory Analysis	Monitoring Type/ Frequency
	- PH - Water Temp - Electrical Conductivity - DO - Turbidity	- Total Nitrogen - Total Phosphorus - Chlorophyll a - Faecal Coliforms - Suspended Solids - Total Recoverable Hydrocarbons - Diuron - Atrazine - Metals	Stormwater Quality Monitoring (event flow conditions) 4 events per year in months of December, January, February & March 4 events in Event flow

Monitoring by community groups such as Waterwatch at a selection of the sites eg McWQ2 (freshwater) and McWQ8 (estuarine) would have mutual benefits to Council and MWNRM. Groups such as Waterwatch monitor field parameters such as pH, Water Temp, Electrical Conductivity, DO, turbidity, phosphorus at monthly intervals. The benefits are in validation of data and in working together to monitor the regions water quality to assess the benefits of changed practices.

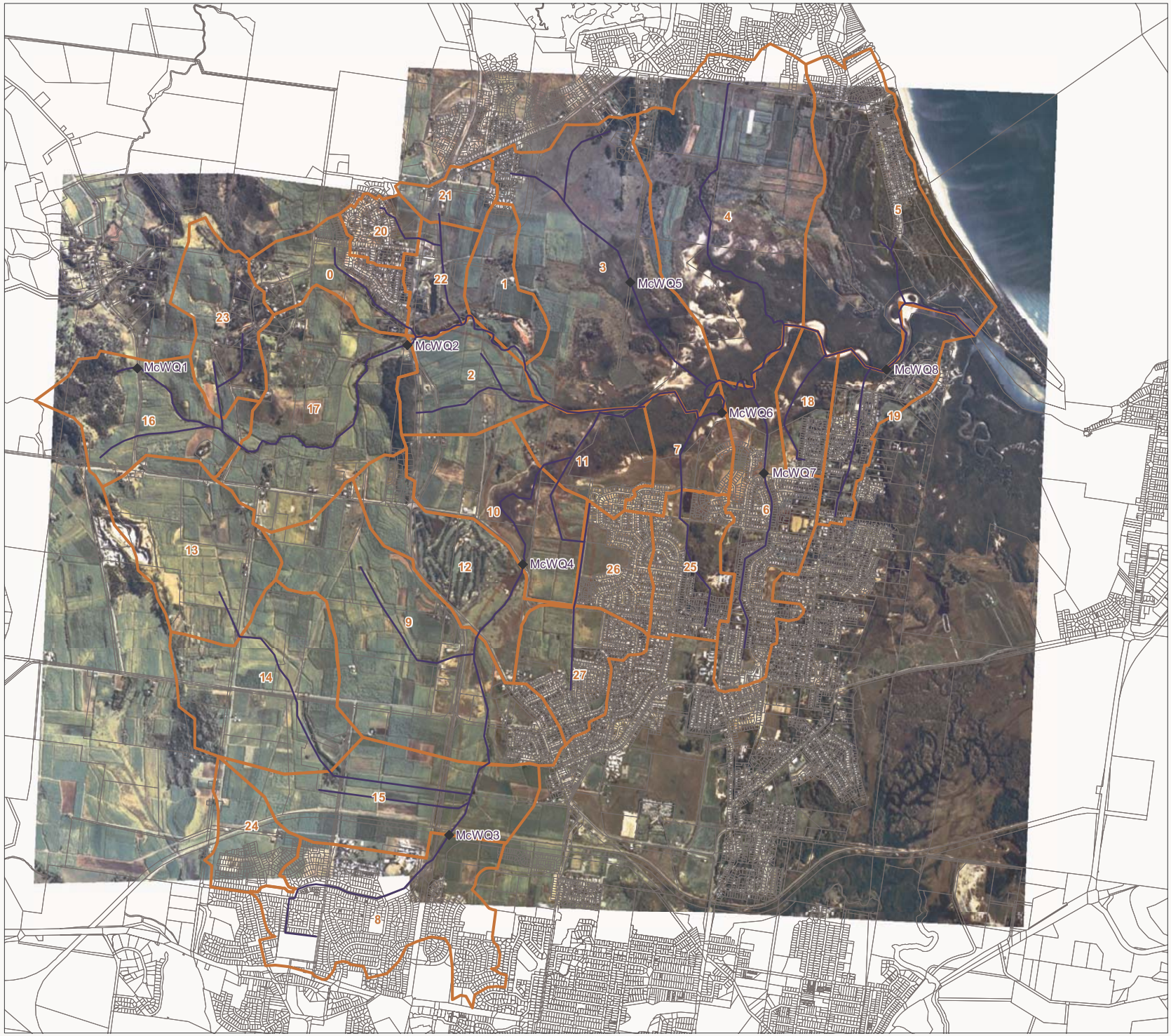
1.2 Time frame

It is recommended that Mackay City Council undertake the WHMP over the long term (min 5 years) and review the program biennially (eg every two years).

1.3 Reporting

It is recommended that annual reports on the WHMP be prepared to analyse and report on the results and review the WQO's for McCreadys Creek.

The reports should contain results for all monitoring sites in box and whisker plots. Box and whisker plots are widely used in reporting water quality information and show where the data points are concentrated (the box) along with the outlying values in the data set. The top of the box in these plots is the 80th percentile (80% of the data fall below this line), while the bottom of the box represents the 20th percentile (20% of the data fall below this line). The square located between the 80th and 20th percentile represents the median (50% of the data fall above and 50% below this number). The whiskers in each box plot represent the minimum and maximum concentrations recorded over the monitoring period.



McCreadys Creek Catchment Management Plan

FIGURE B1-1
McCreadys Creek Waterway Health Monitoring Program (WHMP) Locations

Legend

- Proposed Monitoring Location
- Subcatchment Boundary

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Scale: 1:30,000 (A3)

North

Source Information: Aerial Image, Cadastre and Catchment Plan from MCC

GHD MANAGEMENT ENGINEERING ENVIRONMENT

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DRAFT

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