Basins, Catchments and Receiving Waters of the Black and Ross River Basins Water Quality Improvement Plan Area

May 2009

Australian Government

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Contents

Tables

Page

Figures

Page

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1. Introduction

1.1 Background

Creek to Coral is the manager of the Coastal Catchments Initiative (CCI) project for the Black and Ross River Basins and along with its many partners is responsible for the preparation of a Water Quality Improvement Plan (WQIP). One of the first tasks is to delineate the extent of the receiving water bodies that will be the subject of the WQIP. The estuarine reaches of major waterways, the catchments, sub-catchments and minor drainage systems adjacent to the receiving water body also need to be delineated.

This document provides the rationale for the delineation of the receiving waters and then defines the estuarine reaches of the waterways within the Black and Ross River Basins WQIP study area. The sub-basins, catchments and sub catchments are delineated and the main features of the catchments relevant to the WQIP are described.

1.2 WQIP areas relevant to the GBR

"*The Great Barrier Reef is renowned internationally for its ecological importance and the beauty of its seascapes and landscapes. These natural values also provide important ecosystem services, which underpin Australian $6.9 billion worth of economic activity and incalculable social values. In combination, the social-ecological system centred on the reef is extraordinary in its importance, and in its complexity*" (Johnson and Marshall (eds) 2007, p.2)

The Great Barrier Reef Marine Park (GBRMP) is almost 350,000 square kilometres in area and is located along 2,100 kilometres of the Queensland coastline, spanning 14 degrees of latitude. The Great Barrier Reef (GBR) is a complex maze of about 2900 separate coral reefs accounting for around 6% of the area of the Great Barrier Reef Marine Park.

"*About 36 percent of the Great Barrier Reef Marine Park is continental slope, where the water is between 150 and 2000 metres deep. The remaining 64 percent is continental shelf, including the coral reefs, which is anywhere from 1 to 150 metres deep. The other main geographical components of the continental shelf are the inter-reef areas (25% of the Marine Park) and the lagoon (33%). The vast majority of the coral reefs are found relatively far offshore with the inshore lagoon having few reefs*".

"*Within these major geographic divisions of the Great Barrier Reef are many different types of habitat and biological community. The best known of these are the coral reefs, but there are also seagrass beds, algal meadows, sponge and soft coral gardens, sandy and muddy areas, mangrove forests and islands. This array of habitats supports an amazing biodiversity*" (Johnson and Marshall (eds) 2007, p.3).

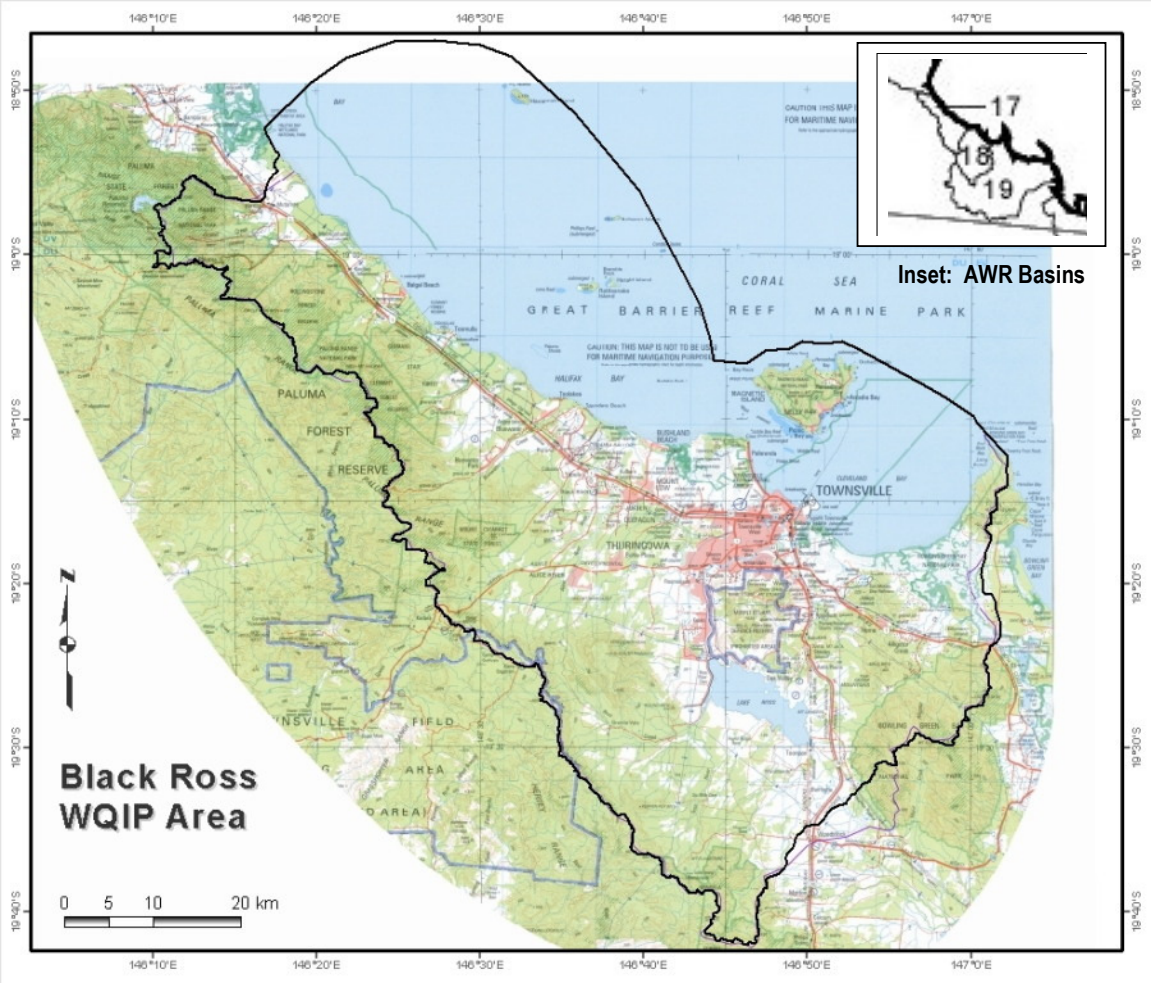
The quality of water in the GBR lagoon is important to the maintenance of the habitats and amazing biodiversity of the GBRMP, and especially of the near shore areas. The water quality of the GBR is impacted by the quality of water entering the GBRMP from the catchments stretching the 14 degrees of latitude from Cape York to the Burnett-Mary catchment. Collectively known as the GBR catchments, the activities that take place on this land mass ultimately have significant impacts on the quality of water of the GBR. The Black and Ross River Basins are part of the GBR catchment and Townsville is home to the largest urban population in the GBR catchments The Black Ross WQIP area is therefore relevant to the Great Barrier Reef and has some water quality issues which are unique to urban population centres.

2. Black Ross Receiving Waters

2.1 Black and Ross Basins WQIP Area

The Black Ross WQIP area covers most waterways within the Townsville City local government area with the exception of the Reid River and Major Creek catchments, which are part of the Haughton River Basin. The WQIP area includes the Black River (No. 17) and Ross River (No. 18) Australian Water Resource Council (AWR) Basins and a small part of the Haughton River Basin (No. 19) where the waterways flow to Cleveland Bay. It also includes Magnetic Island, as well as the coastal and marine waters of Cleveland Bay and Halifax Bay

Figure 2-1 Black/Ross WQIP Area

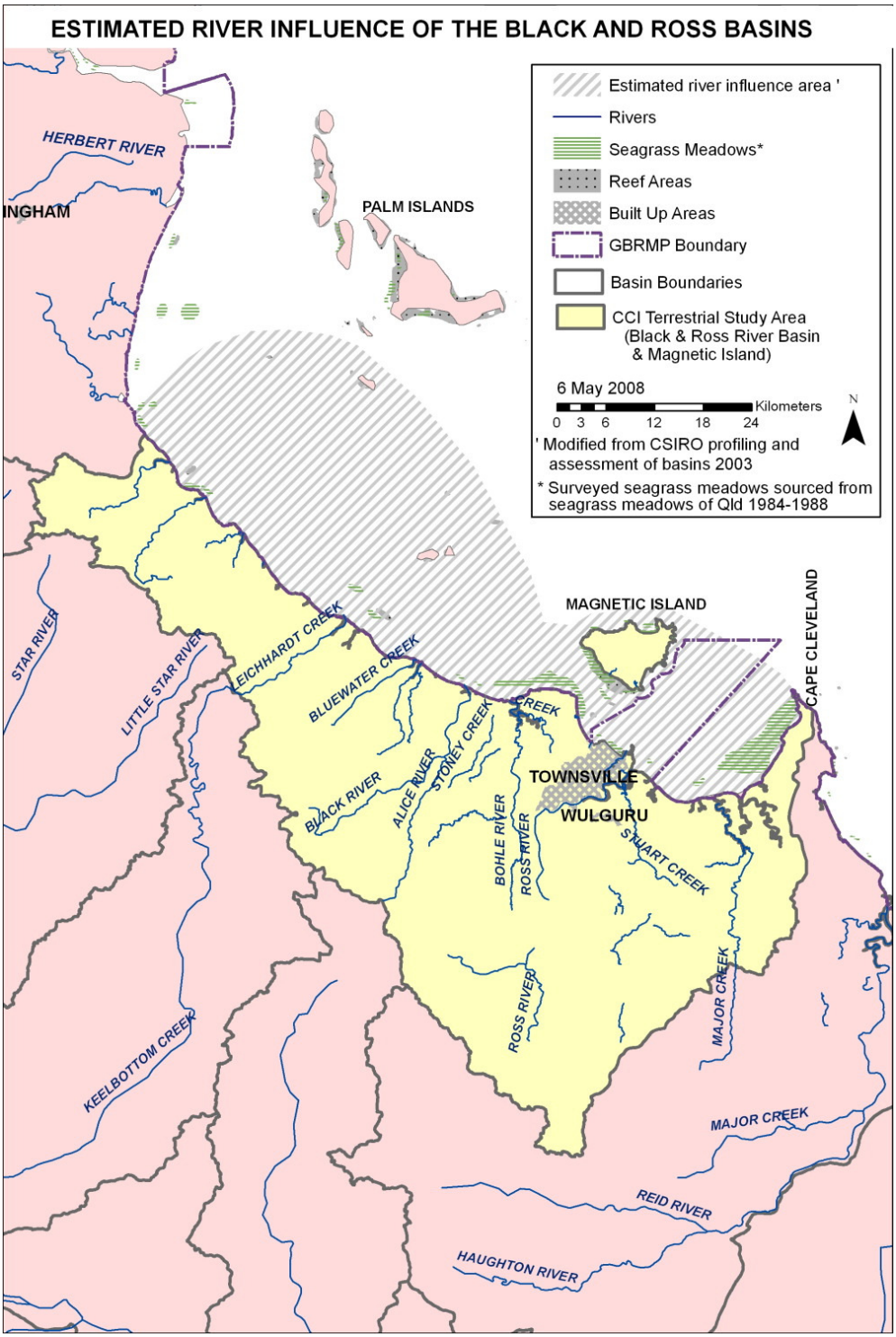


2.2 Black Ross WQIP Receiving Waters

As the initial step in determining the receiving waters of the Black Ross WQIP the estimated areas of marine influence of the Black River and Ross River Basins, as calculated by Greiner et al (2003), were combined. This accounted for the mainland terrestrial influence (see Figure 2-1).

As Magnetic Island is also a part of the Black Ross WQIP area the near coastal zone around the northern extent of Magnetic Island, which could reasonably be expected to be influenced by run-off from the island, was added to the area influenced by the mainland run-off. The result is the marine extent of the receiving waters of the Black Ross WQIP area (see Figure 2-2).

Figure 2-2 Black Ross WQIP Receiving Waters Based on River Influence

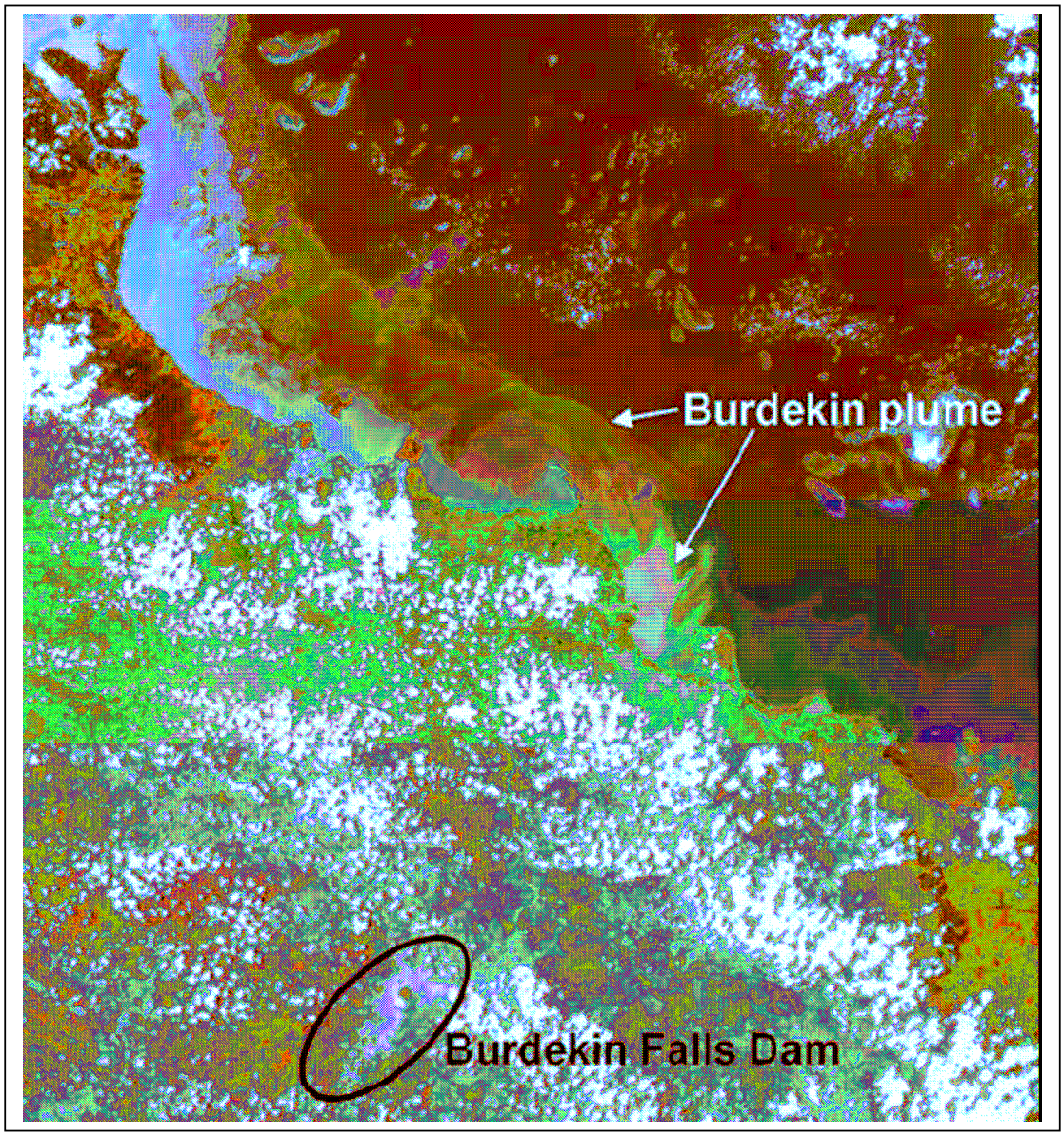


Source: Estimated river/waterway influence prepared by CSIRO based on Greiner et al 2003 report and mapping titled *Profiling and assessment of basins with respect to the sediment, nutrient and other diffuse-source loads they export to the Great Barrier Reef WHA*

2.2.1 Other influences

It is recognised that run-off from the Burdekin and Haughton River Basins (see Figure 2-3) also influences the receiving waters of the Black Ross WQIP area, and especially Cleveland Bay.

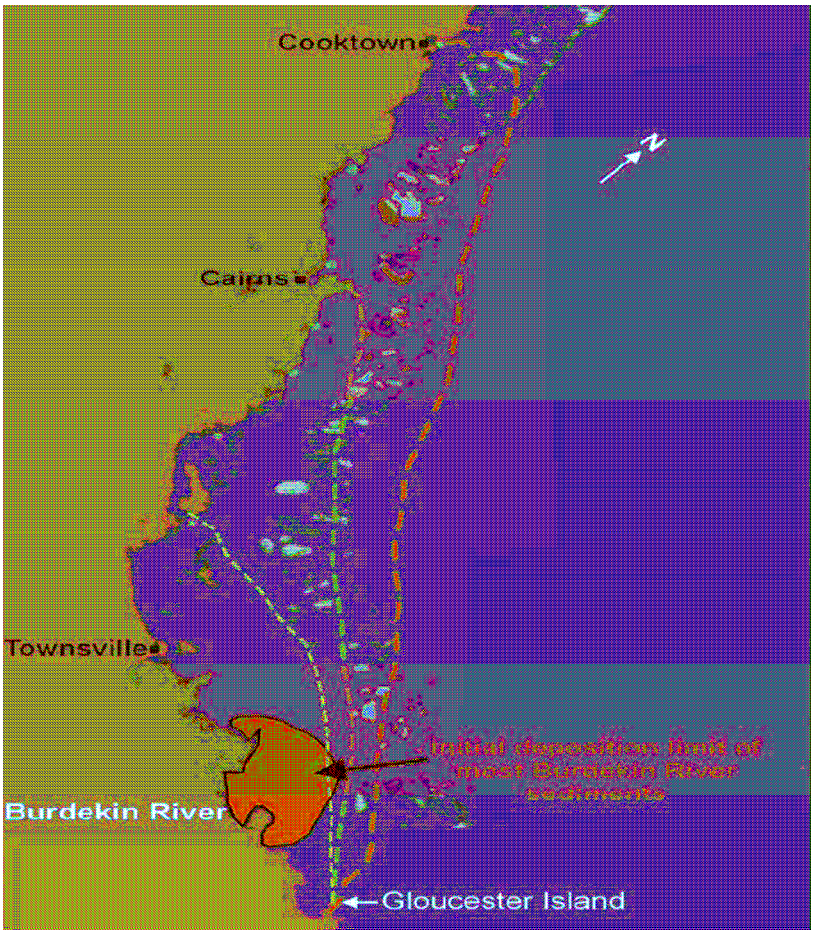
Figure 2-3 Burdekin River Influence on Black Ross WQIP Area



Note: This satellite image of the 2005 Burdekin River shows the plume from the Mackay Whitsunday Rivers joining from the south with the northerly drift. The Burdekin River is characterised by a highly turbid plume near the delta followed by algal outbreaks further away from the river mouth. Source: ACTFR 2007.

"*Most sediments in the Burdekin River plume flocculate and settle out within 10 km from the delta, equivalent to the 0-10‰ salinity zone. These sediments are resuspended and deposited in sheltered north-facing embayments.*

Approximately 80-90% of the fine sediment fraction delivered from the Burdekin River is deposited in Bowling Green Bay while the remaining sediments are trapped within Upstart and Cleveland Bays" (Lewis et al 2006, p.41).



Source: ACTFR 2007.

Notes: Map of the extent of sediments exported from the Burdekin River in the GBR lagoon during very large-extreme events (red dashed line), large events (orange dashed line) and moderate events (yellow dashed line). The limit of the 0-10% salinity zone, where most of the sediment from the Burdekin River is deposited, is shown for the largest Burdekin flood on record (1974) by the red shading.

2.3 Marine Water Quality Condition

Improving the quality of the water entering the Great Barrier Reef lagoon and in particular Cleveland and Halifax Bays is the main priority for the Black Ross WQIP. The condition of these marine areas is affected by runoff from land use activities within the WQIP area (i.e. mostly urban and peri-urban in the Ross Basin and predominantly rural in the Black Basin) as well as from flood plumes originating from the Burdekin and Haughton Basins, particularly during large flood events.

Recent water monitoring quality data (ACTFR, 2008) and modeling (BMT WBM, 2009) suggests that Ross River and to a lesser extent the Stuart Creek and Alligator Creek sub basins influence the inshore areas of Cleveland Bay. Flood plumes, especially in large events move up the coast into Halifax Bay where plumes mix with run-off from the Bohle River, Black River and Bluewater Creek and, to a lesser extent from the Rollingstone Creek and Crystal Creek sub basins.

The smaller catchments of Magnetic Island have a limited impact on Cleveland Bay and Halifax Bay with their impact likely to be confined to the bays and near shore areas of the island.

Marine waters are fundamentally different to freshwaters due to higher salt concentrations, variable water depth, tidal influences and the expanse of the waterbody meaning certain water quality parameters are more important for measuring marine water quality condition. In addition, different biological indicators such as sea grass extent and coral condition are used to measure marine ecosystem health.

Marine areas are divided into a number of zones relative to distance from the coastline or continental shelf and the water depth. Near shore and enclosed waters are generally expected to have lower relative water quality than offshore areas due to their proximity to land based run-off and the re-suspension of sediment associated with shallower water.

A set of draft water quality trigger values for chlorophyll a, suspended solids, particulate nutrients and secchi depth (a proxy measure for turbidity) have been developed (GBRMPA 2009). These values outline the levels that if exceeded may threaten the health of GBR ecosystems.

The GBR Marine Monitoring Program (MMP) has established several sites to measure water quality and ecosystem health, some of which are within or immediately adjacent to the WQIP study area. This program measures chlorophyll a, a full suite of nutrients with a particular focus on particulates, secchi depth and range of ecosystem health parameters. Site description and sampling frequency is shown in Table 2-1 and results from this program are presented in Table 2-2

Table 2-1 Marine Sampling Sites

Site description	Sampling period	Samples
Chlorophyll a		
[1] Inside Cleveland Bay (M1)	26/10/1995 to 10/4/2003	58
[2] Magnetic - Geoffrey Bay (M2)	15/02/2007 to 2/07/2008	11
Nelly Bay Jetty (M3)	23/10/2005 to 9/03/2007	20
Outside Cleveland Bay (M10)	26/10/1995 to 10/04/2003	28
[3] Pandora Reef (M7)	27/10/1995 to 31/10/1996	12
[4] Townsville - Middle Reef (M5)	1/01/2007 to 6/06/2007	14
[5] Townsville Shipping Channel (M9)	3/12/2003 to 17/05/2008	10
MMP sites - nutrients etc		
[1] Cleveland Bay (middle)	21/09/2005	1
[2] Geoffrey Bay	21/09/2005 to 24/03/2008	6
Picnic Bay (M4)	21/09/2005 and 31/01/2006	2
Horseshoe Bay (M6)	21/09/2005	1
Magnetic Island (NE of Orchid rocks) (M8)	21/09/2005	1
[3] Pandora Reef	20/09/2005 to 25/03/2008	6
[4] Middle Reef	20/09/2005 to 15/04/2007	4
[5] Underway (Lodestone Reef - Magnetic Island)	31/01/2006	1

Note: MMP sites are listed in the upper rows and historic chlorophyll a sampling sites are listed in the lower rows. The [numbers] in the site description column indicate chlorophyll a sites that are in similar location to MMP sites i.e. [1] Cleveland Bay (middle) is in a similar position to [1] Inside Cleveland Bay. See Figure 2-4 for site locations.

Impacts on the inshore reefs of Cleveland and Halifax Bay are most evident during flood events where the maximum values for chlorophyll a, turbidity and secchi depth all exceeded GBRMPA guidelines. Mean values for chlorophyll a also exceeded guideline values 46% of the time indicating that phytoplankton biomass was an issue of concern throughout the year (Schaffelke et al 2008).

In terms of turbidity Geoffrey Bay Reef had the highest mean turbidity in the Burdekin region of ~3 NTU and this was below the suggested 5 NTU limit for coral photo-physiological stress for ~90% of the time (Schaffelke et al 2008).

Table 2-2 MMP Sampling Results (Mean)

Site description	SS	Chl a	Secchi	NH4	NO2	NO3	DIN	TDN	DON	PN	TN	PO4	TDP	DOP	PP	TP
	mg/L	µg/L	m	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Cleveland Bay (middle)	2.295	0.32	6.5	0.000	0.000	0.000	0.000	52.061	52.061	13.163	65.224	2.999	17.070	14.071	2.081	19.151
Geoffrey Bay	4.524	0.88	4	1.118	0.417	1.611	3.145	69.113	65.968	20.725	89.838	3.134	8.455	5.321	4.552	13.006
Picnic Bay	2.48	0.96	4.25	1.651	0.000	0.460	2.111	74.358	72.247	22.828	97.187	2.483	15.396	12.912	3.810	19.205
Horseshoe Bay	4.14	0.45		0.000	0.000	0.000	0.000	71.361	71.361	17.896	89.257	2.809	19.314	16.505	3.404	22.717
NE of Orchid Rocks	2.07	0.26	9.5	0.000	0.000	0.000	0.000	57.833	57.833	13.582	71.415	3.133	16.700	13.567	1.748	18.448
Pandora Reef	2.12	0.47	6	0.776	0.010	0.325	1.111	63.946	62.835	12.965	76.910	2.533	7.808	5.327	2.649	10.457
Middle Reef	6.00	0.94	2.13	1.498	0.854	1.136	3.488	83.659	80.171	24.589	108.25	3.757	11.855	8.098	6.072	17.927
Underway	3.14	1.19		4.853	0.000	0.000	4.853	97.902	93.049	40.437	138.34	1.363	9.197	7.834	5.447	14.644
Inside Cleveland Bay		0.61														
Magnetic - Geoffrey Bay		0.53														
Nelly Bay Jetty		2.76														
Outside Cleveland Bay		0.39														
Pandora Reef		0.36														
Tvl - Middle Reef		0.52														
Tvl Shipping Channel		0.93														

Source: Australian Institute of Marine Science (AIMS) and GBRMPA Marine Monitoring Program (MMP) as input to Reef Plan reporting. (ClevelandBay_Data_for GBRMPA_Aug08/excel - Chlorophyll a [Chl_Cleveland bay worksheet]).

Studies suggest that generally the Burdekin average for hard coral cover is lower while macroalgae cover is higher when compared with other GBR regions. This may be attributed to the frequency and severity of disturbances to reefs in this region in recent times. Of the reefs monitored in the WQIP region hard coral cover was generally above the overall GBR wide mean but settlement of recruits was lower meaning fewer juvenile colonies and therefore negligible potential for increases in hard coral cover over time.

The exception in our WQIP region is Middle Reef, which continues to exhibit higher than the GBRMP average for hard coral cover and consequently lower than average macroalgae cover for data collected up until 2007/08 (Schaffelke et al 2008*)*. However recent and unpublished data indicates that Middle Reef and other reefs around Magnetic Island have exhibited a significant loss in hard coral cover which is most likely the result of temperature and salinity (freshwater input) stresses, combined with an outbreak in coral disease in 2009 (pers. comm. Groves, P.). Given the lower than average coral recruitment to reefs in this region it is unlikely that these reefs will recover significantly in the short term.

Marine sampling sites within and near the Black Ross WQIP area are displayed in Figure 2-4 with the location of GBRMPA and AIMS marine sampling sites further offshore shown in Figure 2-5.

Figure 2-4 Black Ross WQIP Marine Sampling Points

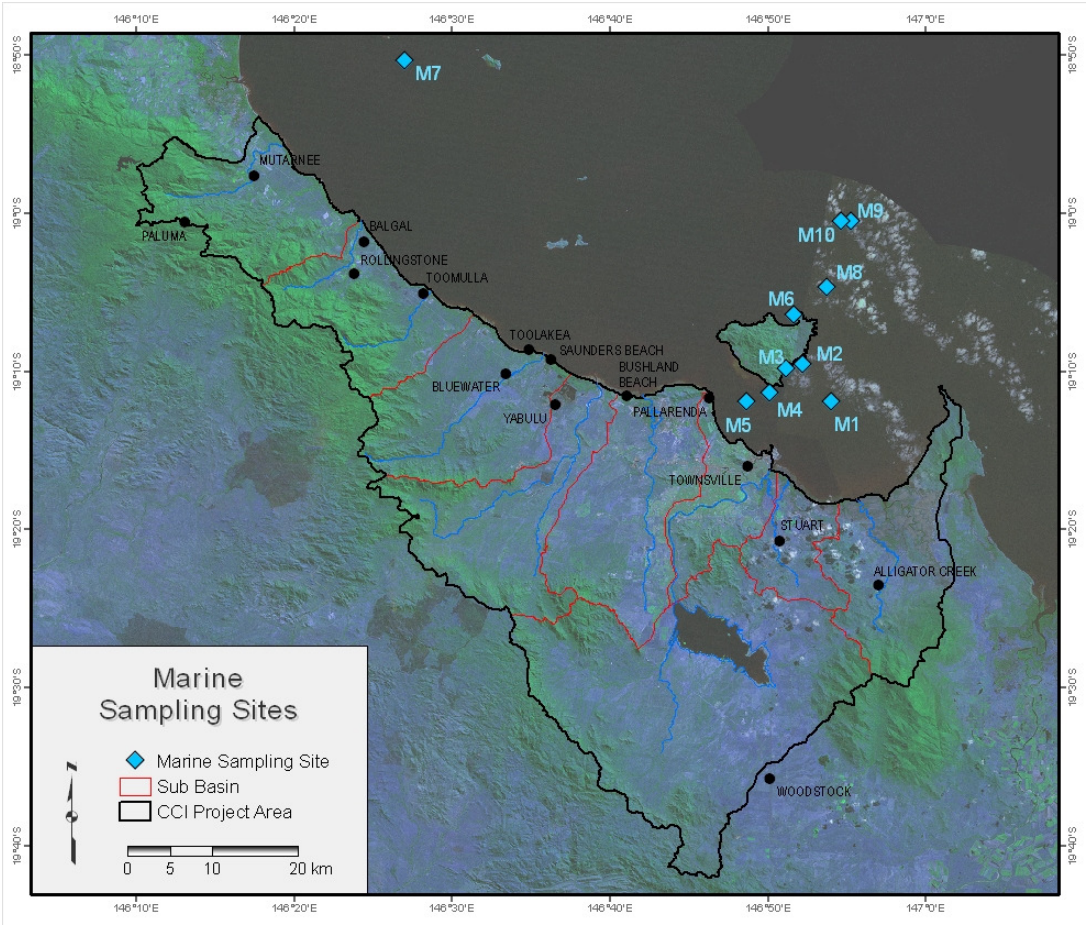
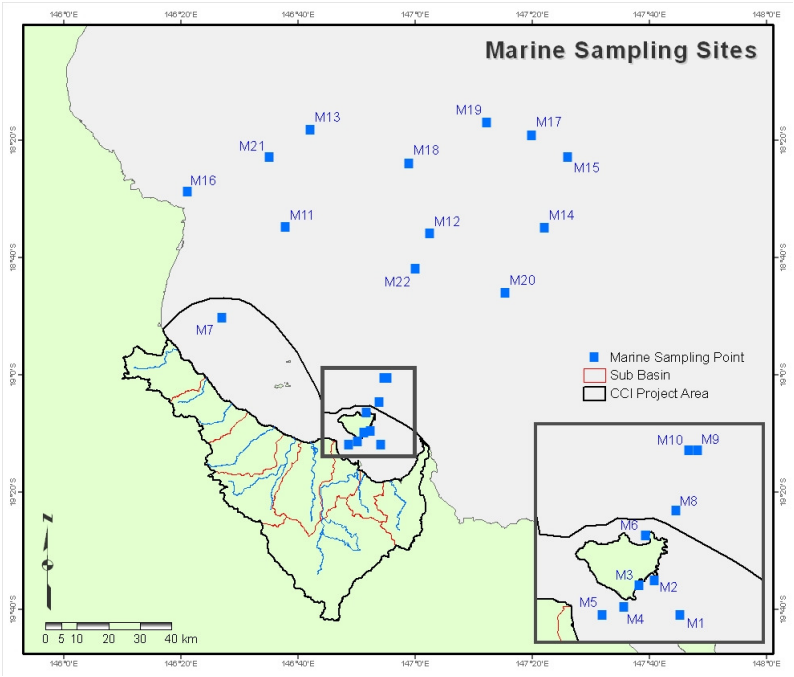


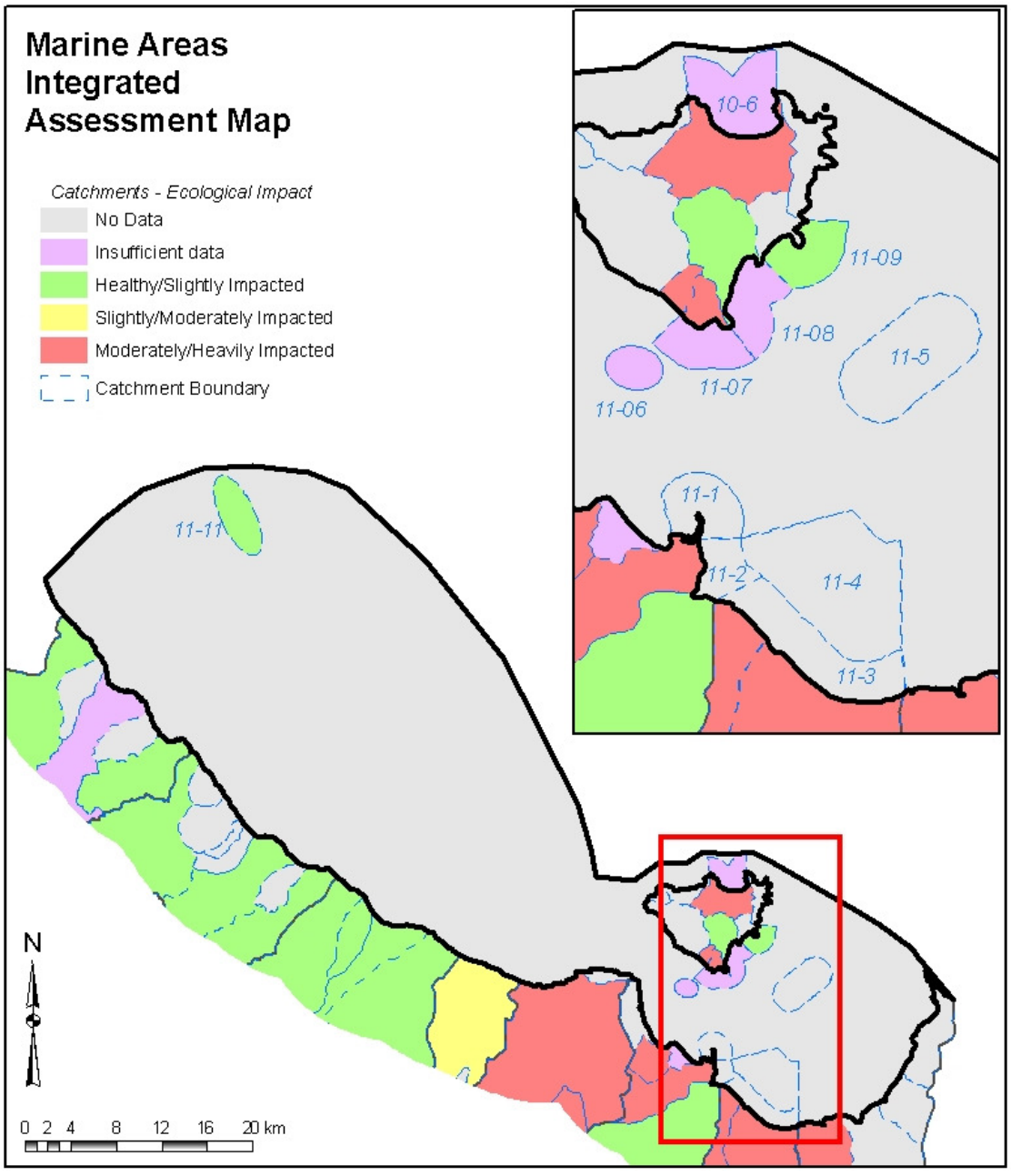
Figure 2-5 GBRMPA and AIMS Marine Sampling Sites



A water quality condition analysis (Connell Wagner 2008) indicated that generally there is insufficient data to assess the water quality for the marine areas of Cleveland Bay, Halifax Bay and the waters around Magnetic Island (see Figure 2-6). From the data available, of the twelve areas, three were assessed as slightly impacted, one was moderately impacted and one was heavily impacted. Of the remaining areas six have insufficient data and one has no data.

Recently recorded data for these areas were generally within the guideline values however the number of monitoring events and the parameters sampled make it difficult to determine the level of impact on these areas.

Figure 2-6 Marine Areas Ecological Impact



Source: Connell Wagner 2008

3. WQIP Area Overview

3.1 Introduction

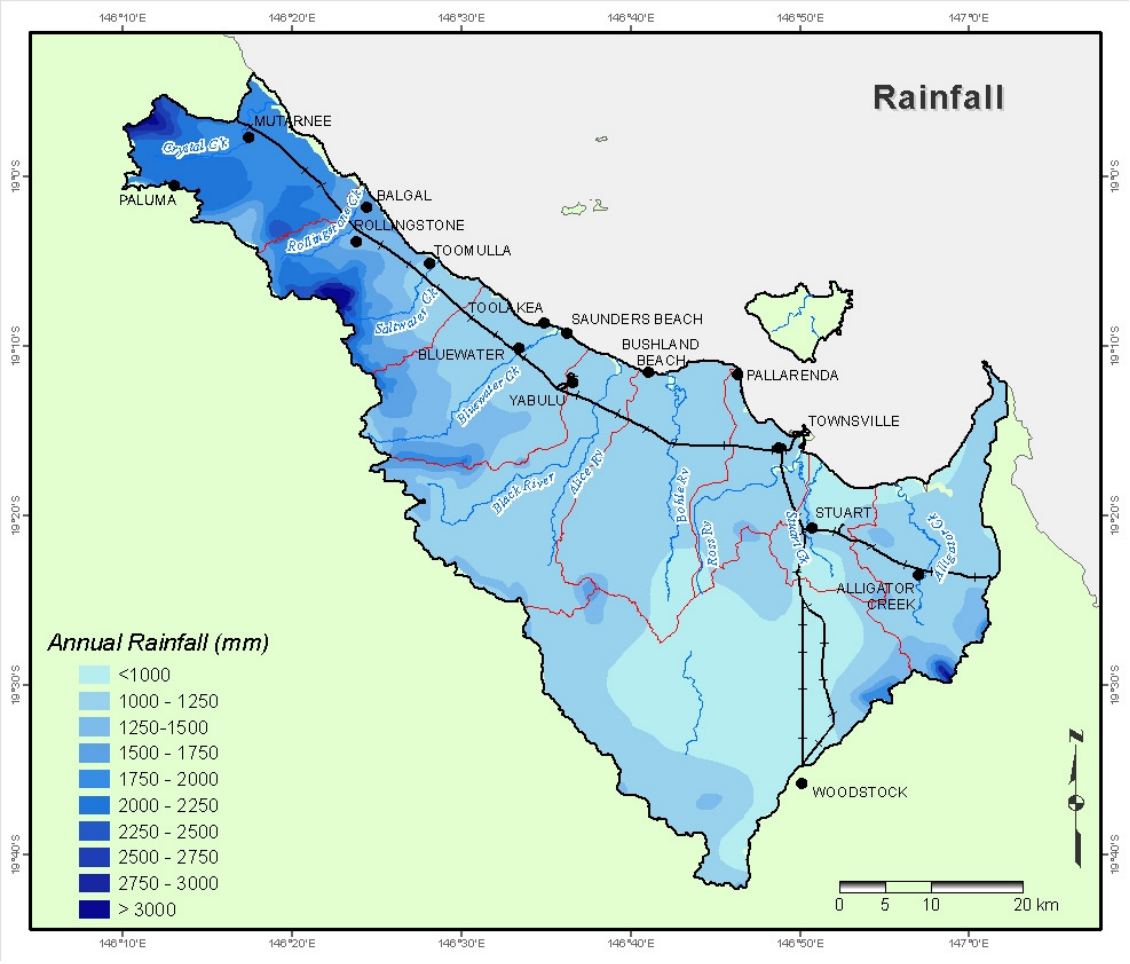
Statistical and descriptive information is not readily available for the overall Black Ross WQIP area so a number of aggregations and desegregations were required to provide a relevant overview (see separate Demographics Report). The overview is based primarily on the Townsville City local government area, which consists of the now combined Townsville and Thuringowa local government statistical divisions (Australian Bureau of Statistics) with modifications to fit the WQIP area.

3.2 Climate

The region typically experiences a dry tropical climate, characterised by a distinct wet and dry season. The typical yearly weather pattern features a short wet summer (December to March) with considerable rainfall, warmer temperatures and higher relative humidity, followed by a period of relatively cooler temperatures, lower humidity and minimal rainfall for the remainder of the year.

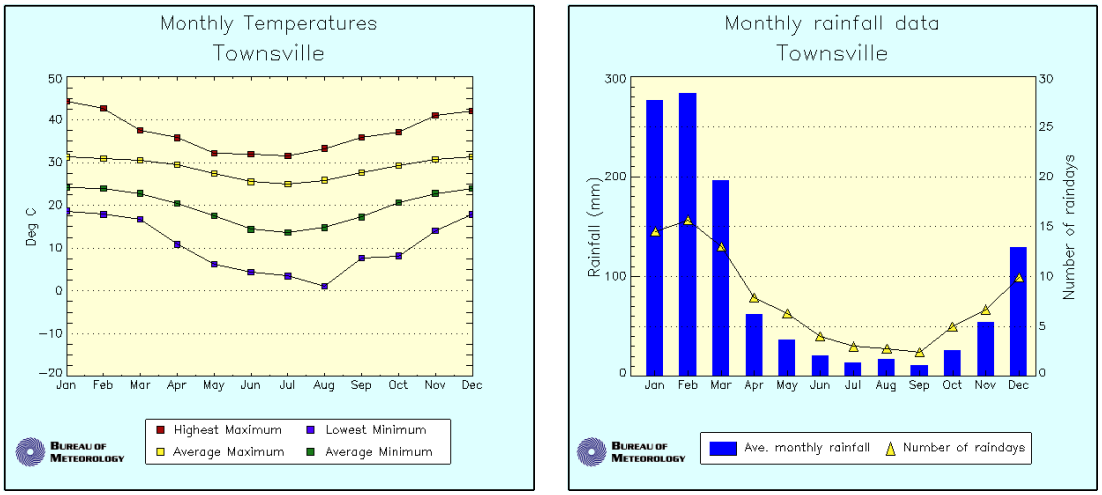
The average annual rainfall for Townsville is approximately 1100 millimetres with substantial variation across the region from a high of 2571 millimetres at Paluma (northern ranges) to a low of 853 millimetres at Woodstock on the western boundary of the WQIP area (see Figure 3-1). In comparison evaporation for Townsville is approximately 2400mm per annum (BOM records 1969-1999).

Figure 3-1 Rainfall



High intensity tropical storms and cyclones are also a feature of the region's weather patterns.

Figure 3-2 Climatic graphs



Source: Bureau of Meteorology (BOM)

3.3 Environment

"*The landscape of Townsville is an abrupt contrast between flat coastal lowlands, isolated mountain masses (Castle Hill, Mount Stuart and Mount Elliot) and the ramparts of the Hervey Range escarpment on the western horizon*" (Trezise and Stephenson 1990) (see Figure 3-4).

A brief explanation of how the region has been shaped is provided in the section on geology (see section 3.3.2).

Figure 3-3 Black/Ross WQIP Google Earth image

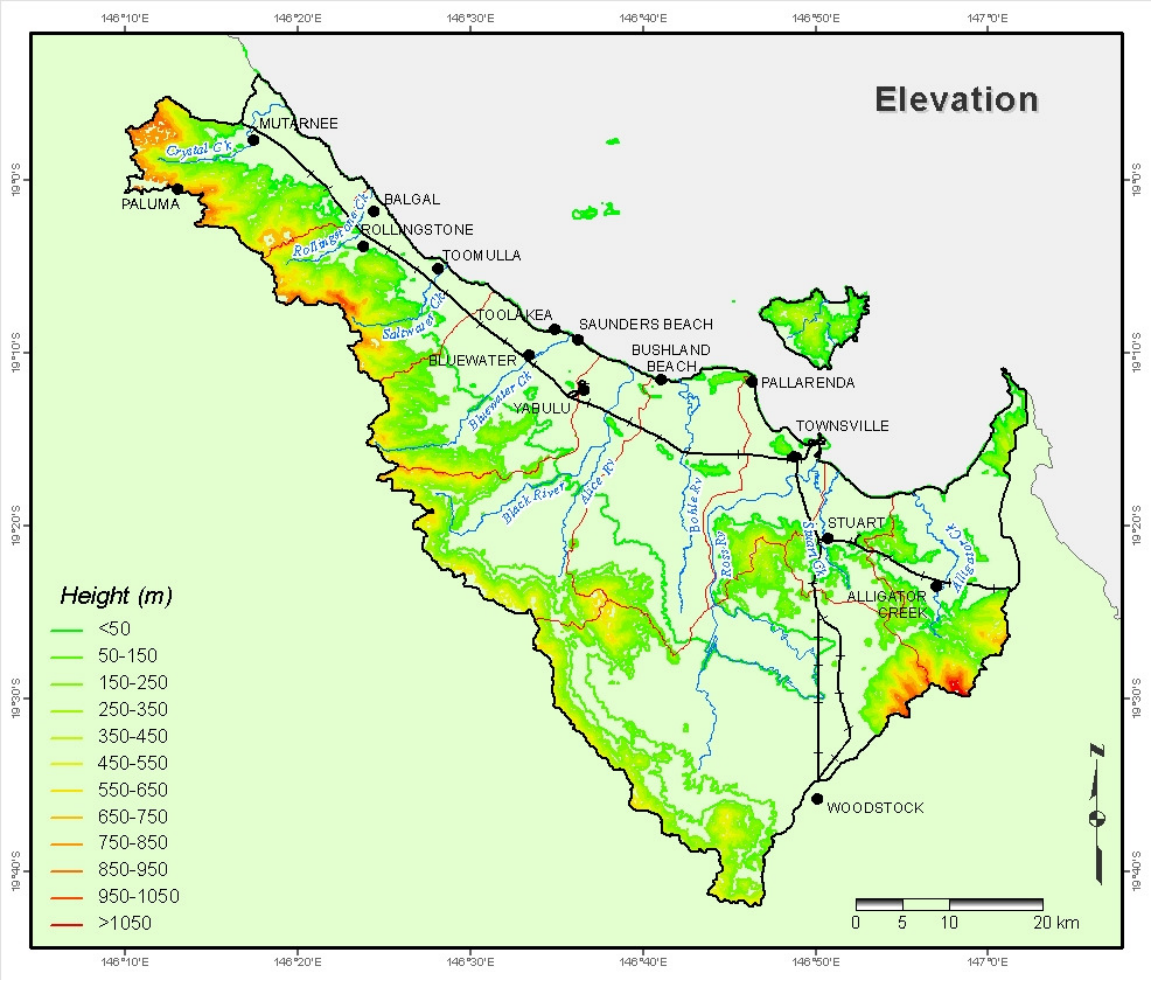
Source: http://wiki.bdtnrm.org.au/index.php/Townsville_Catchments

The region can be roughly divided into four distinctive geographic sections (see Figure 3-3):

- 1 Crystal Creek to Bluewater Creek sub basins – relatively short coastal streams draining the Paluma Range;
- 2 Black River, Bohle River and Ross River sub basins – larger drainage systems dissecting the sediments of the Townsville coastal plain, and bounded the west by the Hervey Range;

- 3 Stuart Creek and Alligator Creek sub basins – relatively short coastal streams draining from the Mt Stuart and Mt Elliot isolated coastal mountain masses, and Cape Cleveland; and
- 4 Magnetic Island.

Figure 3-4 Elevation/Relief Map



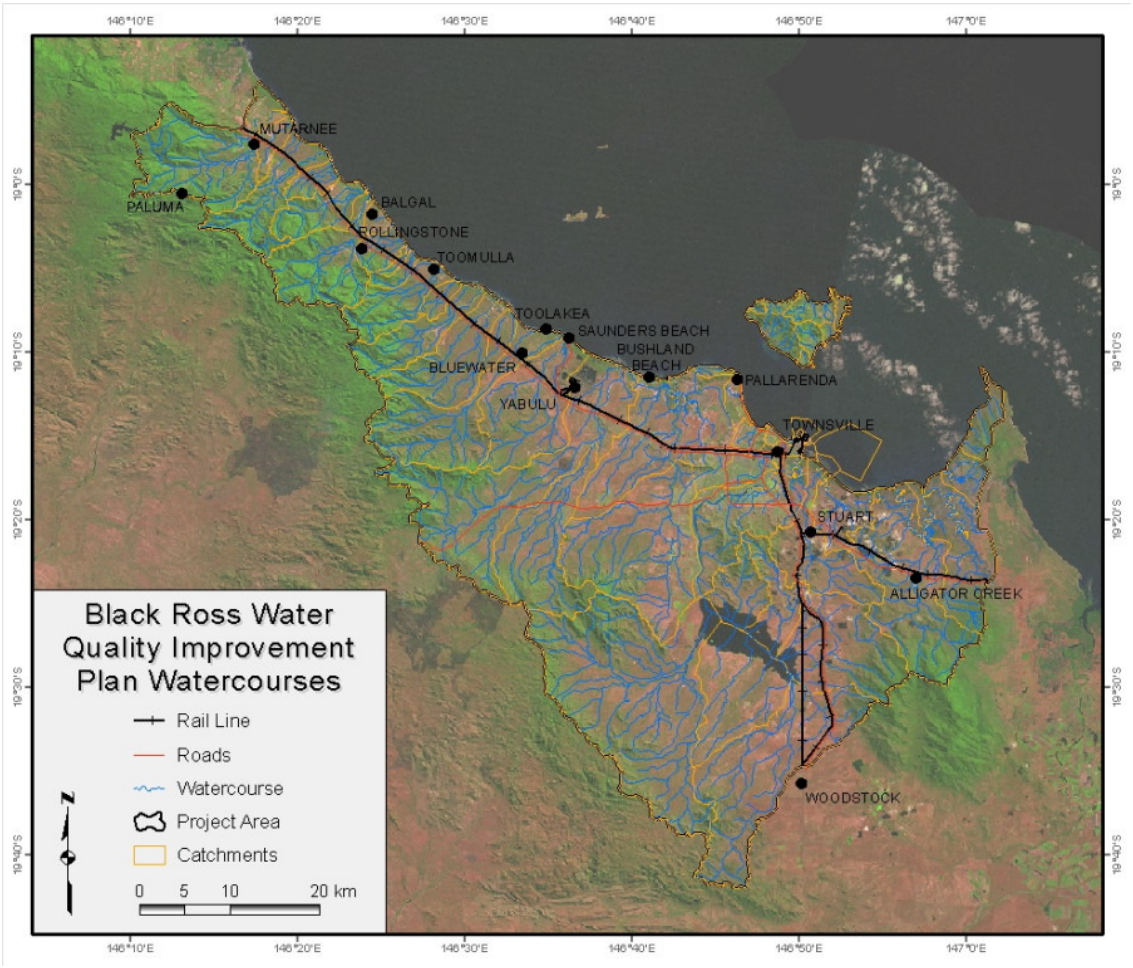
With the exception of some wet tropics vegetation on the Paluma Range and Mt Elliot, the area consists primarily of a savanna landscape (Dry Tropics). The Townsville Dry Tropics environment is primarily a function of the climatic regime and the underlying geology of the region. The main environmental features of the region are described briefly in the following sections.

3.3.1 Drainage

The study area is comprised of two major AWR drainage basins, the Black River and Ross River Basins. There are four rivers and numerous creeks and waterways, which drain the catchments from the escarpments of Mount Elliot, Herveys Range and the Paluma Range in the west to the coast. The drainage system generally trends from southwest, at the headwaters, to northeast.

The drainage of Magnetic Island is a radial system with waterways flowing from the high points in the centre of the island to the various bays around the island. The main drainage features, including primary reaches, of the study area are illustrated in Figure 3-5 with more detailed drainage patterns for each sub basin in section 5.

Figure 3-5 Drainage patterns of the Black/Ross WQIP area



3.3.2 Geology

The principle geological features of the Townsville region consist of remnants of Permian and Carboniferous volcanics and plutonics, protruding above the sedimentary deposits of the coastal plain. "*The regional geological setting for Townsville is complex; ancient rocks about 600 million years old form a basement of foundation which is largely concealed by rocks of younger igneous activity – volcanic eruptions and emplacement of molten granite magmas*" (Trezise and Stephenson 1990).

The oldest rocks in the Townsville region (formed 600 to 460 millions years ago) consist of remnants of a once extensive sedimentary and volcanic sequence, which now occurs around Charters Towers. This ancient basement rock was crumpled and metamorphosed around 480 to 460 million years ago with isolated outcrops occurring on the lower slopes of the Hervey Range and Frederick Peak plateau. Elsewhere they have been eroded away or buried by later volcanic activity.

The ensuing period (500 to 250 million years) was dominated by activities associated with the Tasman Orogenic Zone. This included periods of upheaval and mountain building associated with the movement of tectonic plates, formation and submergence of basins and subsequent erosion of mountains and formation of marine sediments. The evidence of this activity can be seen in the limestone deposits at Calcium, to the west of the Black/Ross WQIP area. While difficult to imagine it is conjectured that the mountains formed in the Tasman Zone might have been as significant as the present European Alps.

Following this period of mountain building and erosion there was a period (320 to 286 million years ago) of large scale eruptions of volcanic material i.e. rhyolite, dacite and andesite. This series of explosive events created large sheets of welded and compacted, very hard volcanic rock. Towards the end of this volcanic episode (296 to 283 million years ago) molten magma rose up through the denser surrounding basement rock to push into and push aside the base of the volcanic pile. The magma slowly cooled to form granites. The granites were eventually exposed after erosion of the older rocks above.

Another period of volcanic activity occurred during the early Permian period (286 to 258 million years ago) believed to be associated with tectonic plate movement. The Julago Volcanics are the remnants of this event with considerable volumes of the material having been eroded. Remnants include parts of Mount Stuart and the hills to the southeast as well as Mount Saint John, Mount Bohle and Many Peaks Range. As with the earlier volcanic event after the Julago Volcanics ceased erupting a period of magmatic intrusion took place. The Magnetic Island Granite, Muntalunga Range Granite and Mount Storth Granite were formed from this process, along with a number of unnamed intrusions northwest of Townsville and Cape Cleveland.

There was a long period of stability (150 million years) marked mainly by the erosion, which removed much of the volcanic sequences to expose the underlying granitic rocks. There was a further period of granitic intrusion during the Cretaceous (144 to 100 million years ago) however most of the activity was off shore from Townsville with only landward evidence of the activity being near Mount Margaret.

Over the next 45 million years (100 to 55 million years ago) an extensive erosion surface was formed with parts of this surface being older. The Hervey Range and Frederick Peak plateau are sections of this surface. Around 65 million years ago there was a significant event, which resulted in the sinking of part of the Australian landmass including the formation of the Townsville Trough and Halifax Basin. This formed a new escarpment, which gradually eroded westwards eating into the higher Cretaceous erosion surface to eventually reach its current position along the Hervey Range. More resistant rocks were left behind as remnant mountains and hills such as Mount Stuart and Mount Elliot.

Sediments resulting from this Tertiary erosion were deposited on the newly formed coastal plain and offshore. Fluctuating sea levels of recent times (last 2 million years) has seen periodic exposure and erosion of the continental shelf with subsequent sea level rise then resulting in erosion of coastal features and a change in marine sediment deposition.

The coastal plain as we see it now is composed of relatively coarse recently weathered and eroded material at the base of the Hervey Range grading into the older (Pleistocene) alluvial plains towards the coast. The material of the alluvial plains was deposited mainly by braided stream systems with a sequence of abandoned and infilled channels visible as slightly raised areas in the Ross, Bohle, Alice and Black River catchments.

Most of the present drainage pattern across the Townsville coastal plain has emerged over the last 6,000 years with the larger rivers and streams cutting narrow channels into the older alluvial plain.
(Source: Trezise and Stephenson 1990).

The major bedrock type for the Black and Ross Basins is igneous material (>95%) compared to the average for the GBR catchments of 62% sedimentary, 34% igneous and 3% metamorphic (Furnas 2003, p. 53). It is the underlying geology of the area, along with the landscape forming functions over time, and climatic conditions that influences the soil types of the region.

Figure 3-6 Main Geological Features

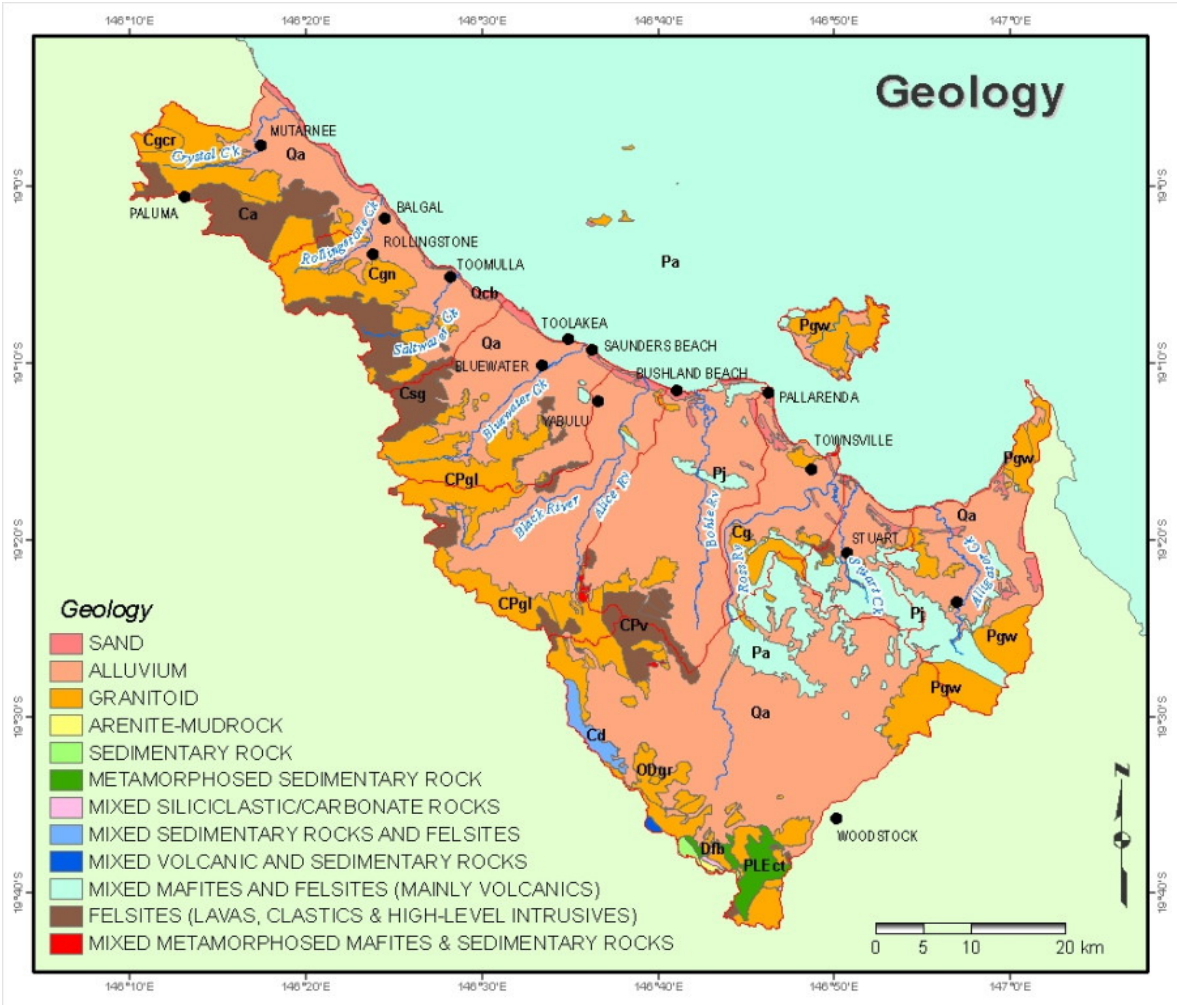


Table 3-1 Geology Key

Dominant Rock	Symbol	Age	Formation	Description
Sand	Qcb	Quaternary		Quartz sand, minor shells (beach barrier deposits)
Alluvium	Qa	Quaternary		Clay, silt, sand, gravel; floodplain alluvium
Granitoid	Cg	Carboniferous		Undivided and/or unassigned granite and granodiorite
	Cgcr		Coane Range Granite Complex	Pink, grey, cream, and orange, fine to coarse-grained, equigranular, seriate, and porphyritic biotite granite and common microgranite; local greisen
	Cgk		Kallanda Granites	Pink, orange, or cream, fine to coarse-grained, porphyritic to seriate biotite granite; common microgranite and abundant greisen and chloritic alteration zones
	Cgn		Clemant microgranite	Grey to pink, abundantly porphyritic biotite microgranite

	Cgrs		Rollingstone Granite	Mottled cream and pink, fine to medium-grained, slightly to abundantly porphyritic biotite granite
	CPgi	Late Carboniferous – Early Permian	Ingham Granite Complex	Pale grey to pale pink, fine to medium-grained porphryritic hornblende-biotite and biotite monzogranite and granodiorite; undivided granites of the northern Ingham Batholith (I-types)
	CPgl	Carboniferous – Early Permian	Leichhardt Suite	Grey biotite and hornblende-biotite granodiorite and granite; microgranite, dacite and volcaniclastic rocks in high-level complexes
Granitoid	Kg	Cretaceous		Hornblende-biotite granodiorite, biotite granite
	ODgr	Ordovician - Devonian	Ravenswood Baotholith	Undivided and/or unassigned granodiorite, tonalite and quartz diorite, minor granite
	Pgw	Permian	Woodstock Supersuite	Pink to red medium-grained, locally miarolitic biotite granite; hornblende-biotite granodiorite, diorite, gabbro
Arenite - Mudrock	Dfc	Middle Devonian	Cultivation Gully Formation	Feldspathic sandstone, yellowish grey to light brown mudstone and siltstone and minor limestone; marine fossils
Sedimentary	Dd	Late Devonian	Dotswood Group	Undivided feldspathic to quartzose sandstone, polymictic conglomerate, and red mudstone and siltstone
	Df	Early - Middle Devonian	Fanning River Group	Undivided calcareous, fossiliferous, feldspathic sandstone, pebbly sandstone and conglomerate, and fossiliferous limestone
Metamorphosed Sedimentary	PLEct	Neo proterozoic - Cambrian	Charters Towers Metamorphics	Mica schist, quartzite, quartz-feldspar-biotite gneiss, hornblende schist; cordierite, andalusite and staurolite hornfelsed, chlorite schist, marble
Mixed siliciclastic carbonate rocks	Dfb	Early - Middle Devonian	Burdekin Formation	Fossiliferous limestone (calcirudite, calcarenite, and lesser calcilutite); minor sandy limestone, calcareous sandstone and mudstone
Mixed sedimentary and felsites	Cd	Early Carboniferous	Mt Douglas Formation	Conglomerate, pebbly sandstone, volcanilithic sandstone, tuffaceous siltstone, rhyolitic ignimbrite and crystal-vitric tuff
Mixed volcanic and sedimentary	CPe	Carboniferous	Ellenvale Beds	Rhyolitic lavas and volcaniclastics, rhyolite breccia, andesite, subgreywacke, feldspathic sandstone, conglomerate, shale, mudstone
Mixed mafites and felsites	Cp	Carboniferous	Percy Creek Volcanics	Basaltic to andesitic lava and volcaniclastics, some rhyolitic ignimbrite
	Pa	Early Permian	Agate Creek Volcanic Group	Basaltic to andesitic lava and volcaniclastics, some rhyolitic ignimbrite
	Pj	Permian	Julago Volcanics	Rhyodacitic welded tuff, agglomerate, andesite, basalt, mudstone, quartzose sandstone

Felsites	Ca	Carboniferous	Paluma Rhyolite	Dark grey, crystal-rich to very crystal-rich rhyolitic ignimbrite
	CPi	Late Carboniferous – Early Permian		Undivided and/or unassigned microgranite, microgranodiorite and granophyre
	CPv	Late Carboniferous – Permian		Unassigned. mainly felsic volcanic rocks, including ignimbrite, lava and epiclastic rocks
	Csg	Carboniferous	Saint Giles Volcanics	Grey to dark grey, sparsely to moderately crystal- and clast-rich, rhyolitic to dacitic ignimbrite, lapilli tuff, and minor breccia; minor flow-banded, spherulitic, moderately porphyritic rhyolite lava
Mixed metamorphosed mafites and sedimentary	PLa/ca	Proterozoic – Early Palaezoic	Argentine Metamorphics	Laminated amphibolite (para?), quartzite, banded-iron-formation, subordinate mica schist

3.3.3 Soils

The dominant soils of the region (78% of all the soils) are saline clays or shallow, sandy loams with a clay substructure (duplex). Soil moisture is a major constraint for production in the region. In fact, soil water recharge potential is very limited west of the Bohle River, north of Hervey Range Road and on the Townsville coastal plain. As a result there is limited intensive agriculture in the region with the exception of the area adjoining the wet tropics region i.e. Crystal and Rollingstone Creek sub basins. The areas of the main soil types in the Black and Ross Basins are listed in Table 3-2 and Table 3-3.

Table 3-2 Soil Structure Types

Element (GBRC%)	Black River (117)		Ross River (118)		Black Ross WQIP Area	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Clay (16.1)			12,300	7.2	12,300	4.5
Duplex (24.9)	46,400	43.9	108,600	63.6	155,000	56.1
Earth (24.7)	57,400	54.4	32,300	18.9	89,700	32.5
Loam (11)			7,300	4.3	7,300	2.6
Sand (11.9)	1,800	1.7	9,800	5.7	11,600	4.2
Unclassified (0.4)			400	0.2	400	0.1
Totals	10,600		170,700		276,300	

Source: Furnas 2003 (pp. 57-58) Table 8 Dominant soil structural types (Source Soils of Australia digital coverage 1999)
Note: Other soil types not mentioned in the Black and Ross Basins: Red, Brown, Yellow (11% GBR), Organic (0.4% GBR) (p. 58)

Table 3-3 Australian Great Soil Groups

Soil Group	Black River (117)		Ross River (118)		Black Ross WQIP Area	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Alluvial Soil	1,800	1.7	19,900	11.7	21,700	7.9
Grey Clay		0.0	1,300	0.8	1,300	0.5
Gleyed Soil		0.0	4,100	2.4	4,100	1.5
Humic Gley		0.0	11,000	6.4	11,000	4.0
Krasnozem	13,000	12.3	8,900	5.2	21,900	7.9
Red Earth	44,600	42.2	18,700	10.9	63,300	22.9
Solodic Soil	800	0.8	8,700	5.1	9,500	3.4
Red Podzolic	3,200	3.0	12,300	7.2	15,500	5.6

Yellow Podzolic	42,200	40.0	85,500	50.1	127,700	46.2
Unclassified		0.0	400	0.2	4	0.1
Totals	105,600		170,800		276,400	

Source: Furnas 2003 (p. 56) Table 7 Australian Great Soil Groups (Source CSIRO 1999)

Figure 3-7 Soils

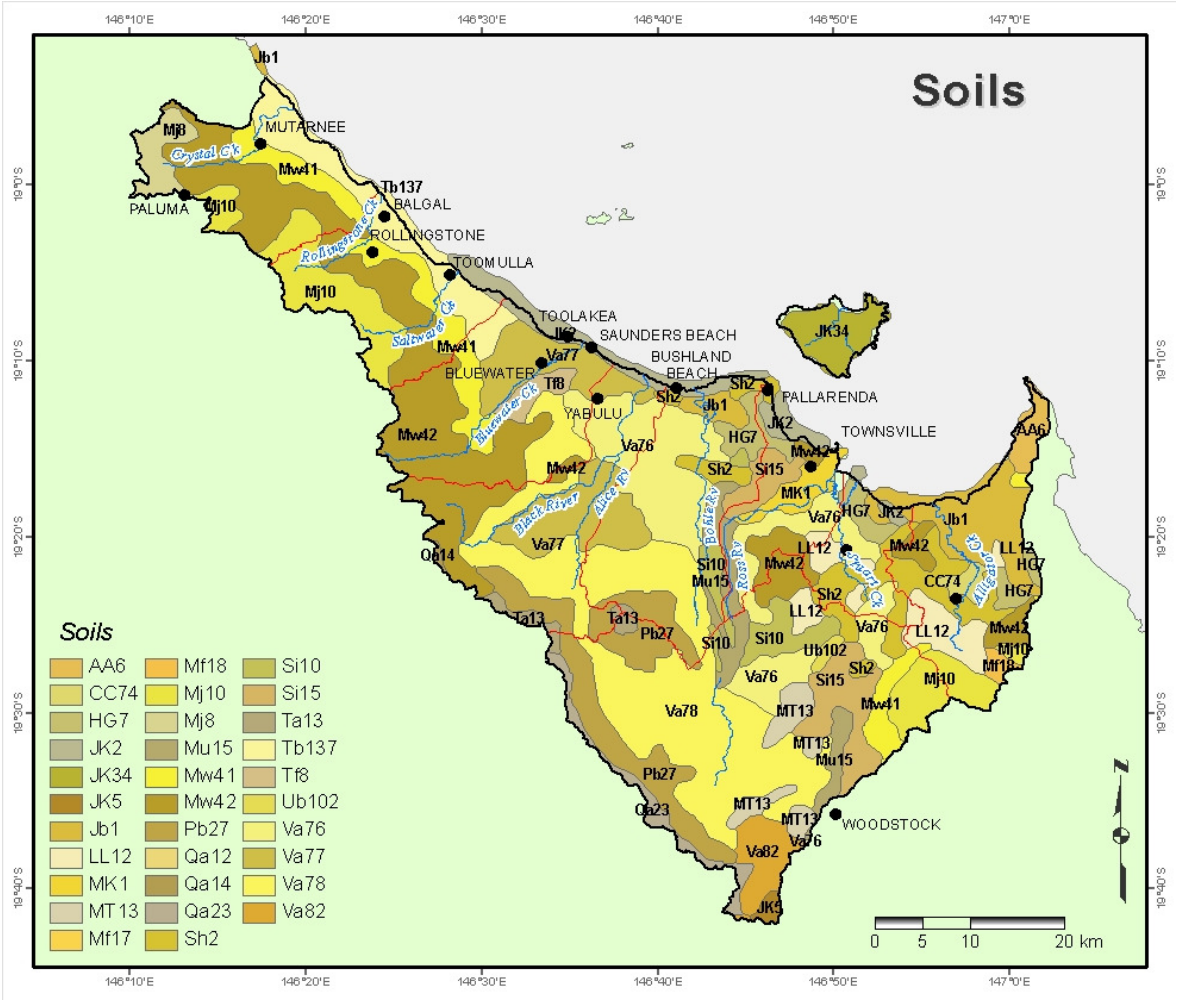


Table 3-4 Soils Key

Code	Landscape position	Soil general description	Dominant
AA6	Hilly or high hilly lands with very steep slopes	Brownish sands	Uc5.11
CC74	Level alluvial plains with slight to moderate gilgai microrelief	Grey self-mulching cracking clays	Ug5.24
HG7	Level alluvial plains which merge seaward into tidal flats mangrove swamps & salt pans	Hard setting black duplex soils	Dd1.33
Jb1	Salt pans & tidal flats or salt water couch meadows merging into mangrove swamp	Non-cracking plastic clays	Uf6.62
JK2	Low fixed sand dunes paralleling the coastline	Pale sands with a colour B horizon	Uc4.21
JK34	Hilly lands with steep slopes & much granite tor outcrop		Uc4.21
JK5	High hilly lands with steep slopes & high scarped margins		Uc4.2
LL12	Hilly to high hilly lands with very steep slopes narrow ridge crests	Pale loams with a colour B horizon	Um4.21

Mf17	Moderately to strongly undulating or occasionally low hilly plateaux	Yellow smooth-ped earths	Gn3.74
Mf18	High hilly to mountainous lands with much acid or intermediate volcanic rock outcrop		Gn3.74
Mj10	High hilly or mountainous lands often with very steep slopes & precipitous scarps	Red smooth-ped earths	Gn3.14
Mj8	Hilly high plateaux often bounded by precipitous scarps		Gn3.14
MK1	Alluvial delta plains with a complex pattern of present & prior stream channels &levees	Brown or mottled-red massive earths	Gn2.42
MT13	Gently undulating lands	Grey massive earths	Gn2.94
Mu15	Level alluvial plains with numerous old meander channels & terraces	Red massive earths	Gn2.15
Mw41	Gently undulating to undulating outwash slopes & fans		Gn2.14
Mw42	High hilly to mountainous lands with very steep slopes		Gn2.14
Pb27	Extremely steep dissected mountain scarps & steep-sided high hills	Hard setting red duplex soils	Dr2.21
Qa12	High hilly lands with some mountainous areas nearly all hills have steep slopes but crests are often rounded		Dr2.12
Qa14	Moderately or less commonly strongly undulating lands with occasional isolated hills surrounded by strongly dissected steep slopes		Dr2.12
Qa23	Moderately or strongly undulating plateau		Dr2.12
Sh2	Gently undulating to undulating footslopes & outwash fans & some isolated low hills	Hard setting yellow duplex soils	Dy2.32
Si10	Level alluvial plains		Dy2.33
Si15	Level alluvial plains with slightly elevated old levees & shallow prior & present stream channels		Dy2.33
Ta13	Moderately undulating plateau with many low knolls	Hard setting mottled-yellow duplex soils	Dy3.21
Tb137	Very gently undulating alluvial plains rising to gentle outwash slopes & low foothills		Dy3.41
Tf8	Very gently undulating alluvial plains		Dy3.81
Ub102	Very gently undulating plains with many relic stream channels & levees		Dy3.42
Va76	Alluvial plains with some low stream levees & relic infilled stream channels		Dy3.43
Va77	Gently undulating alluvial plains with numerous stream levees & channels		Dy3.43
Va78	Gently undulating to undulating outwash slopes & fans with occasional isolated low hills		Dy3.43
Va82	High hilly to mountainous lands with very steep slopes		Dy3.43

Soil type (including clay content) and structure (including organic content) is significant in terms of water quality as the erodibility, permeability and nutrient content of soils can impact the amount of sediment and nutrients entering waterways. Water availability is also important in the microbial breakdown of soil organic matter with wet tropics soils generally having higher concentrations of organic matter, nitrogen (N) and phosphorus (P) than dry tropic soils. Furthermore the highest concentrations of organic matter, N and P are usually near the surface and throughout the GBR catchment are broadly correlated with the clay content. It is of course these surface areas that are most prone to disturbance and erosion. The amount of vegetation cover is the other key factor influencing erosion potential.

Clay, organic carbon and nutrient content of soils in the Black and Ross Basins are displayed in Table 3-5. It should be noted that there has been limited soil sampling of this kind throughout the GBR catchment and figures are therefore subject to relatively high uncertainties.

Table 3-5 Clay, Carbon and Nutrient Content of Soils

Element	Black River (117)	Ross River (118)
Clay %	12 ± 5	10 ± 6
Organic C %	1.1 ± 0.7	1.2 ± 0.3
Total N (% dry weight)	0.10 ± 0.04	0.08 ± 0.03
Total P (% dry weight)	0.019 ± 0.018	0.014 ± 0.005

Source: Furnas 2003 (p. 61) Table 10 Average (+ 1 standard deviation) clay, organic carbon and nitrogen content of surface soil samples (Sources literature DNRM, DPI, CSIRO)

Note: Average total (of dry soil weight) for GBR catchments of N ~ 0.15% (1500 parts per million) and P ~ 0.05% (500 ppm).

3.3.4 Vegetation

The local vegetation reflects the particular climate and weather patterns of the area and contrasts with the wetter north and drier west. Topography and soils also play an influential role in determining vegetation type and density. Dry tropical and eucalypt dominated savanna vegetation prevails in the lowlands and reaches the coast in places with deciduous vine thickets occuring as a mosaic of isolated patches. Narrow riverbank communities thread through the coastal plain and are heavily populated by Eucalyptus and Melaleucas. Rainforests are prevalent in the high rainfall upland areas of Mount Elliot in the south and the Paluma Range in the north.

The percentage groundcover i.e. vegetation cover, has been shown to significantly influence the erosion potential of soils and the likelihood of sediment reaching waterways. The condition of riparian vegetation is also important as it influences the movement of eroded soil and associated nutrients into watercourses.

"*Soil erosion, which begins the movement of soil and nutrients from catchments, is a continuous, but entirely natural part of landscape change and evolution. There is clear evidence, however, that human land use has changed soil erosion rates at the landscape level*" (Furnas 2003, p. 129). The accelerated erosion rates are associated primarily with the reduction of vegetation cover, often associated with the change of land use from natural areas to more intensive uses. The level of disturbance influences the erosion rate and is exacerbated by local and regional topography, soil types and drainage patterns. Estimates of cleared areas in the Black and Ross Basins, compared to the overall GBR catchment, are provided in Table 3-6.

Table 3-6 Vegetation Cleared

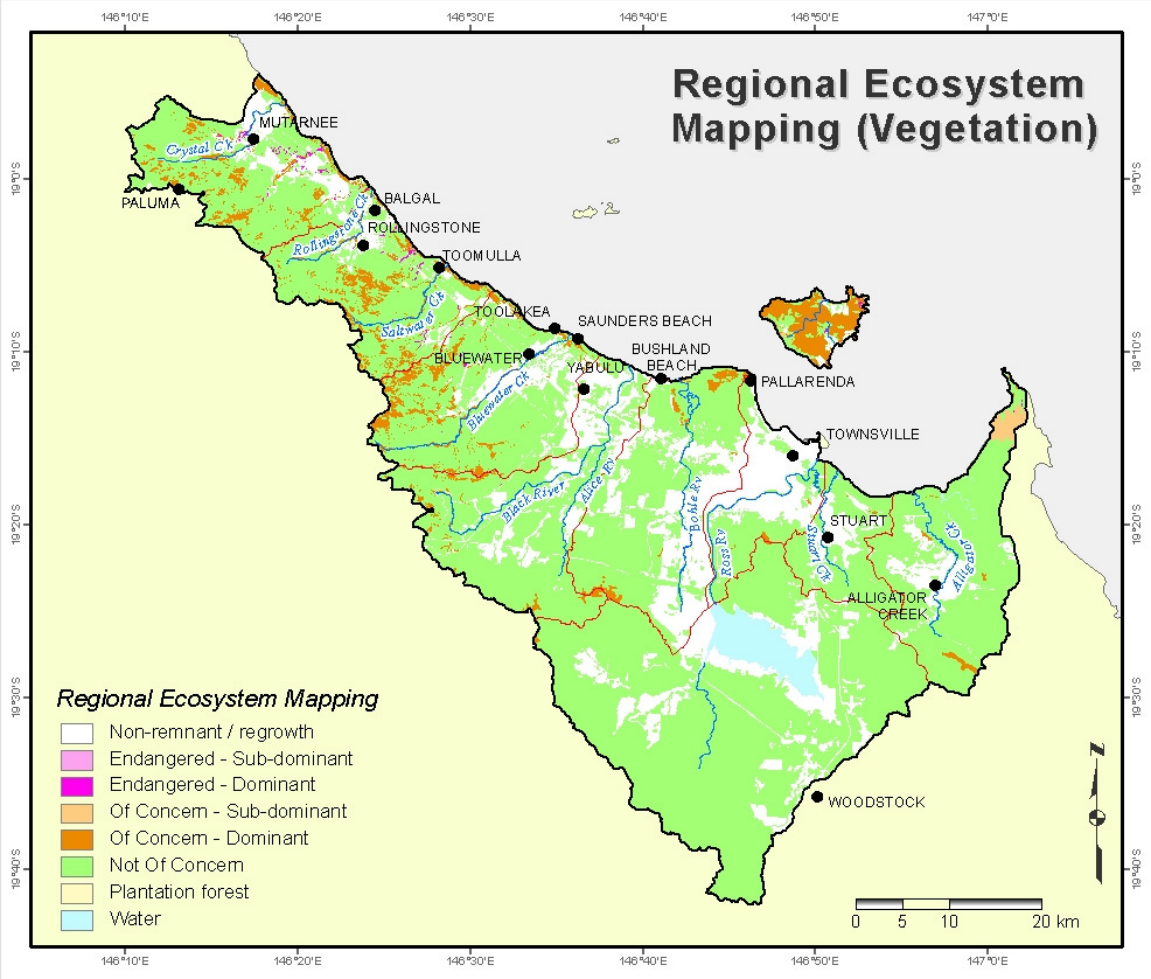
Element	Black River (117)	Ross River (118)	GBR Catchment
Basin area (km²)	1,057	1,707	423,070
Cleared (km²)	55 – 5.2% [16.2%] (17%)	336 – 19.7% [25%] (26.3%)	95,100 - 22% [37.6%] (38.3%)
Thinned (km²)	446	893	147,000 - 35%
Uncleared (km²)	539	442	169,000 - 40%
Intermediate (km²)			9,216 – 2.2%
Unclassified (km²)	17	36	

Source: Furnas 2003, p.140 and 144) Table 25 Estimates of land clearing in GBRC (ca. 1988) from analysis of satellite imagery (p.140) Data Graetz et al 2005 and Table 28 Estimates of remnant vegetation GBRCs.

Note: In general figures are for calculations based on 1988 information and are in square kilometres and percentages of total basin area. Figures in [square brackets] are calculated percentages of cleared areas in 1997 and figures in (brackets) are calculated percentages of cleared areas in 1999.

Remnant vegetation cover and cleared/disturbed areas are shown on the EPA's regional ecosystem mapping in Figure 3-8. It should be noted that regional ecosystem mapping does not take into account the condition of vegetation or the actual groundcover and as such is not a good indicator of erosion potential or riparian condition status. It does however provide a starting point for assessment in lieu of more detailed condition assessments.

Figure 3-8 Remnant Vegetation (Regional Ecosystem) Status



"*Most measurements of erosion from undisturbed land have been made to compare with soil loss rates from experimental cropping or grazing plots. There are considerable differences between soil loss rates from plots (<1 km²) or small catchments (<100 km²) and the net export of sediment from whole river catchments due o short-range soil movements within sub-catchments and sediment storage in catchments. Broad-scale estimates of sediment delivery to the GBR based on relationships between land use and soil loss produce reasonable estimates when they assume that net sediment export is only 10% of the landscape soil erosion rate (delivery ratio = 0.1)*" (Furnas 2003, p.138)

3.3.5 Fauna

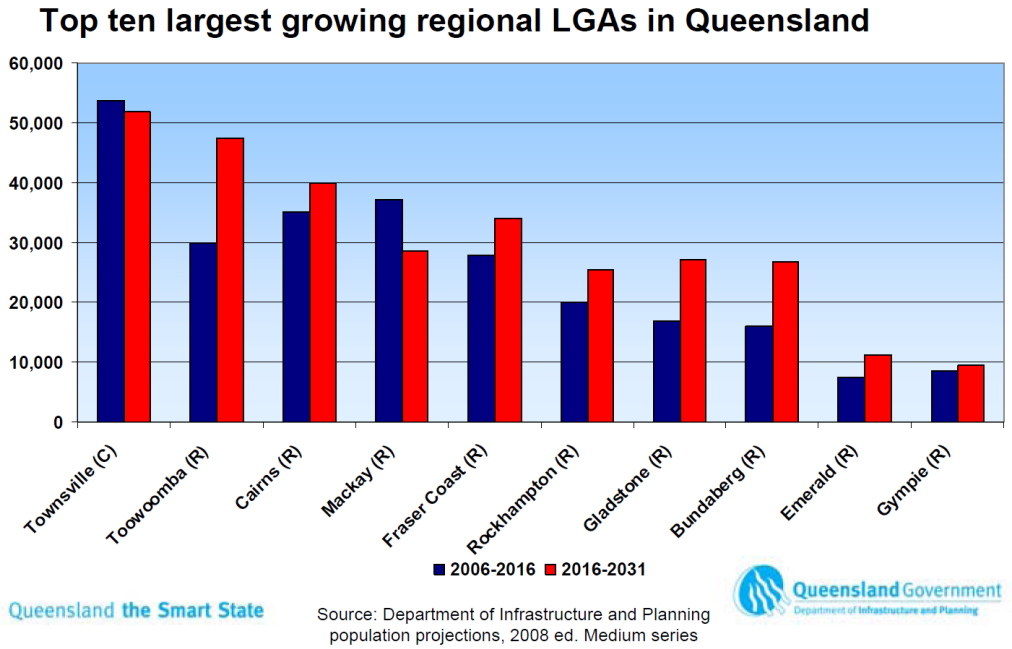
The fauna of the region also reflects the regions unique combination of climate, topography and coastal location. Arid land species may be found in close proximity to wet tropics species. A key feature of the area is the importance of coastal wetlands for migratory and drought nomadic species. The large and abrupt boundary changes between areas of mono-specific deciduous Eucalypt and Melaleuca woodlands are important to local ecology.

3.4 Socio Economic Summary

3.4.1 People

The amalgamated City of Townsville covers an area of 3,736 square kilometres, encompassing the Black Ross Water Quality Improvement Plan (WQIP) area. Townsville's position as a coastal port town on the Ross River along with mineral processing industry and a large military base means it is well placed as a focal point of the region. Due to its status as a strong and vital regional centre, Townsville attracts and continues to attract growth. Townsville's population growth makes it one of the top ten largest growing regional local government areas in the state (see Figure 3-9).

Figure 3-9 Regional Growth Comparison



In 2005 (the base year for the Black Ross WQIP relative to updated land use mapping) the Estimated Resident Population (ERP) for Townsville stood at 160,220, representing an annual increase of 3.1% from 2004. Estimated resident population (ERP) trends are shown in Table 3-7 and Figure 3-10.

Table 3-7 Estimated Resident Population Growth Trends

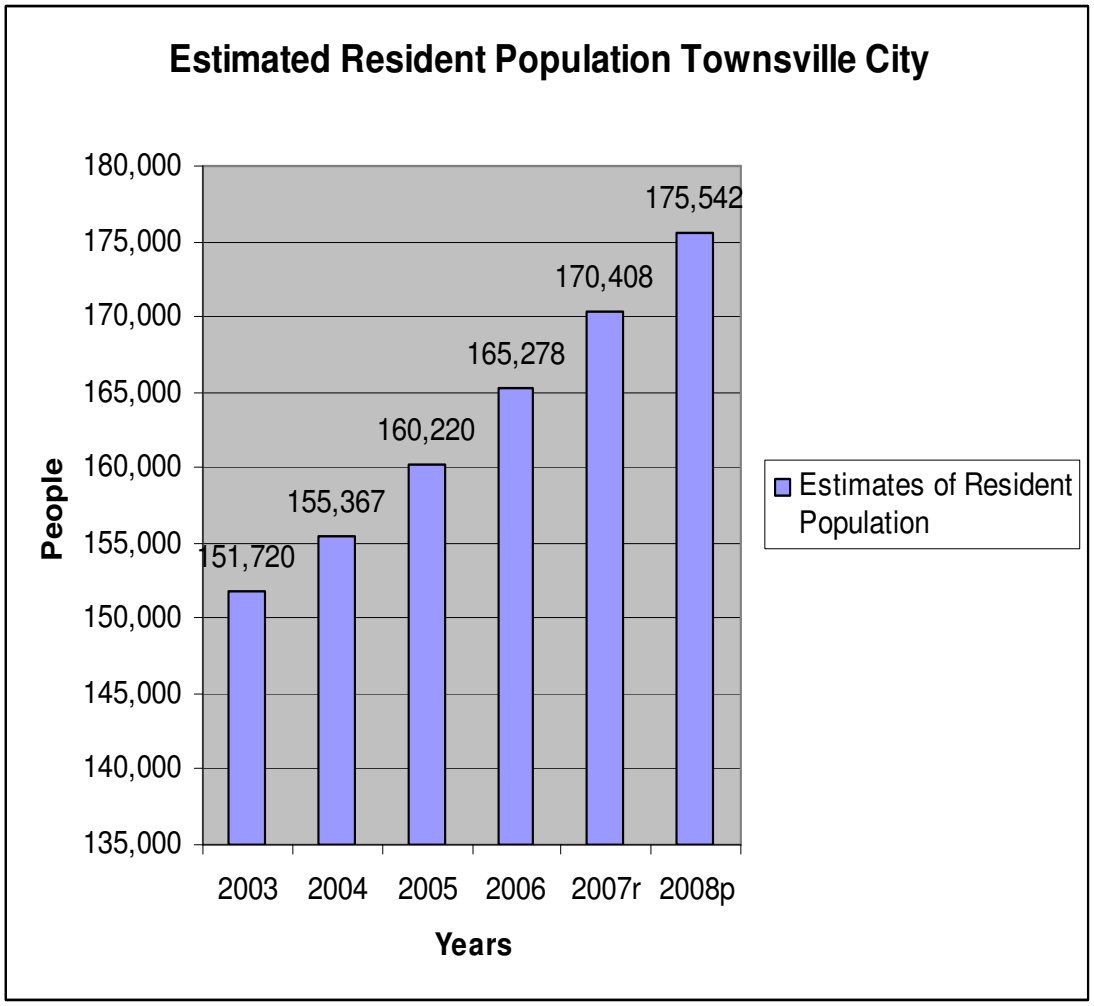
Year at 30 June	Number	Year to 30 June	Number	Percent
2003	151,720			
2004	155,367	2004	3647	2.40%
2005	160,220	2005	4853	3.10%
2006	165,278	2006	5058	3.20%
2007r	170,408	2007r	5130	3.10%
2008p	175,542	2008p	5134	3.00%
2003-2008p				3.00%

Source: Regional Population Growth, Australia, 2007-08 (cat. no. 3218.0) The estimates in the above table are final for 2003 to 2006 and revised for 2007 (denoted 2007r) to align with new June 2007 state totals which were released in September 2008 issue of Australian Demographic Statistics (ABS cat. no. 3101.0). Estimates for 2008 are preliminary (and denoted 2008p).

During the years 2004-2006, Townsville experienced strong population growth. The rate of growth has tapered slightly since that time. As at 30 June 2008, the estimated resident population was 175,542 people, which represents 4.1% of Queensland's population. Townsville's annual increase of 5,134 people over the year to June 2008 represents a 3% growth rate. This compares with an increase of 5,130 people or 3.1% for the year to 30 June 2007.

Between 2007-2008, the growth rate for the state of Queensland was 2.3%. This was the slowest annual growth for Queensland in the five years to June 2008. The average annual rate of change in population in the Townsville local government area, over the five years between 30 June 2003 and 30 June 2008 was 3%, compared with 2.4% for the State.

Figure 3-10 Townsville Recent Population Growth Trend



Source: Australian Bureau of Statistics Catalogue Number: 3218.0 - Regional Population Growth, Australia, 2007-08; released 23 April 2009.

The 1996 Census indicated a median age for Townsville of 31 years. At the 2006 Census, the median age for Townsville increased to 33 years, still significantly younger than the median age for Queensland (36 years) and for Australia (37 years). Projections from the Queensland Department of Infrastructure and Planning indicate the median age of Townsville City Council's population will increase to 39 by 2031 (an increase of 6 years from the 2006 median age.

The 2006 Census showed the average household size for Townsville City to be 2.8 people per dwelling. This is high in comparison with the average household size for Queensland (2.6 people) and for Australia (2.6 people). It is likely that the young population profile for Townsville, which includes significant numbers of families with children, is a factor contributing to the higher than average household occupancy.

3.4.2 Land and housing

Residential land activity is a strong potential indicator of both population growth and expansion of the urban footprint. In the year to the June quarter 2005, Townsville produced 1743 residential lots. Lot production has continued to be strong through the years to 2008, however the economic downturn has acted to dampen the volume of recent land sales. Land sales for the year to June 2008 were down significantly from previous years while lot consumption i.e. dwellings being constructed, continued to record strong growth during 2008.

New household formation is an important indicator for population growth. If there is a downturn or upswing in new household formation there is likely to be a corresponding movement in the annual percentage population change.

Coupled with residential land activity, Building Approval data offers a key indicator for population growth. In the year ended March 2009, there were 1,575 residential dwelling approvals in Townsville City Council. These approvals were valued at $495.8 million and represented 5.0% of the overall total for the State.

Table 3-8 Residential and Non-residential Building Approvals

	Dwelling units in new residential buildings	(a) Residential building value	(b)Total residential building value	(b)Total non-residential building value	(b)Total building value	Proportion of total value that is residential (c)
		$,000s				
Townsville City Council	1,575	457,455	495,802	265,209	761,011	65.2%
Queensland	32,170	8,767,555	9,973,341	7,935,870	17,909,210	55.7%
Townsville as % of Qld	4.9	5.2	5.0	3.3	4.2	na

Notes: Townsville City Council for the 12 months ending 31 March 2009.

na = not applicable

(a) Excludes alterations, additions and conversions.

(b) Including alterations, additions and conversions.

(c) Represents total residential building value as a proportion of total building value.

Based on ASGC 2006.

Data for Reformed Local Government Area(s) are based on concorded Statistical Local Area data (ASGC 2006). The concordance is population based and has been derived from Planning Information and Forecasting Unit within the Department of Infrastructure and Planning.

Source: Australian Bureau of Statistics, Building Approvals, Queensland (Cat. no. 8731.3)

3.4.3 Labour force and income

Townsville's role as the primary urban centre serving the Northern Region (it is often termed 'the capital of North Queensland') has helped the City develop its diverse economy. The strength and diversity of the Townsville economy is reflected in the broad range of industries of employment (see Table 3-10) and high employment levels (Table 3-9).

The labour force in the Northern labour force region, encompassing the City of Townsville, grew by 3.2% in the 2005 calendar year, while the labour force participation rate was generally higher than overall participation rates for Queensland and Australia. At the time of the 2006 Census of Population and Housing in Townsville City Council, there were 3,523 unemployed persons. With a labour force consisting of 79,849 persons, this corresponded to an unemployment rate of 4.4% compared to 4.7% for Queensland as a whole.

Table 3-9 Labour Force Status

Characteristic	Townsville (people)	Queensland (people)
People aged 15 years and over	121,120	3,097,998
Labour force status (a):		
Employed, worked full-time (b)	51,262	1,180,889
Employed, worked part-time	19,797	530,501
Employed, away from work (c)	5,278	113,607
Unemployed, looking for work	3,513	90,950
Total labour force	79,849	1,915,947
Not in the labour force	33,326	971,829
Unemployment rate (d)	4.4%	4.7
Labour force participation rate (e)	65.9%	61.8
Employment to population rate (f)	63.0%	58.9

Source: Australian Bureau of Statistics 2006 Census of Population & Housing, Community Profile Series (Cat No: 2001.0)
Notes: (a) Applicable to people aged 15 years and over.
(b) 'Employed, worked full-time' is defined as having worked 35 hours or more in all jobs during the week prior to Census Night.
(c) Includes employed people who did not state their hours worked.
(d) The number of unemployed people expressed as a percentage of the total labour force.
(e) The number of people in the labour force expressed as a percentage of people aged 15 years and over.
(f) The number of employed people expressed as a percentage of people aged 15 years and over.

Table 3-10 Employment by Industry

Industry	%
Public Administration and Safety	12.6
Retail Trade	11.0
Health Care & Social Assistance	10.9
Construction	9.9
Manufacturing	8.2
Education and Training	8.0
Accommodation and Food Services	6.8
Transport, Postal & Warehousing	5.1
Professional, Scientific and Technical Services	4.3
Other Services	3.5
Wholesale Trade	3.2
Administrative and Support Services	2.8
Mining	2.6
Financial and Insurance Services	1.8
Rental, Hiring and Real Estate Services	1.8
Information Media & Telecommunications	1.6
Electricity, Gas, Water and Waste Services	1.4
Arts and Recreation Services	1.3
Agriculture, Forestry and Fishing	0.8

Source: ABS, Census of Population and Housing, 2006
Notes:(a) Based on place of usual residence. (b) Based on 2006 ANZSIC

The median weekly income for Townsville at the 2006 Census for individual income was $ 531.00, household income $1,101.00 and family income $ 1,237.00. Median household income levels in Townsville were significantly higher than the medians for Queensland and Australia.

3.4.4 Economy

Townsville is widely regarded as the capital of North Queensland and is home to many State and Federal Government agencies, as well as many primary and secondary industries, the mining, commerce and retail sectors, and community and cultural services. The diversity of the eonomy is relected in the Business Numbers for Townsville 2006/2007 (see Table 3-11).

Table 3-11 Townsville Business Numbers and Employees

Industry	Non employing	Employing Persons			Total
		1 to 4	5 to 19	20+	
Agriculture Forestry And Fishing	435	90	27	21	573
Mining	39	12	9	9	69
Manufacturing	249	147	108	51	555
Electricity Gas And Water Supply	12	0	3	0	15
Construction	1,419	798	354	117	2,688
Wholesale Trade	117	141	72	24	354
Retail Trade	513	480	327	111	1,431
Accommodation Cafes And Restaurants	90	78	87	78	333
Transport And Storage	615	135	54	30	834
Communication Services	48	51	6	0	105
Finance And Insurance	336	102	51	9	498
Property And Business Services	1,743	627	243	90	2,703
Education	78	24	9	3	114
Health And Community Services	288	228	84	42	642
Cultural And Recreational Services	135	45	21	21	222
Personal And Other Services	246	126	87	24	483
Total	6,363	3,084	1,542	624	11,619

Source: Australian Bureau of Statistics, Counts of Australian Businesses, including Entries and Exits, Jun 2003 to Jun 2007, (Cat no. 8165.0).

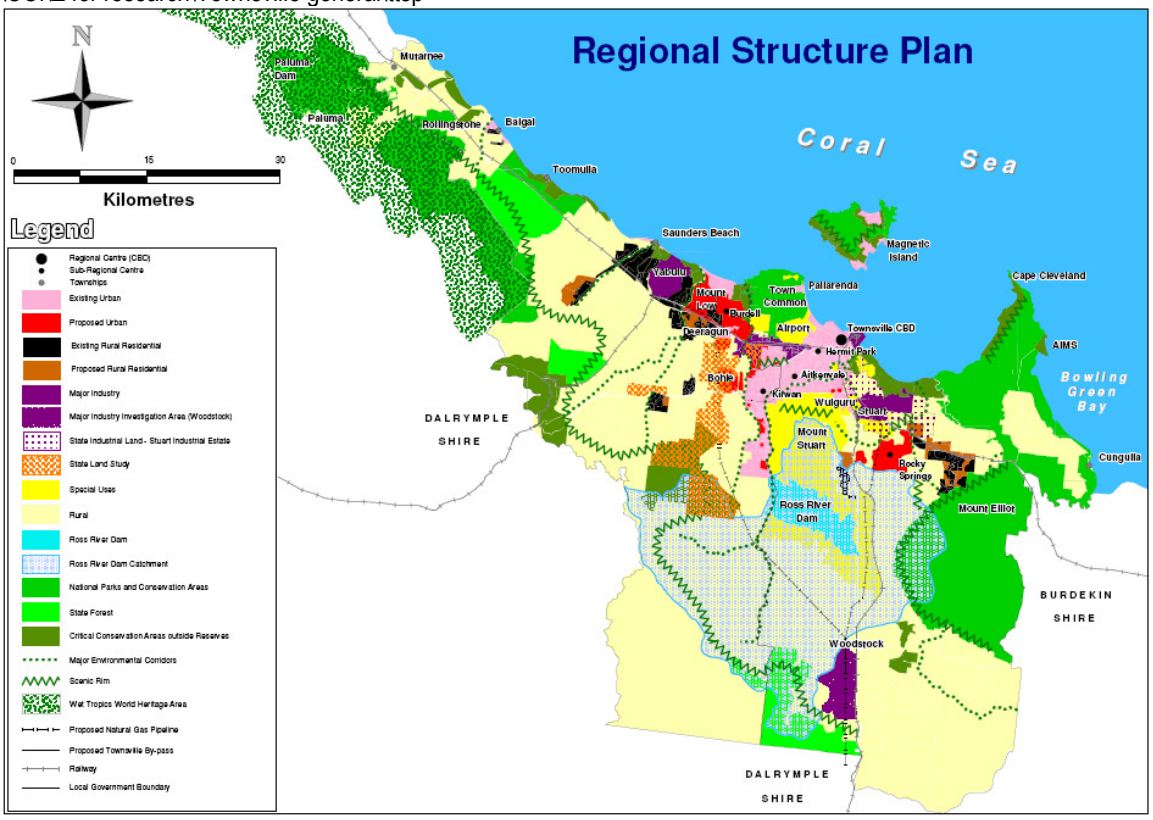
The regional economy of Townsville, expressed in Gross Regional Product (GRP) has increased by 12% over 2004/05 to reach $10.2 billion, representing 7.2% of Queensland's Gross State Product. Manufacturing (in particular minerals processing) contributes 16.6% to the GRP with other major contributions from Government Administration and Defence (11.3%) and Construction (8.5%).

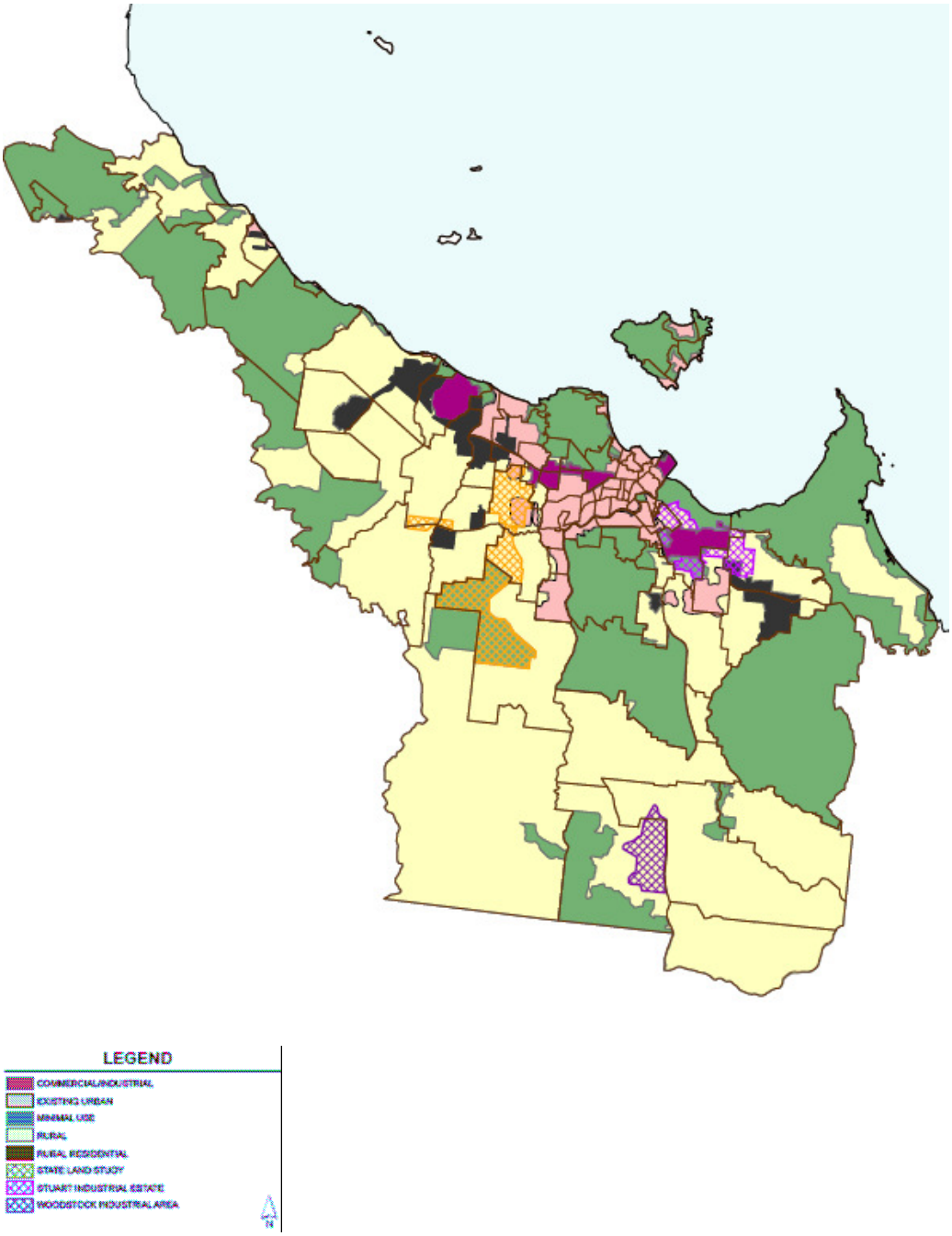
The Port of Townsville exports a diverse range of goods including sugar, copper, lead, zinc, fertilizer, timber, sand gravel, and general purpose oils which are worth $3 billion annually.

Source: AEC Group - Report on the Townsville Regional Economy Third Quarter 2005. Townsville Enterprise Limited - Townsville and North Queensland

3.4.5 Growth Planning

TTSP Regional Structure Plan
\CCI\Z for research\Townsville general\ttsp





Source: Proposed Future Land Use Layer (Proposed_Future_Land_Use_Layer.pdf)

There are significant social and economic benefits to Australia from the Great Barrier Reef. The major activities that occur on the Great Barrier Reef are tourism, recreation and commercial fishing. During 2005, 1.9 million people visited the Great Barrier Reef using tourism services and it is estimated that there are a further 6 million recreational visits to the Great Barrier Reef annually. Recreation includes activities such as fishing, snorkelling, diving, sightseeing, adventure sports and sailing. Tourism is a major activity on the Great Barrier Reef and is estimated to contribute as part of regional tourism $6.1 billion to the Australian economy annually1. The tourism industry also employs an estimated 63,000 people. Commercial fishing activity undertaken in the Great Barrier Reef has a gross value of production of $119 million annually and employs an estimated 3,600 people or 0.94 percent of the Great Barrier Reef coastal labour force. Recreational fishing and boating contribute $640 million annually to the region and comprise a major recreational activity for residents and visitors to the region.

At the 2006 census, there were approximately 836,000 people living in the Great Barrier Reef Catchment with an average annual growth rate of 1.23 percent. This is 21 percent of Queensland's resident population of almost 4 million (Figure 1.2). The region is economically dependent on agriculture, manufacturing and mining except in Cairns city, Douglas and Whitsunday Shires that have tourism as their major industry. Sugar cane is the main crop grown on the Queensland coast.

The value of agricultural production from Great Barrier Reef coastal communities is in the order of Australian $1.7 billion annually. The resources sector contributes Australian $14.5 billion annually in exports from the 11 ports located in the Great Barrier Reef region . Of these exports, 94 percent are for mineral products, primarily coal and metal ores, and the remaining 6 percent agricultural and manufactured products.

The key regional centres of Cairns, Townsville, Mackay, Rockhampton and Gladstone provide services to inland mining and agricultural industries. Townsville is the largest major centre in the Great Barrier Reef region with considerable government, education and defence activities servicing state and national interests.

Limiting the effects of people, within and adjacent to the Great Barrier Reef is the challenge presented to marine managers, communities, industries and governments when considering how best to manage the Great Barrier Reef. The nature of the interactions people have with the Great Barrier Reef are shaped by the demands they have to meet. For each ecosystem the type of management applied to maintain its functional status, as a 'healthy' ecosystem is directly dependent on the social, economic and institutional context of the society that interacts directly and indirectly with the ecosystem.

The length of time that humans have interacted with the Great Barrier Reef provides an appropriate historical context for understanding current social, economic, institutional and political issues involved in the management of the Great Barrier Reef. Unlike many other tropical marine ecosystems , the Great Barrier Reef exists in close proximity to a region that has experienced intensive farming and pastoral activities as well as substantial urban development for close to one hundred and fifty years. Apart from the Cape York region, which has experienced much less land based development; coastal and catchment regions bordering the Great Barrier Reef bear witness to the progressive development of the region's ocean, land and mineral resources.

The infrastructure for supporting the growing regional population of approximately 836,000 people with associated manufacturing, agricultural and urban services from Bundaberg in the south to Cairns in the north represents a substantial modification of the Great Barrier Reef's coastal and catchment landscape. The effect of 68,000 personal watercraft, active commercial fisheries, 1.9 million tourist visits annually, defence activities and development of infrastructure to support visitors and residents accessing and enjoying the Great Barrier Reef combines to make an extensive ecological footprint. This will affect the Great Barrier Reef in far more complex forms than tropical marine ecosystems that are more isolated.
(Johnson and Marshall (eds) 2007, pp.6-8)

3.4.6 Land Use

In conjunction with the physical environment it is land use and management practices that influence the potential for pollutants to enter waterways and waterbodies. General land use categories are shown in Table 3-12 and Table 3-13 with a more detailed breakdown by sub basin in Table 3-14. Land use patterns are illustrated in Figure 3-11 and Figure 3-12.

Table 3-12 Black Ross WQIP Area Land Use 2005

Land Use	Hectares	%
Channel/Aquaduct	7	0.00
Cropping	188	0.07
Grazing Natural Vegetation	133908	49.75
Intensive Animal Production	258	0.10
Irrigated Cropping	2333	0.87
Irrigated Perennial Horticulture	856	0.32
Irrigated Seasonal Horticulture	443	0.16
Manufacturing and industrial	1599	0.59
Marsh/Wetland	4651	1.73
Mining	462	0.17
Nature Conservation	62025	23.04
Other minimal use	37761	14.03
Perennial Horticulture	34	0.01
Plantation Forestry	70	0.03
Production Forestry	3	0.00
Reservoir/Dam	4720	1.75
Residential	15186	5.64
River	649	0.24
Services	3003	1.12
Transport and Communication	953	0.35
Utilities	28	0.01
Waste treatment and disposal	34	0.01
Total (hectares)	269171	

Note: The dominant landuse is shaded in yellow, 2nd in blue, 3rd in green, and 4th in pink.

Table 3-13 Principal Land Use Categories (2005)

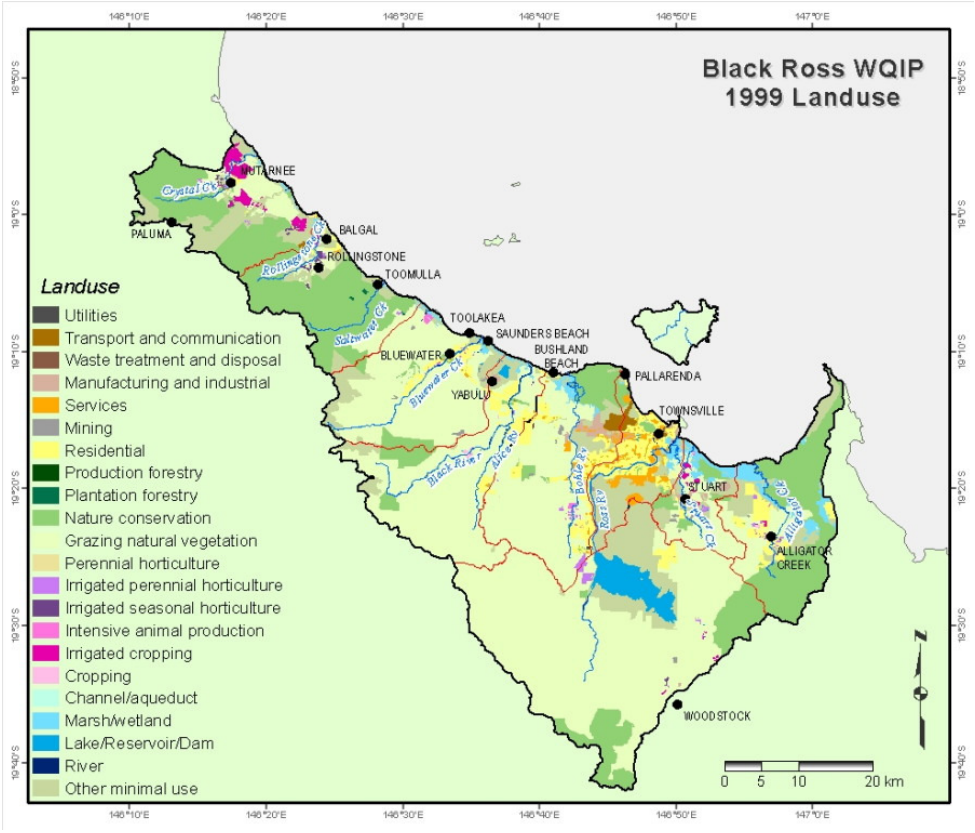
Land use	Hectares	%
Grazing	133,908	49.7
Nature conservation/minimal use	99,786	37.1
Water and wetlands	10,020	3.7
Intensive agriculture	4,112	1.5
Mining/quarrying	462	0.2
Forestry	74	<0.1
Urban		
Residential	15,186	5.6
Services and utilities	4,026	1.5
Manufacturing and industrial	1,599	0.6
Urban sub total	20,811	7.7
Total (hectares)	269,173	

Table 3-14 Land Use by Sub Basin 2005

Land Use	Crystal		Rollingstone		Bluewater		Black		Bohle		Lower Ross		Upper Ross		Stuart		Alligator		Magnetic Is	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Channel/Aquaduct					7	0.0														
Cropping	10	0.0	28	0.1			103	0.3	4	0.0							43	0.2		
Grazing Natural Vegetation	2,287	9.5	2,382	10.8	21,912	75.3	23,295	76.2	19,965	61.9	316	2.3	54,437	71.7	5,203	50.2	4,111	15.5		
Intensive Animal Production			40	0.2	105	0.4			90	0.3					23	0.2				
Irrigated Cropping	1,697	7.1	52	0.2			7	0.0	254	0.8			63	0.1	234	2.3	26	0.1		
Irrigated Perennial Horticulture	88	0.4	70	0.3	77	0.3	58	0.2					323	0.4	56	0.5	184	0.7		
Irrigated Seasonal Horticulture	178	0.7	215	1.0									35	0.0			15	0.1		
Manufacturing and industrial							119	0.4	837	2.6	268	2.0	11	0.0	359	3.5			5	0.1
Marsh/Wetland	205	0.9	96	0.4	352	1.2	165	0.5	529	1.6	516	3.8			1,033	10.0	1,755	6.6		
Mining	4	0.0			169	0.6			95	0.3	21	0.2	53	0.1	109	1.1	11	0.0		
Nature Conservation	11,786	49.2	15,865	72.1	1,682	5.8	1,963	6.4	3,185	9.9	944	7.0	8,367	11.0	1,366	13.2	14,229	53.6	2,639	52.9
Other minimal use	7,365	30.7	2,863	13.0	3,185	10.9	2,284	7.5	2,115	6.6	5,016	37.2	7,580	10.0	1,753	16.9	3,676	13.9	1,924	38.6
Perennial Horticulture	4	0.0							27	0.1							3	0.0		
Plantation Forestry			70	0.3																
Production Forestry	1	0.0	2	0.0																
Reservoir/Dam	2	0.0	5	0.0	27	0.1	183	0.6	3	0.0	149	1.1	4,335	5.7	16	0.2				
Residential	171	0.7	253	1.1	1,473	5.1	1,979	6.5	3,944	12.2	3,737	27.7	647	0.9	173	1.7	2,427	9.2	383	7.7
River	61	0.3	10	0.0	58	0.2	343	1.1	16	0.0	92	0.7	27	0.0			43	0.2		
Services	25	0.1	34	0.2	45	0.2	53	0.2	694	2.2	2,017	15.0	75	0.1	33	0.3			27	0.5
Transport and Communication	85	0.4	15	0.1			7	0.0	443	1.4	390	2.9			14	0.1				
Utilities									17	0.1	9	0.1			2	0.0				
Waste treatment and disposal			5	0.0	4	0.0			12	0.0									13	0.3
Total (hectares)	23,969		22,003		29,096		30,559		32,230		13,475		75,953		10,374		26,523		4,990	

Note: The dominant landuse is shaded in yellow, 2nd in blue, 3rd in green, and 4th in pink. Bohle land use has been calculated for modeled sub catchments also (results in BBN Report)

Figure 3-11 Land Use 1999 and 2005



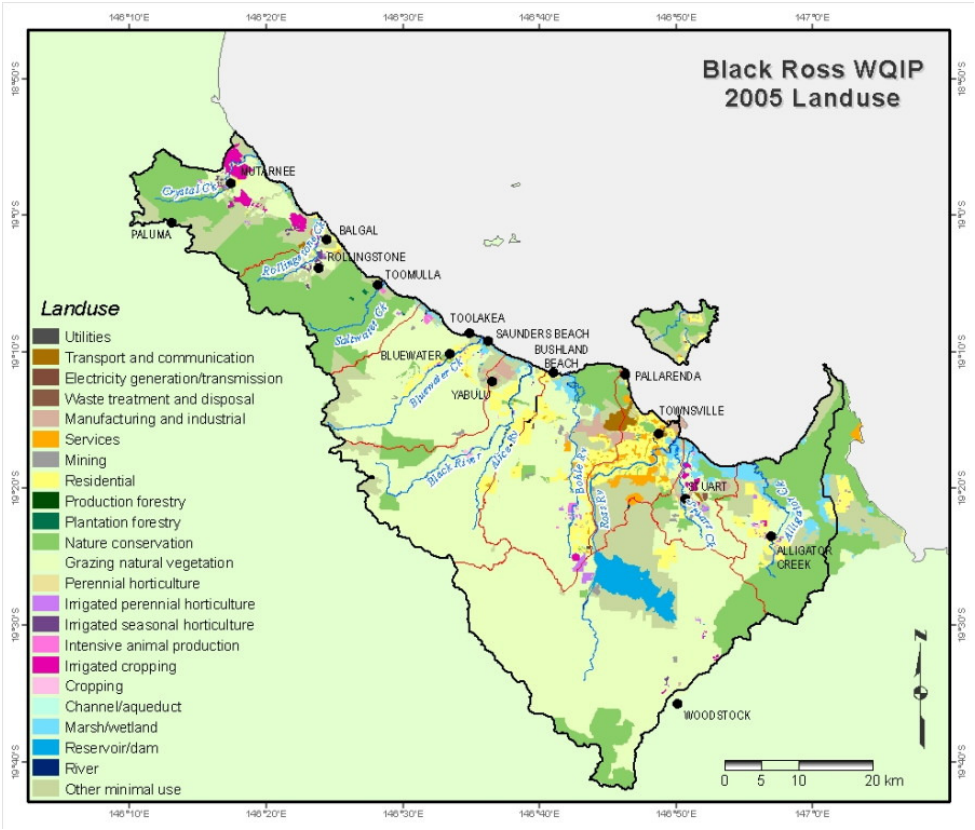
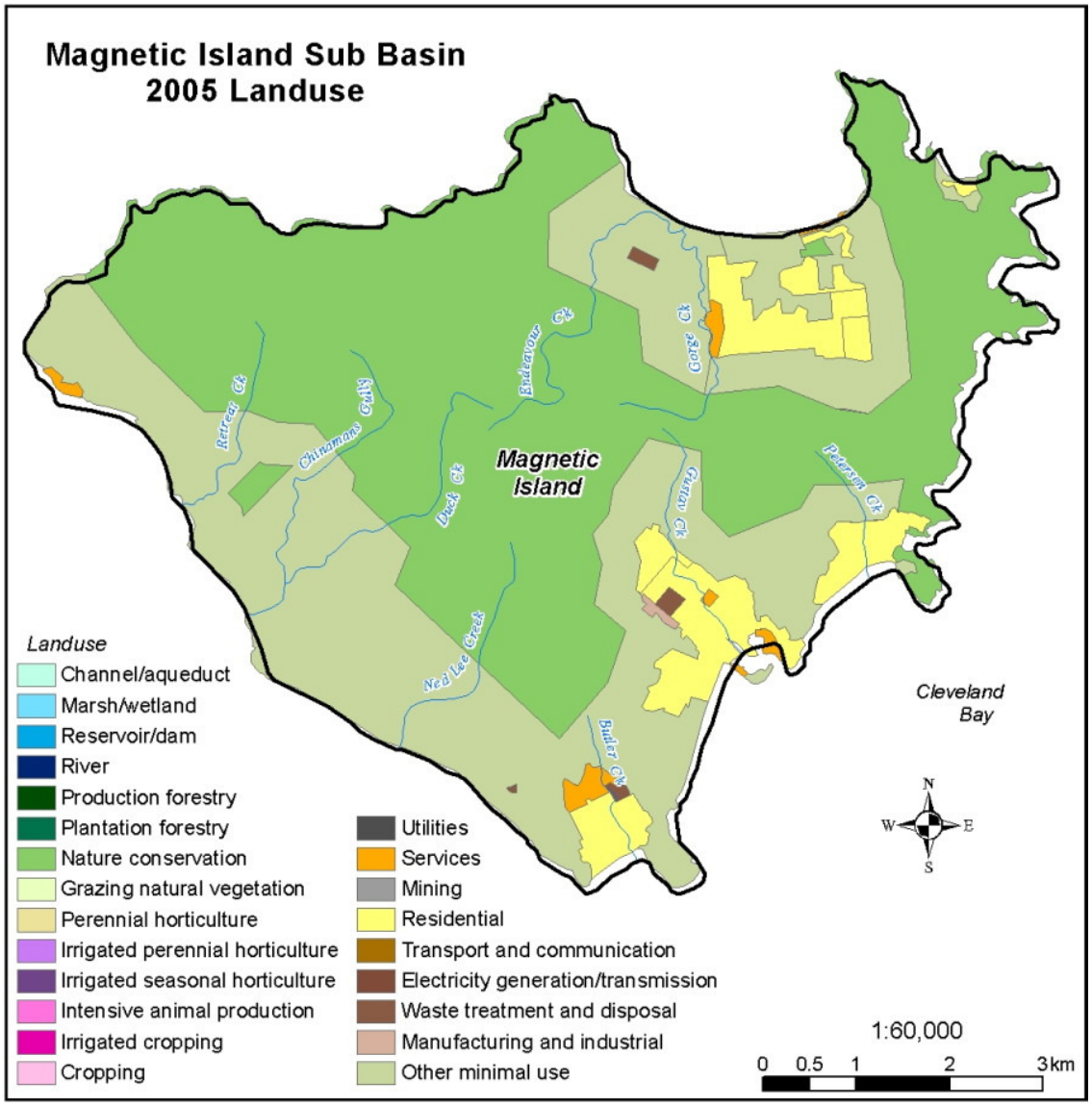


Figure 3-12 Magnetic Island Land Use 2005



3.5 Current Water Quality Condition

A desktop review of the current condition of water quality in each catchment in the Black Ross WQIP area was undertaken (Connell Wagner 2008) utilising an integrated ecological assessment process developed by the EPA (EPA 2006).

Of the sixty catchments found in the Black Ross WQIP area the integrated assessment of current condition found that fifteen were slightly impacted, three moderately impacted and eleven were heavily impacted. The remaining catchments either had no data (23) or insufficient data (8) to make an assessment (Connell Wagner 2008).

Similarly at the waterbody reach level, eighteen waterbody reaches were found to be slightly impacted, fifteen moderately impacted and nineteen were heavily impacted. Of the remaining waterbody reaches 84 have no data and 12 have insufficient data to make an assessment.

A draft Report Card format has also been produced by Connell Wagner (2009) (now Aurecon) and summary information is included in Appendix A.The report card report (*Development of a Report Card Format for the Waterways of the Black/Ross Basins*) can be viewed on the Creek to Coral website (www.creektocoral.org/).

4. Basins, Sub Basins and Catchments

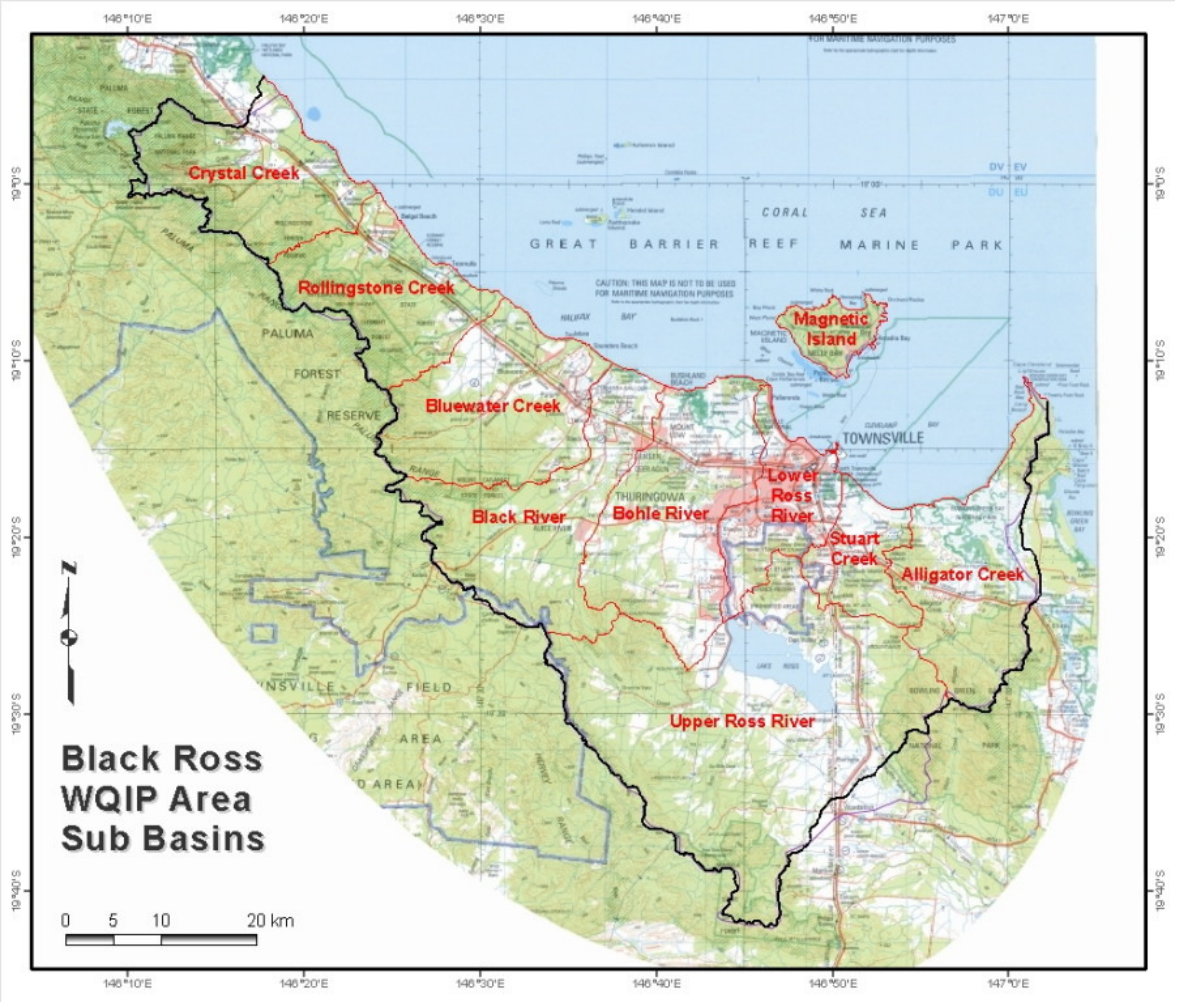
4.1 Components of the WQIP Area

The coastline of the Black Ross WQIP area (including Magnetic Island) is approximately 130 kilometres, which is equivalent to approximately 6% of the total GBR catchments coastline.

The total land area of the catchments that flow to Cleveland and Halifax Bays is 270,065 hectares (2,700 square kilometers). This represents approximately 0.6% of the total area of the GBR catchments.

As previously described the land area of the Black/Ross WQIP consists of the Black and Ross River Basins and Magnetic Island. The land area has been further divided into 10 sub basins (see Figure 4-1) and 47 catchments and sub catchments (see Figure 4-4). These divisions have been established to assist with condition assessment, monitoring, modelling and reporting. The individual areas of the basins and sub basins are listed in Table 4-1 and catchment areas are listed in Table 4-5.

Figure 4-1 WQIP Area Sub Basins



The remainder of this report provides an overview of the Black River and Ross River Basins, sub basins, catchments, sub catchments and associated waterways and wetlands in the Black Ross WQIP area.

Table 4-1 Basin and sub basin areas

Basin	Sub basin No.	Sub basin	Hectares	km²	% land area
Black River	1	Crystal Creek	24409.53	244.10	9.0
Black River	2	Rollingstone Creek	22207.80	222.08	8.2
Black River	3	Bluewater Creek	29102.86	291.03	10.8
Black River	4	Black River	30563.67	305.64	11.3
Ross River	5	Bohle River	32243.60	322.44	11.9
Ross River	6	Lower Ross River	13515.11	135.15	5.0
Ross River	7	Upper Ross River	75952.34	759.52	28.1
Ross River	8	Stuart Creek	10380.53	103.81	3.8
Haughton River	9	Alligator Creek	26541.45	265.41	9.8
	10	Magnetic Island	5148.34	51.48	1.9
		Total	**270,065**	**2,701**	**100**
Black River Basin			106283.86	1062.84	39.4
Ross River Basin			132091.58	1320.92	48.9

Note: For total area of the Basins to equal the total area of the sub basins the area of the Haughton River Basin (Alligator Creek sub basin) and Magnetic Island sub basin are added to the areas of the Black and Ross River Basins.

4.2 Drainage Basins

It should be noted that the Drainage Basins as defined by the predecessors of the Queensland Department of Natural Resources and Water (DNRW) are not the same as the Australian Water Resource Council (AWR) Basins. The DNRW Ross Basin is larger than the AWR basin and includes part of the AWR Haughton Basin. The DNRW Ross Basin is 1,707 sq km compared to the AWR Ross Basin area of 1,321 sq km (difference = 386 sq km). Variation in figures associated with the Ross Basin is generally a result of this discrepancy, along with smaller standard errors associated with in GIS calculations.

Some general statistics for the Black and Ross Basins are list in Table 4-2 with additional material on each basin provided in sections 4.3 and 0.

Table 4-2 General Statistics Black and Ross Basins

Element	Black River (117)	Ross River (118)
Area (km²)	1057	1707
% gauged	33	56
Annual runoff km³ Average	0.38	0.49
Annual runoff km³ Maximum	1.54	3.37
Annual runoff km³ Minimum	0	0.01
Ave annual rainfall mm	1530	1027
Ave annual runoff mm	360	287
% runoff	23	28
Population	10,605 *	140,072 *
Clearing (km²)	501	1229
% Cleared	47	72
Area under Grazing (km²)	802	1481
Area under Sugar (km²)	9.7	<10
Area under Horticulture (km²)	4.2	<10
Surface water storages capacity (ML)	487	422,060
Number of production bores	987	1,081
Irrigated sugarcane (ML per annum)	6,000	
Irrigated horticulture (ML per annum)	2,700	3,800
Irrigated crops (ML per annum)		800

Sources: Furnas 2003 (p.43) From Table 4 Average rainfall was calculated from the long-term average isohyet distribution within basin boundaries. Basin areas and gauged runoff from DNRM. Rainfall data from BOM. River Basins Summary (Australian Government - Bureau of Rural Sciences, Bureau of Meteorology and CSIRO), Great Barrier Reef Water Quality Action Plan (GBRMPA 2001). * ABS 2006

4.3 Black Basin

"*The Black River catchment covers an area of 1057 km². Grazing is the dominant land use occupying 802 km². Other land uses are sugarcane farming covers approximately 10 km² and horticulture 4 km². Total forests occupy 220 km² and protected areas, including the Wet Tropics World Heritage Area, cover 231 km². Sediment export is classified as low risk, and total nitrogen and total phosphorus exports are classified as medium risk in the Black River catchment*".

"*Issues in the catchment:*

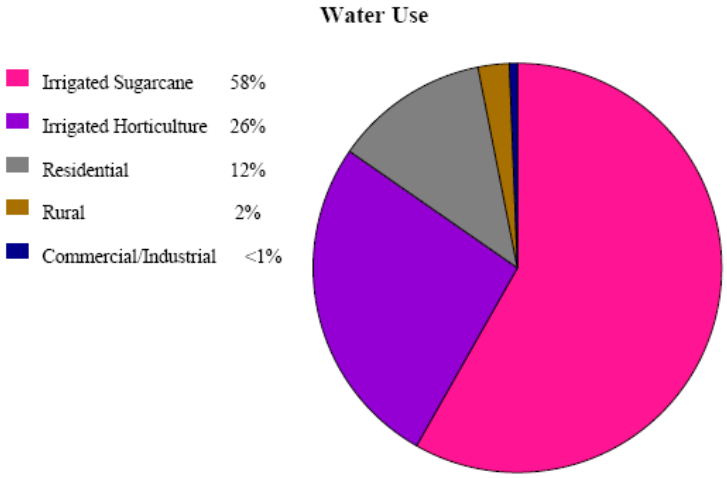
- *There are problems of ground water supplies in the Black River;*
- *Significant quantities of sand and gravel are extracted from the Black River for the Townsville market, creating an in-stream environmental impact;*
- *The riverbanks are severely eroded;*
- *Significant area of the Catchment has been cleared for grazing;*
- *Some fauna species have been subjected to pressure in the catchment;*
- *Approximately 22% of the catchment is within protected areas;*
- *Expansion of cultivated agriculture;*
- *Increasing contribution of nutrient and pesticides;*
- *Commercial and recreational fishery; and*
- *Recreational marine use*" (Brodie et al 2001, p.86).

Table 4-3 Non-Marine Wetland System Summary

System	# Wetlands	Area (km²)	% Wetlands Area	% Total Area
Estuarine	82	13.53	22.5%	1.3%
Lacustrine	87	6.46	10.7%	0.6%
Palustrine	148	4.81	8.0%	0.5%
Riverine	334	35.33	58.7%	3.3%
Total non-marine	651	60.13	100.0%	5.7%

Source: Wetland Summary Information (Qld EPA - http://www.epa.qld.gov.au/wetlandinfo)

Figure 4-2 Average Annual Water Use by Sector



Source: River Basins Summary (Australian Government - Bureau of Rural Sciences, Bureau of Meteorology and CSIRO)

4.3.1 Water Quality Condition

Overall the analysis of water quality condition (Connell Wagner 2008) indicated that the Black River Basin was generally slightly impacted with nine of the nineteen catchments in the basin being assessed as slightly impacted to ecologically healthy and one catchment rated moderately impacted. Of the remaining catchments, eight have no data and one catchment has insufficient data to make an assessment.

More specifically the data indicated a general trend toward low dissolved oxygen relative to guideline values and high total suspended solids for the waterbody reaches across the whole Basin.

4.4 Ross Basin

"The Ross River catchment covers an area of 1707 km². Grazing is the dominant land use occupying 1481 km². State forests and timber reserves occupy 48 km² and protected areas cover 245 km². Other land uses at a much smaller scale include horticulture and sugarcane (both less than 10 km2). Sediment export is classified as low risk, whilst total nitrogen and total phosphorus exports are classified as medium risk in the Ross River catchment."

"Issues in the catchment:

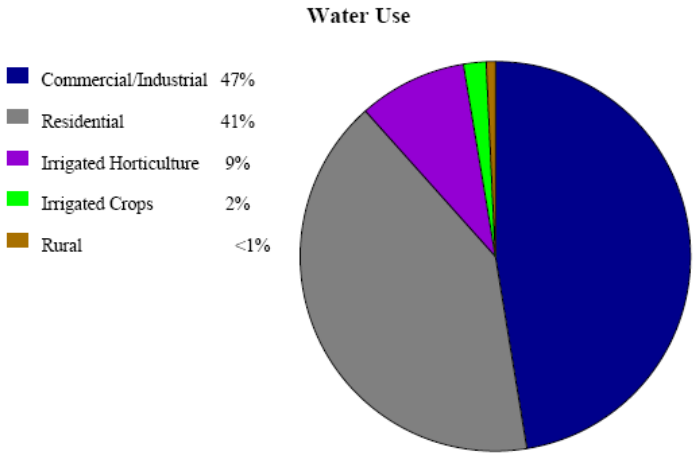
- *Grazing lands are in reasonably good condition with only minor gully and sheet erosion;*
- *Most native grasses are still present;*
- *The Ross River Dam is a major source of the Townsville water supply;*
- *The catchment contains the heavily urbanised City of Townsville and its small surrounds and small areas of sugarcane where suitable soils permit;*
- *Significant alteration of the river has occurred through extractions of sand and gravel to supply construction sites in Townsville and for water storage;*
- *Presence of heavy industry;*
- *Significant area of the catchment has been cleared for grazing;*
- *Approximately 14% of the catchment is within protected areas;*
- *Some fauna species have been subjected to pressure in the catchment;*
- *Commercial and recreational fishery;*
- *Marine tourism;*
- *Commercial port; and*
- *Close proximity to seagrass and dugong protection areas'"* (Brodie et al 2001, p.88).

Table 4-4 Non-Marine Wetland System Summary

System	# Wetlands	Area (km²)	% Wetlands Area	% Total Area
Estuarine	108	137.14	49.4%	8.0%
Lacustrine	171	58.33	21.0%	3.4%
Combined Lacustrine/Palustrine	2	0.31	0.1%	0.0%
Palustrine	266	30.14	10.9%	1.8%
Combined Palustrine/Riverine	1	0.00	0.0%	0.0%
Riverine	256	51.78	18.6%	3.0%
Total non-marine	804	277.70	100.0%	16.3%

Source: Wetland Summary Information (Qld EPA - http://www.epa.qld.gov.au/wetlandinfo)

Figure 4-3 Average Annual Water Use by Sector



Source: River Basins Summary (Australian Government - Bureau of Rural Sciences, Bureau of Meteorology and CSIRO)

4.4.1 Water Quality Condition

The analysis of water quality condition (Connell Wagner 2008) in the twenty catchments of Ross River Basin showed a much worse set of results than the Black River Basin. Only two catchments were rated as slightly impacted to ecologically healthy, one catchment rated moderately impacted and seven catchments rated as heavily impacted. Of the remaining catchments, nine have no data and one catchment has insufficient data to make an assessment.

In general nutrient levels are high and in the Bohle River sub-basin the levels of phosphorus are extremely high compared to the EPA guidelines for low-land streams. Of the nitrogen species, ammonia was consistently high however total nitrogen was generally within or just above the guidelines.

Water quality condition is provided for each of the sub basins in the following sections.

4.5 Sub Basins and Catchments

Catchments are shown by sub basin in Figure 4-4 and Figure 4-5 with areas listed in Table 4-5. Catchment profiles are provided by sub basin in sections 5 to 14, commencing at the northern end of the WQIP study area.

Figure 4-4 Black Ross Sub Basins and Catchments

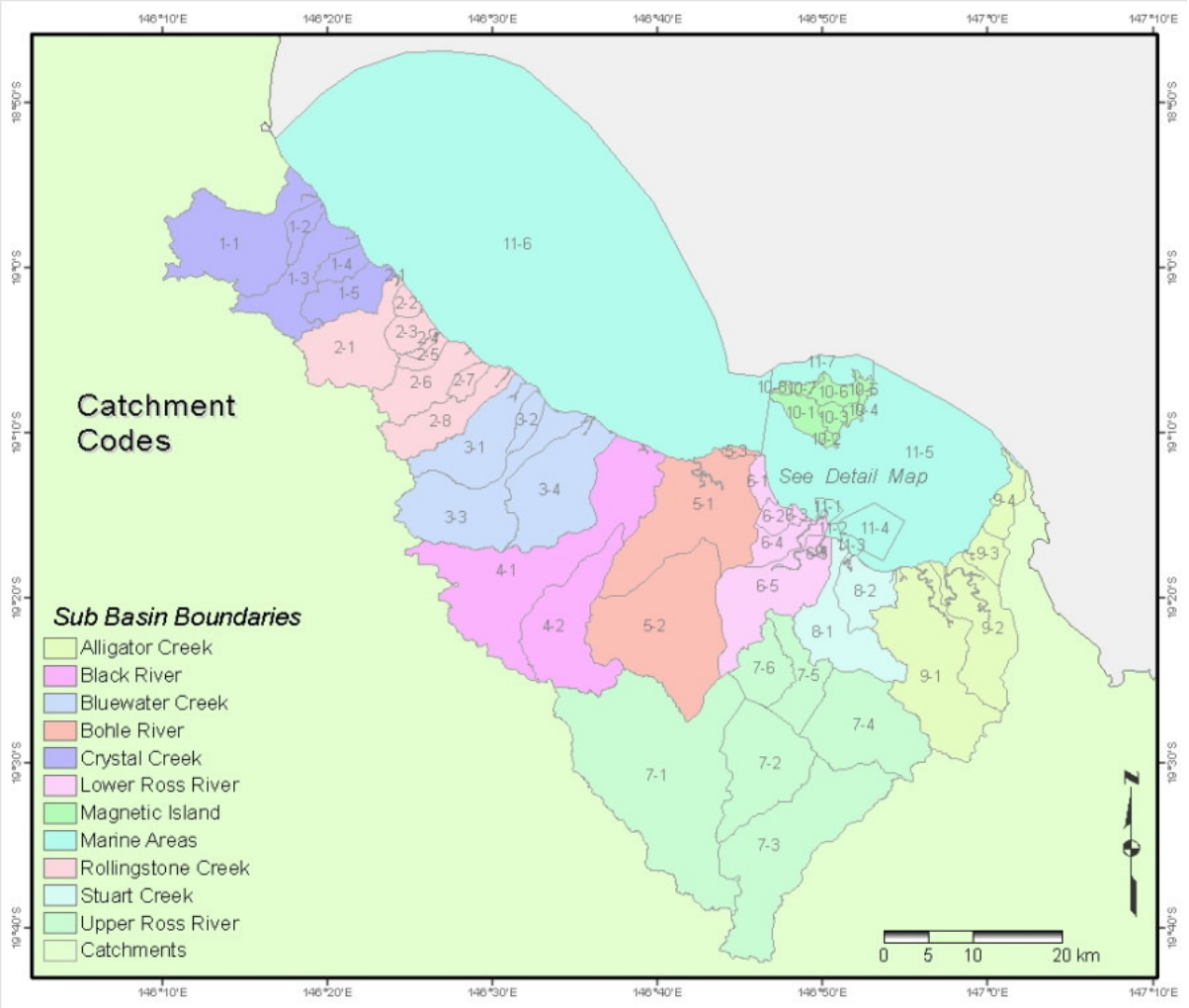


Table 4-5 Black/Ross WQIP catchment areas

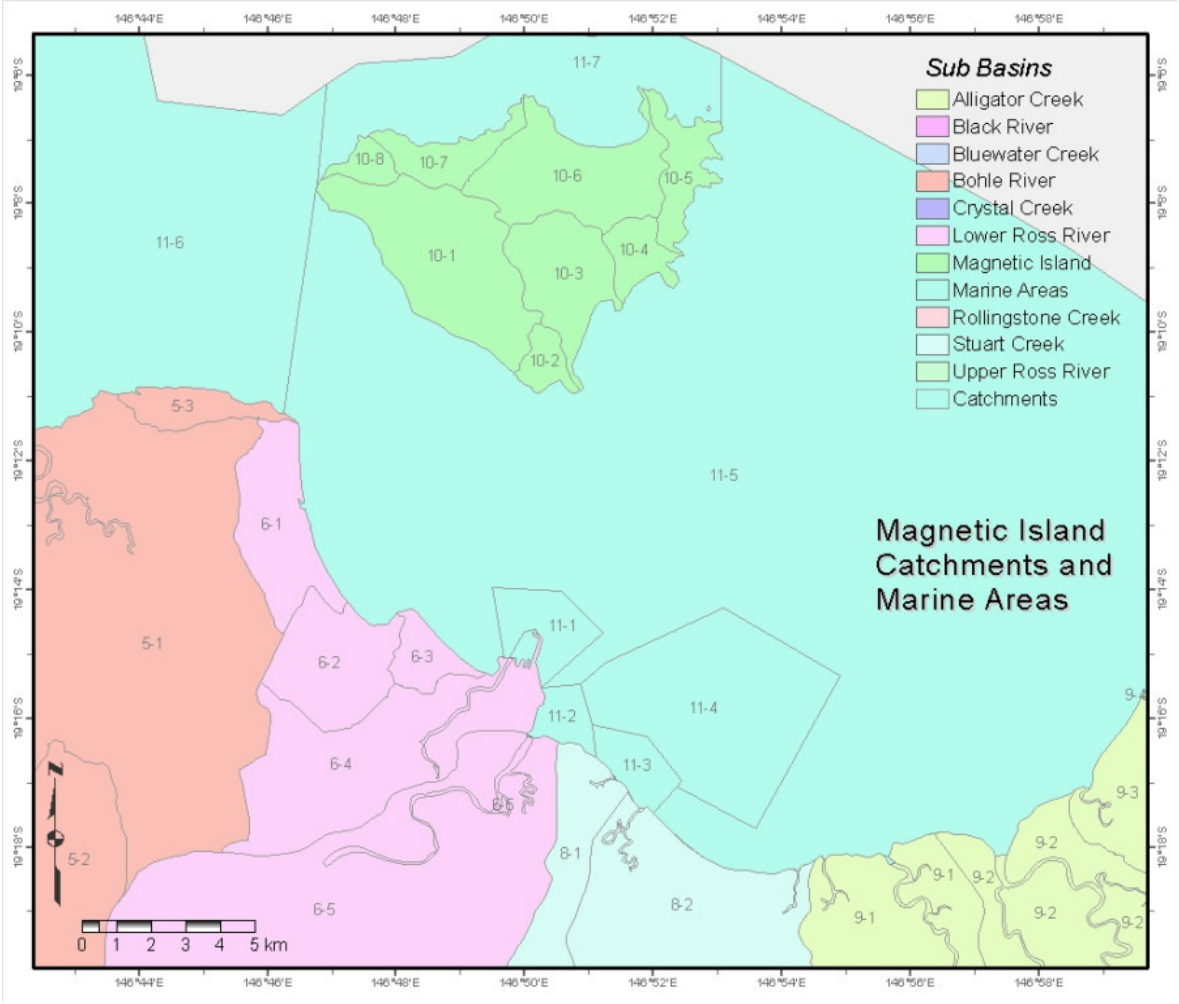
AWRC Basin	Sub Basin	No.	Catchment	Hectares	Sq kms	% area
Black River	Crystal Creek	1-1	Crystal Creek	11888.23	118.88	4.4
Black River	Crystal Creek	1-2	Lorna Creek	1428.38	14.28	0.5
Black River	Crystal Creek	1-3	Ollera Creek	5884.72	58.85	2.2
Black River	Crystal Creek	1-4	Scrubby Creek	1475.26	14.75	0.5
Black River	Crystal Creek	1-5	Hencamp Creek	3732.94	37.33	1.4
Black River	Rollingstone Creek	2-1	Rollingstone Creek	7826.46	78.26	2.9
Black River	Rollingstone Creek	2-2	Unnamed	751.39	7.51	0.3
Black River	Rollingstone Creek	2-3	Surveyors Creek	1691.25	16.91	0.6
Black River	Rollingstone Creek	2-4	Wild Boar Creek	346.23	3.46	0.1
Black River	Rollingstone Creek	2-5	Station Creek	890.58	8.91	0.3
Black River	Rollingstone Creek	2-6	Saltwater Creek	4698.88	46.99	1.7
Black River	Rollingstone Creek	2-7	Cassowary Creek	996.61	9.97	0.4
Black River	Rollingstone Creek	2-8	Leichhardt Creek	5006.39	50.06	1.9
Black River	Bluewater Creek	3-1	Sleeper Log Creek	7168.62	71.69	2.7

Black River	Bluewater Creek	3-2	Two Mile Creek	1338.43	13.38	0.5
Black River	Bluewater Creek	3-3	Bluewater Creek	10534.32	105.34	3.9
Black River	Bluewater Creek	3-4	Deep Creek	10061.49	100.61	3.7
Ross River	Black River	4-1	Black River	20556.89	205.57	7.6
Black River	Black River	4-2	Alice River	10006.78	100.07	3.7
Ross River	Bohle River	5-1	Bohle River	14595.52	145.96	5.4
Ross River	Bohle River	5-2	Bohle River 2	17290.52	172.91	6.4
Ross River	Bohle River	5-3	Shelly Beach	357.56	3.58	0.1
Ross River	Lower Ross River	6-1	Pallarenda	973.19	9.73	0.4
Ross River	Lower Ross River	6-2	Mundy Creek	976.17	9.76	0.4
Ross River	Lower Ross River	6-3	Esplanade	297.77	2.98	0.1
Ross River	Lower Ross River	6-4	Ross Creek	2242.38	22.42	0.8
Ross River	Lower Ross River	6-5	Ross River (btdam)	9025.60	90.26	3.3
Ross River	Upper Ross River	7-1	Ross River (atd)	30520.21	305.20	11.3
Ross River	Upper Ross River	7-2	Six Mile Creek	9624.66	96.25	3.6
Ross River	Upper Ross River	7-3	Toonpan Lagoon	17120.37	171.20	6.3
Ross River	Upper Ross River	7-4	Antill Plains Creek	10759.49	107.59	4.0
Ross River	Upper Ross River	7-5	Sachs Creek	4129.52	41.30	1.5
Ross River	Upper Ross River	7-6	Mt Stuart	3798.10	37.98	1.4
Ross River	Stuart Creek	8-1	Stuart Creek	6726.7	67.27	2.5
Ross River	Stuart Creek	8-2	Sandfly Creek	3644.3	36.44	1.3
Haughton River	Alligator Creek	9-1	Alligator Creek	14802.06	148.02	5.5
Haughton River	Alligator Creek	9-2	Crocodile Creek	7997.30	79.97	3.0
Haughton River	Alligator Creek	9-3	Cocoa Creek	1716.50	17.16	0.6
Haughton River	Alligator Creek	9-4	Cape Cleveland	2025.59	20.26	0.8
	Magnetic Island	10-1	West Coast	1655.20	16.55	0.6
	Magnetic Island	10-2	Picnic Bay	191.86	1.92	0.1
	Magnetic Island	10-3	Nelly Bay	802.63	8.03	0.3
	Magnetic Island	10-4	Arcadia	292.01	2.92	0.1
	Magnetic Island	10-5	Radical Bay	431.26	4.31	0.2
	Magnetic Island	10-6	Horseshoe Bay	1230.09	12.30	0.5
	Magnetic Island	10-7	Five Beach Bay	386.38	3.86	0.1
	Magnetic Island	10-8	Rollingstone Bay	158.92	1.59	0.1
			Total	**270,065.23**	**2,700.65**	

Marine Area	**Name**	**No.**		**Hectares**	**Sq kms**	**% area**
Townsville Harbour		11-1		458		
Ross River Near Shore		11-2		233		
Sandfly Creek Near Shore		11-3		327		
Ross Offshore		11-4		2448		
Cleveland Bay		11-5		33,543	370	22.5
Halifax Bay		11-6		124,883	1,250	75.9
Magnetic Island Near Coastal		11-7		2716	27	1.6

Source: Derived from catchments defined by CSIRO for Creek to Coral CCI WQIP and using QLUMP 1999 data and updated land use 2005 prepared by Connell Wagner. Cleveland Bay sq kms total is the sum of areas 11-1 to 11-5.

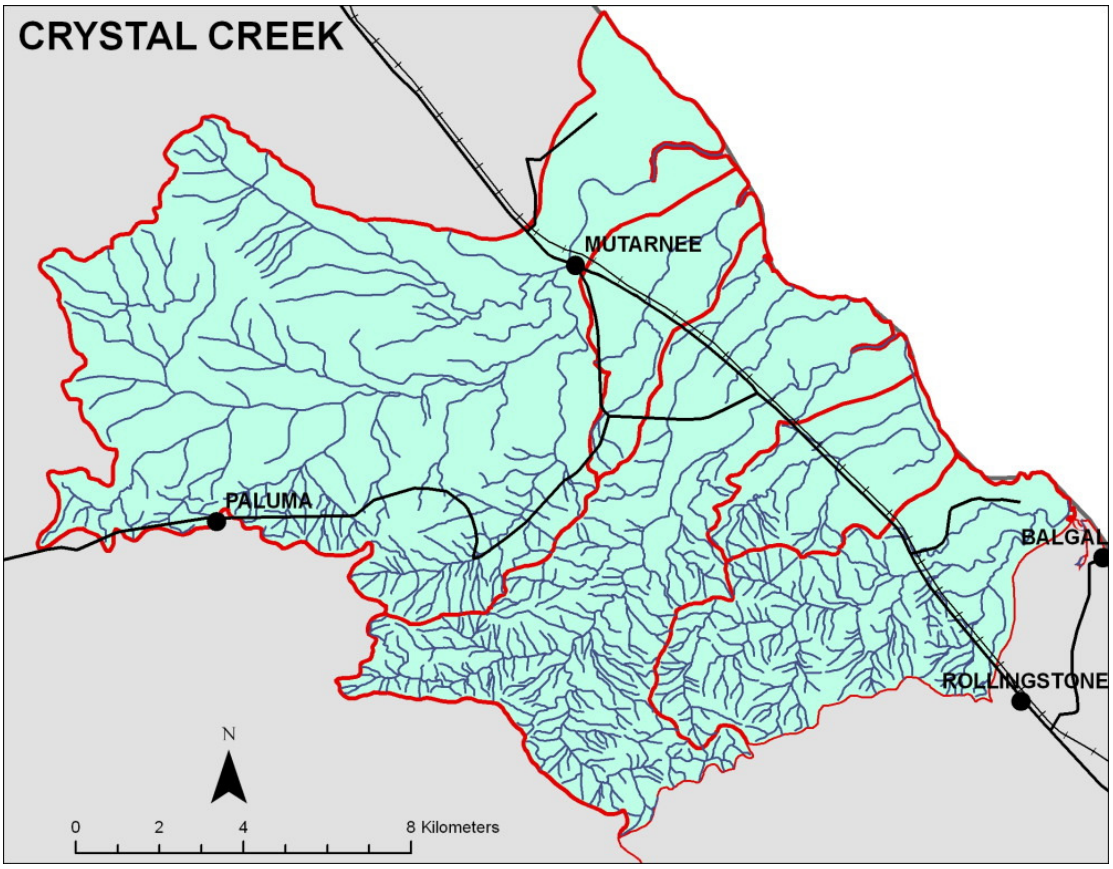
Figure 4-5 Magnetic Island Catchments and Marine Areas Detail



5. Crystal Creek Sub Basin

The Crystal Creek sub basin includes Crystal Creek, Lorna Creek, Ollera Creek, Scrubby Creek and Hencamp Creek catchments. There are also a number of smaller waterways that have been included in the catchments of these larger creeks (see Figure 5-1).

Figure 5-1 Crystal Creek Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\ Crystal_Creek_300

5.1 Crystal Creek Sub Basin Land Use

The Crystal Creek sub basin is approximately 240 square kilometres in size (24,000 hectares). Nature conservation and other minimal use are the main land uses in the Crystal Creek sub basin with grazing and irrigated cropping (sugar cane) being the most dominant of the agricultural land uses (see Table 5-1 and Figure 5-3).

Land use summaries and other physical features of the main catchments of the Crystal Creek sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 5-2 Crystal Creek Sub Basin Imagery

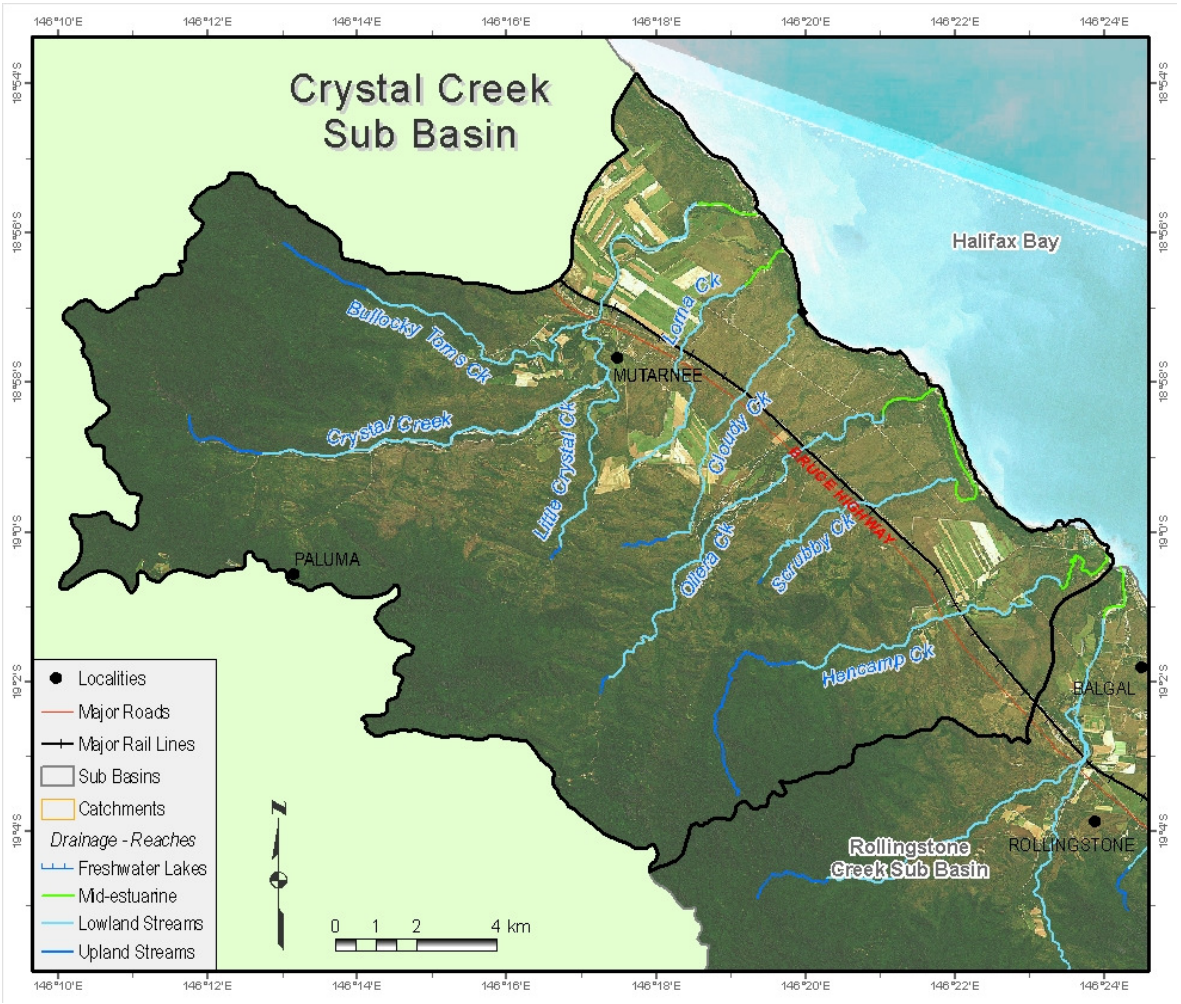
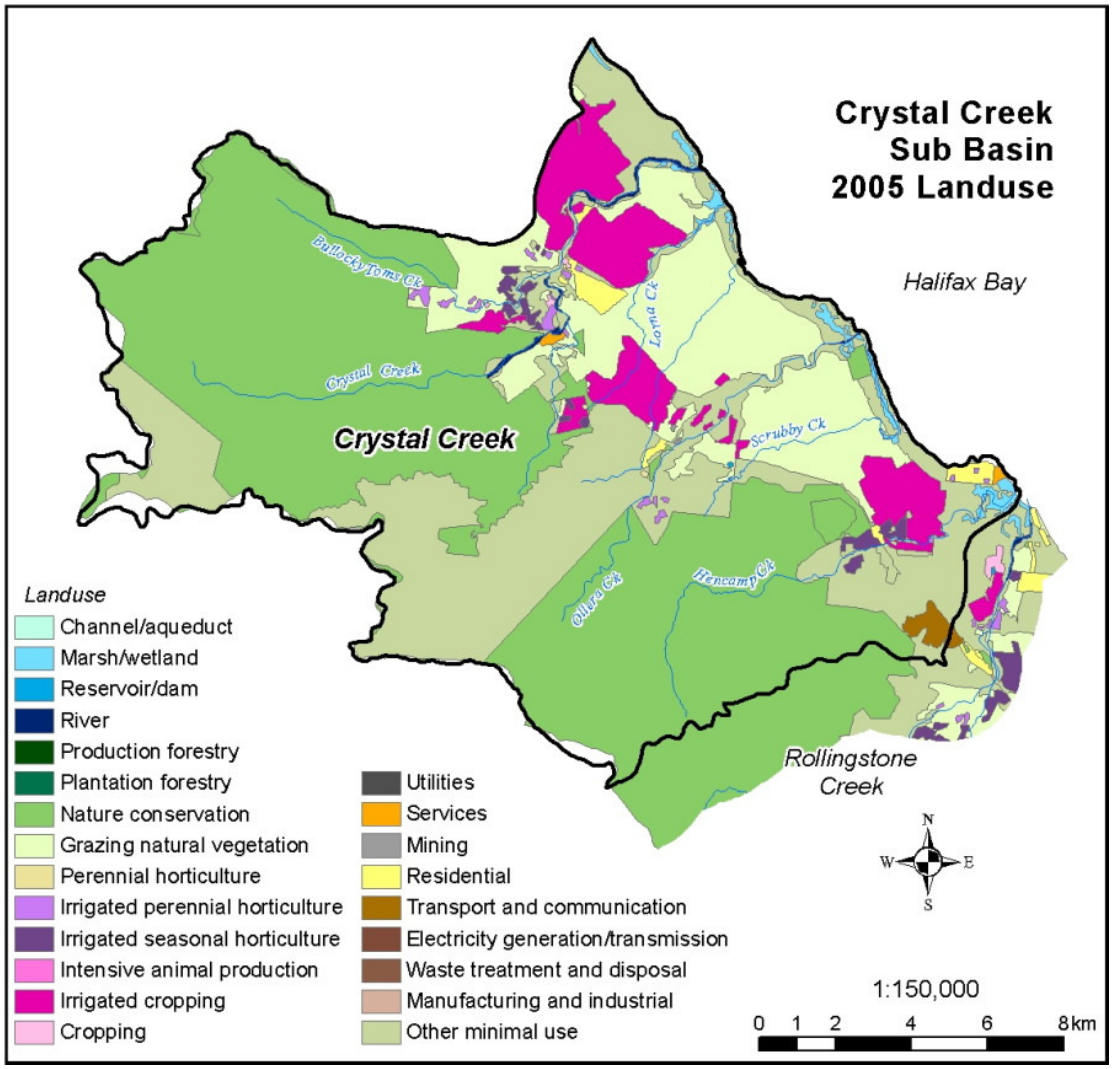


Figure 5-3 Crystal Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 5-1 Crystal Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping (Dryland)	10	0.04	10	0.04
Grazing Natural Vegetation	3597	14.78	2287	9.54
Irrigated Cropping	1579	6.49	1697	7.08
Irrigated Perennial Horticulture	89	0.37	88	0.37
Irrigated Seasonal Horticulture	160	0.66	178	0.74
Marsh/Wetland	205	0.84	205	0.85
Mining	4	0.02	4	0.01
Nature Conservation	12041	49.46	11786	49.18
Other Minimal Use	6291	25.84	7365	30.73
Perennial Horticulture (Dryland)	4	0.02	4	0.02
Production Forestry	1	0.00	1	0.00
Reservoir/Dam	2	0.01	2	0.01
Residential	189	0.78	171	0.71
River	61	0.25	61	0.25
Services	25	0.10	25	0.10

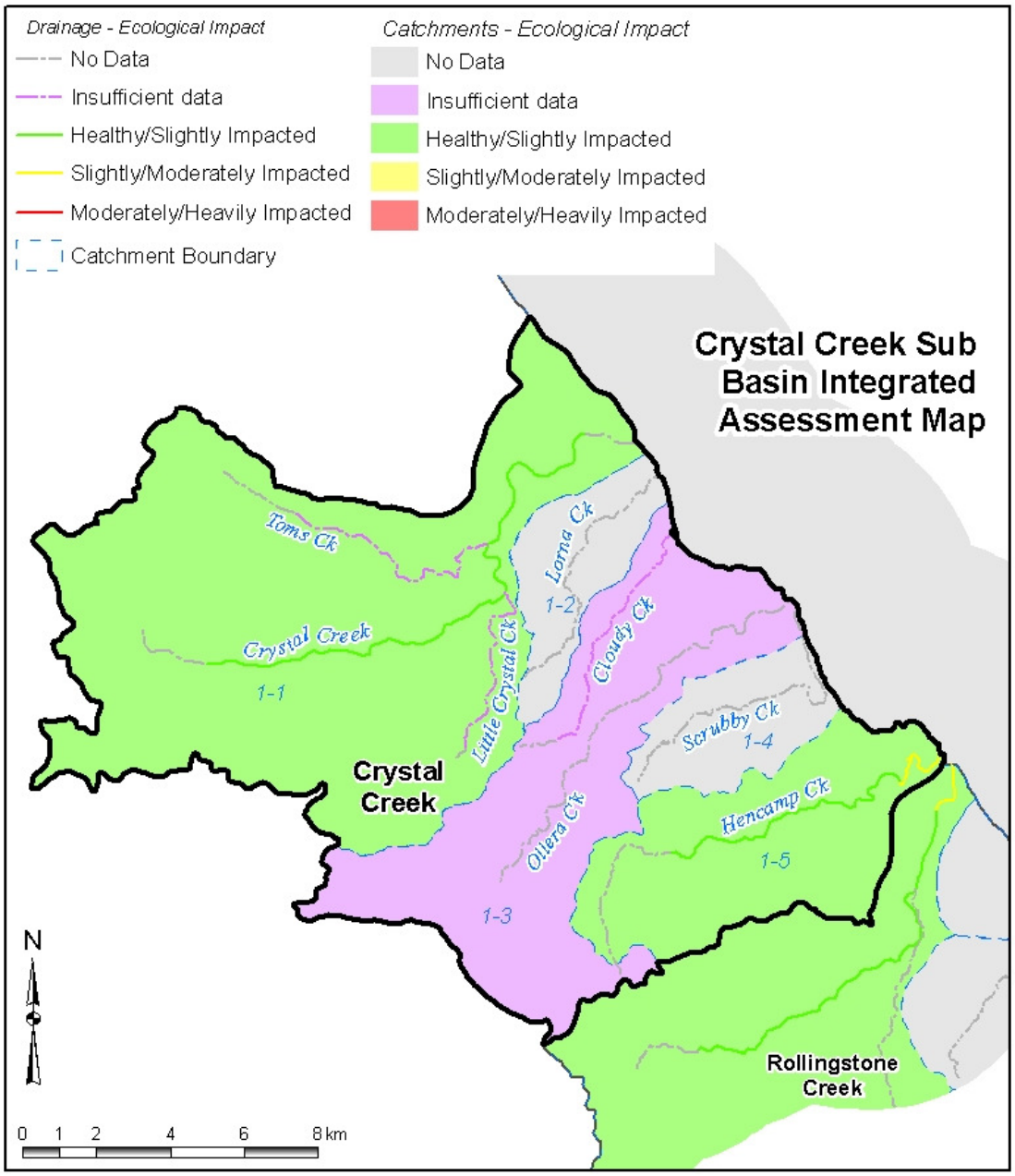
Transport and Communication	85	0.35	85	0.35
Total	24,343	100	23,969	100

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

5.2 Crystal Creek Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) rated two of the catchments, Crystal Creek and Hencamp Creek, as healthy but there was generally insufficient information to assess the remaining areas (see Figure 5-4) . While there is insufficient data for an assessment of Ollera Creek, the available data showed that the median of the data was within the guideline values. Recent data shows that the water clarity for Crystal Creek and Hencamp Creek still rates as ecologically healthy.

Figure 5-4 Crystal Creek Sub Basin Ecological Impact



5.2.1 1-1 Crystal Creek catchment

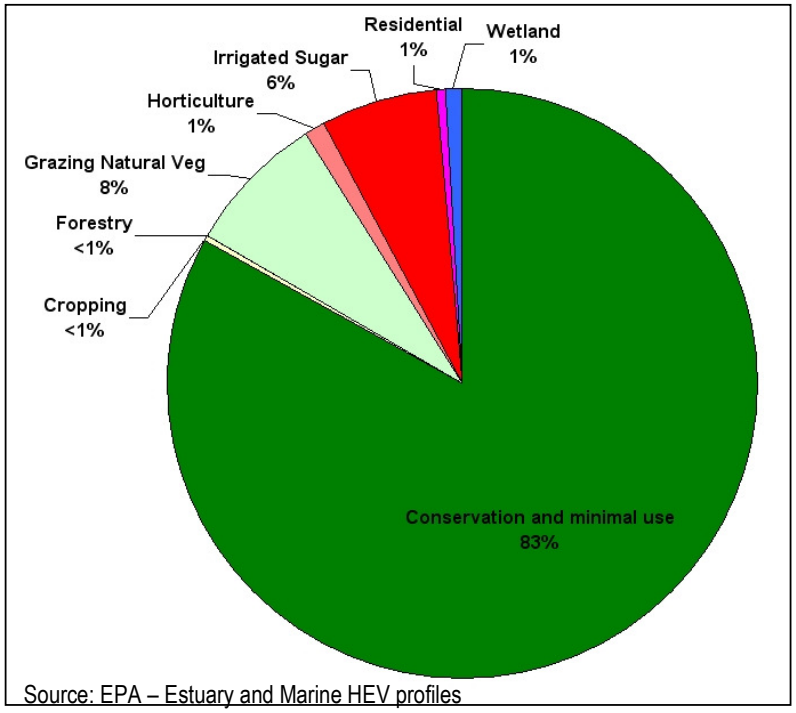
The Crystal Creek catchment is approximately 11,888 hectares in area with the main land use being nature conservation and minimal use.

Table 5-2 Crystal Creek Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	National park	7105.23	59.9	7046.9	60.8
	Natural feature protect.	240.01	2.0	130.4	1.1
	Other conserved area	8.93	0.1	8.9	0.1
Other minimal use		21.13	0.2	20.7	0.2
	Remnant native cover	2637.42	22.2	2527.8	21.8
Grazing natural veg.		870.33	7.3	869.0	7.5
Production forestry		1.35	0.0	0.0	0.0
Cropping		9.77	0.1	9.8	0.1
Perennial horticulture		1.22	0.0	1.2	0.0
Irrigated cropping	Irrigated sugar	707.82	6.0	710.9	6.1
Irrigated perennial horticulture	Irrigated tree fruits	64.68	0.5	63.7	0.5
Irrigated seasonal horticulture	Irrigated fruits	79.53	0.7	79.5	0.7
Residential	Rural residential	21.61	0.2	21.6	0.2
Services	Recreation and culture	13.36	0.1	13.4	0.1
River		57.87	0.5	58.0	0.5
Marsh/wetland		8.70	0.1	8.6	0.1
	Marsh/W Conservation	21.96	0.2	22.0	0.2
		11,871		11,529.5	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 5-5 Crystal Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	27.876 Gl/Year
Flow modification	Yes
Number of fish barriers	4
Presence of EVR species or ecosystems	Not known
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	14%
Estuarine vegetation cleared	1%
OzEstuary 2000	
Type	WDD
Bryce Heap	Tidal estuary
Condition	Largely unmodified
Page & Hoolihan 2002	
Naturalness Estuary	High
Naturalness Catchment	Moderate
Habitat Diversity	Low
International Significance	High
Level of protection	Low

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	Low	Low	Low	Low
Chronic or Storm	(Storm)	(Storm)	(Storm)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

5.2.2 1-2 Lorna Creek catchment

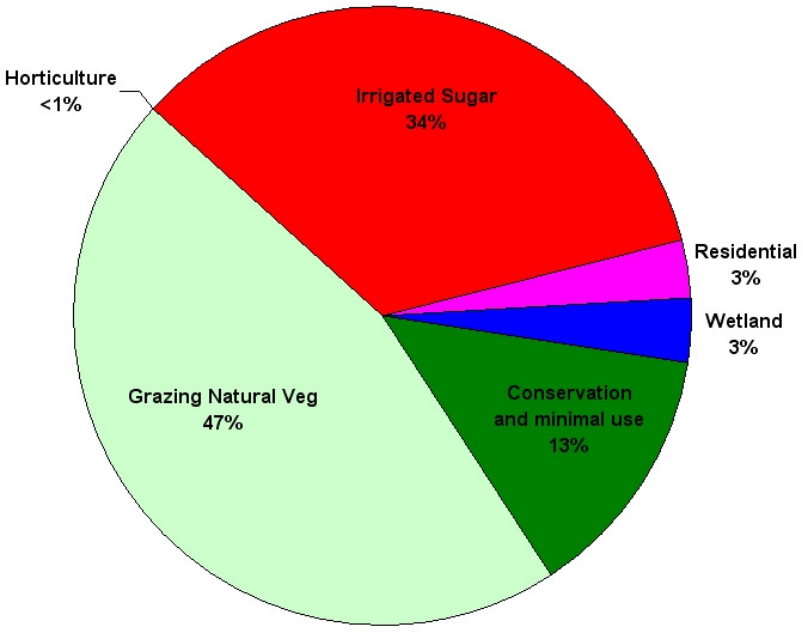
The Lorna Creek catchment is approximately 1,428 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture. While it is not a large area in the context of the study area a significant proportion of the catchment is used for sugar cane production.

Table 5-3 Lorna Creek Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments (16.2%)	Nature conservation	National park	9.74	0.7
		Other conserved area	3.87	0.3
	Other minimal use	Remnant native cover	216.65	15.2
Production from relatively natural environments	Grazing natural vegetation		644.87	45.3
Production from dryland agriculture and plantations	Perennial horticulture		0.25	0.0
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	425.39	29.9
	Irrigated perennial hort.	Irrigated tree fruits	1.42	0.1
	Irrigated seasonal hort.	Irrigated fruits	5.43	0.4
Intensive uses	Residential	Rural residential	82.47	5.8
Water	Marsh/wetland		1.58	0.1
		Marsh/W Conservation	31.50	2.2
		Total	1,423	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 5-6 Lorna Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	Not known
Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	Not known

Presence of STP point source	No
Presence of other point source	No
Catchment cleared	50%
Estuarine vegetation cleared	0%

Source: EPA – Estuary and Marine HEV profiles

5.2.3 1-3 Ollera Creek catchment

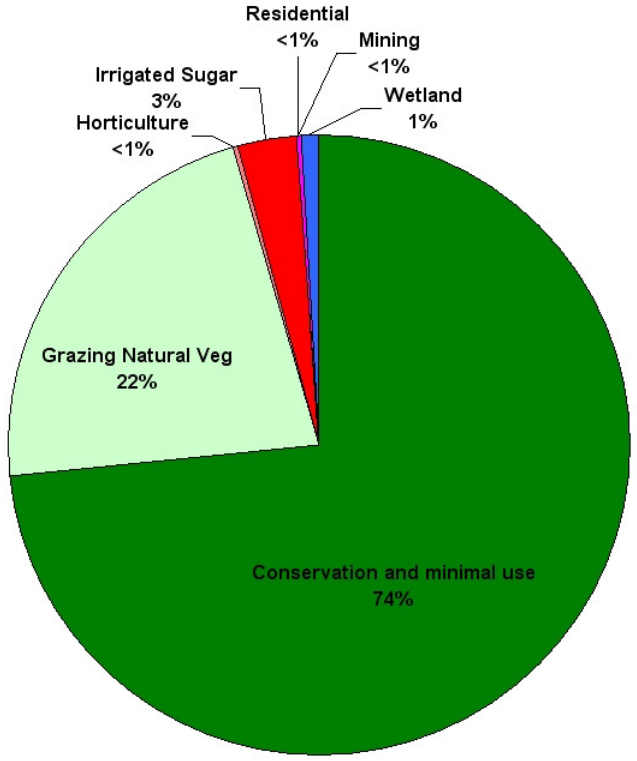
The Ollera Creek catchment is approximately 5,885 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 5-4 Ollera Creek Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments (74.1%)	Nature conservation	National park	2193.53	37.4
		Other conserved area	47.54	0.8
	Other minimal use	Remnant native cover	2107.04	35.9
Production from relatively natural environments	Grazing natural vegetation		1244.76	21.2
Production from dryland agriculture and plantations	Perennial horticulture		2.34	0.0
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	182.57	3.1
	Irrigated perennial hort.	Irrigated tree fruits	17.39	0.3
Intensive uses	Residential	Rural residential	18.31	0.3
	Mining		3.54	0.1
Water	River		2.89	0.0
	Marsh/wetland		2.69	0.0
		Marsh/W Conservation	42.43	0.7
		Total	5,865	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 5-7 Ollera Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	14.847 Gl/Year

Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	Not known
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	11%
Estuarine vegetation cleared	0%
OzEstuary 2000	
Type	WDD
Bryce Heap	Tidal estuary
Condition	Largely unmodified
Page & Hoolihan 2002	
Naturalness Estuary	High
Naturalness Catchment	Moderate
Habitat Diversity	Moderate
International Significance	High
Level of protection	Low

Source: EPA – Estuary and Marine HEV profiles

5.2.4 1-4 Scrubby Creek catchment

The Scrubby Creek catchment is approximately 1,475 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 5-5 Scrubby Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments (42.9%)	Nature conservation	National park	21.67	1.5
		Natural feature protect.	308.22	21.0
		Other conserved area	3.29	0.2
	Other minimal use	Remnant native cover	295.57	20.2
Production from relatively natural environments	Grazing natural vegetation		793.96	54.1
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	9.84	0.7
	Reservoir/dam		1.97	0.1
Water	Marsh/wetland	Marsh/W Conservation	32.01	2.2
		Total	1,467	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

5.2.5 1-5 Hencamp Creek catchment

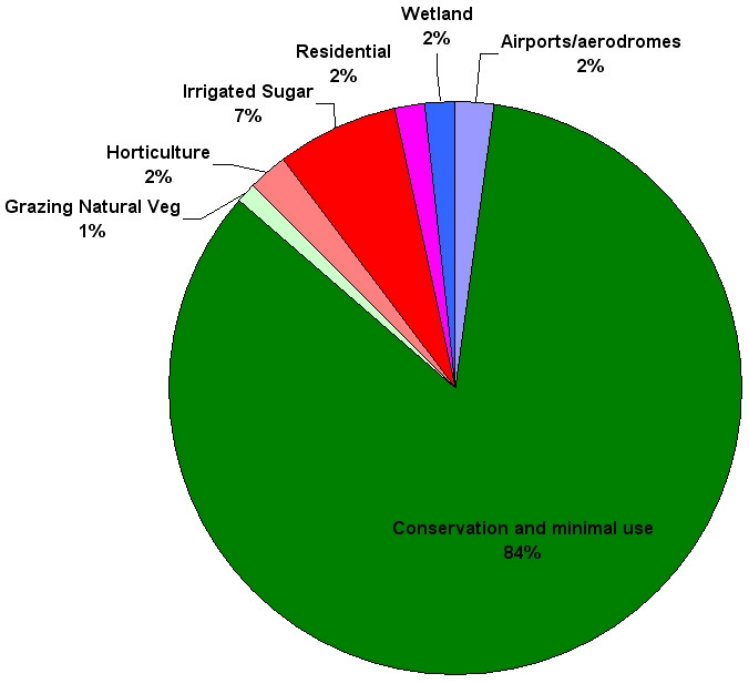
The Hencamp Creek catchment is approximately 3,733 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 5-6 Hencamp Creek Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments (83.7%)	Nature conservation	National park	75.67	2.0
		Natural feature protect.	2023.47	54.4
	Other minimal use		96.46	2.6
		Remnant native cover	916.50	24.7
Production from relatively natural environments	Grazing natural vegetation		42.96	1.2
Production from dryland agriculture and plantations	Cropping		253.04	6.8
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	4.43	0.1
	Irrigated perennial horticulture	Irrigated tree fruits	1.34	0.0
	Irrigated seasonal horticulture	Irrigated fruits	74.99	2.0
Intensive uses	Residential	Rural residential	66.93	1.8
	Services	Recreation and culture	11.69	0.3
	Transport and communication	Airports/aerodromes	84.77	2.3
Water	Marsh/wetland		2.27	0.1
		Marsh/W Conservation	61.70	1.7
		Total	3,716	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 5-8 Hencamp Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description

Average river flow	Not known
Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	1
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	19%
Estuarine vegetation cleared	7%

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	V. Low	V. Low	V. Low	Low
Chronic or Storm	(Storm)	(Storm)	(Storm)	(Storm)

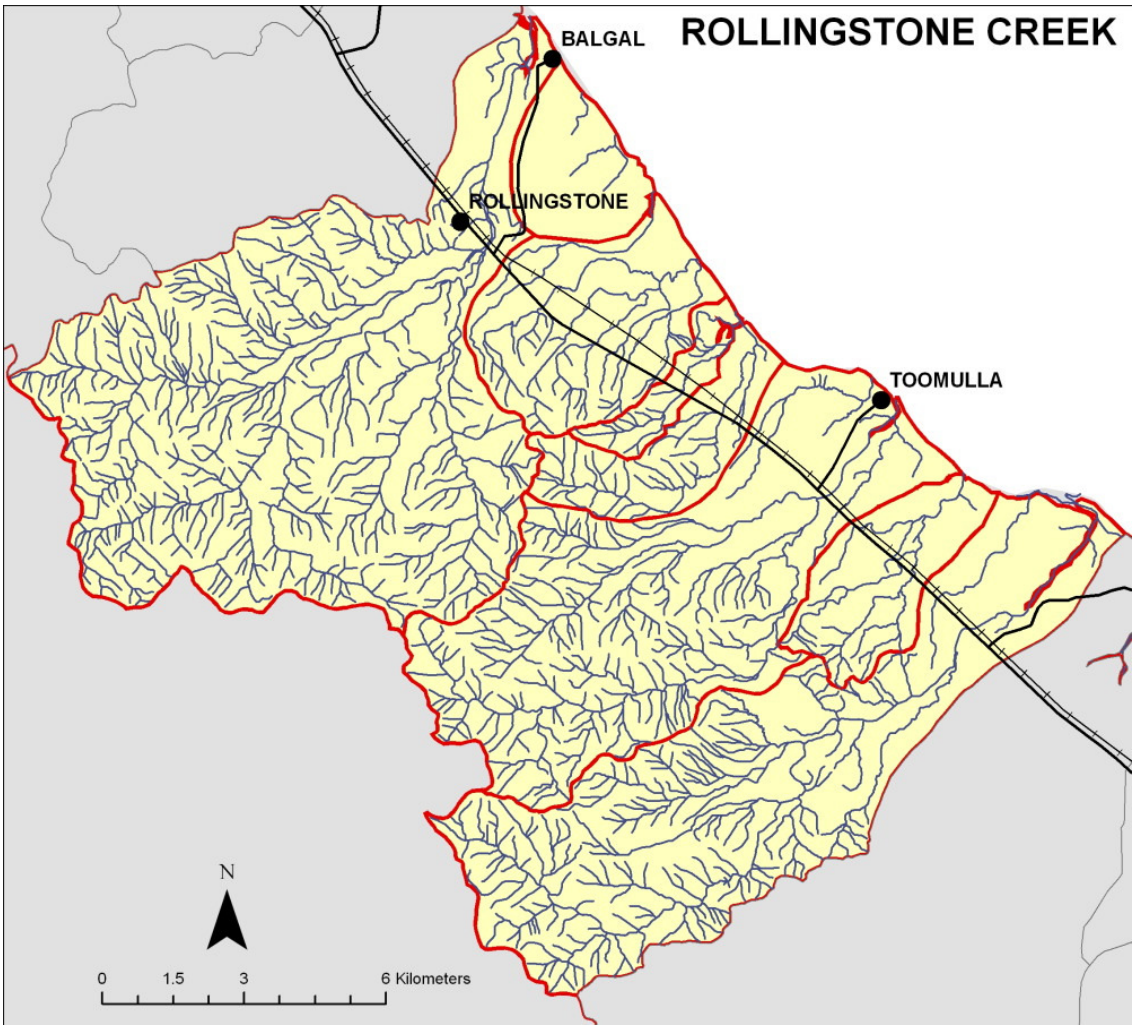
Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

6. Rollingstone Creek Sub Basin

The Rollingstone Creek sub basin includes the Rollingstone Creek, Unnamed, Surveyors Creek, Wild Boar Creek, Station Creek, Saltwater Creek, Cassowary Creek and Leichhardt Creek catchments. There are also a number of smaller waterways that have been included in the catchments of these larger creeks (see Figure 6-1).

Figure 6-1 Rollingstone Creek Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\ Rollingstone_Creek_300

6.1 Rollingstone Creek Sub Basin Land Use

The Rollingstone Creek sub basin is approximately 220 square kilometres in size (22,000 hectares). Land use is dominated by nature conservation and minimal use with grazing, horticulture and residential also being relatively significant land uses (see Figure 6-3 and Table 6-1).

Land use summaries and other physical features of the main catchments of the Rollingstone Creek sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 6-2 Rollingstone Creek Sub Basin Imagery

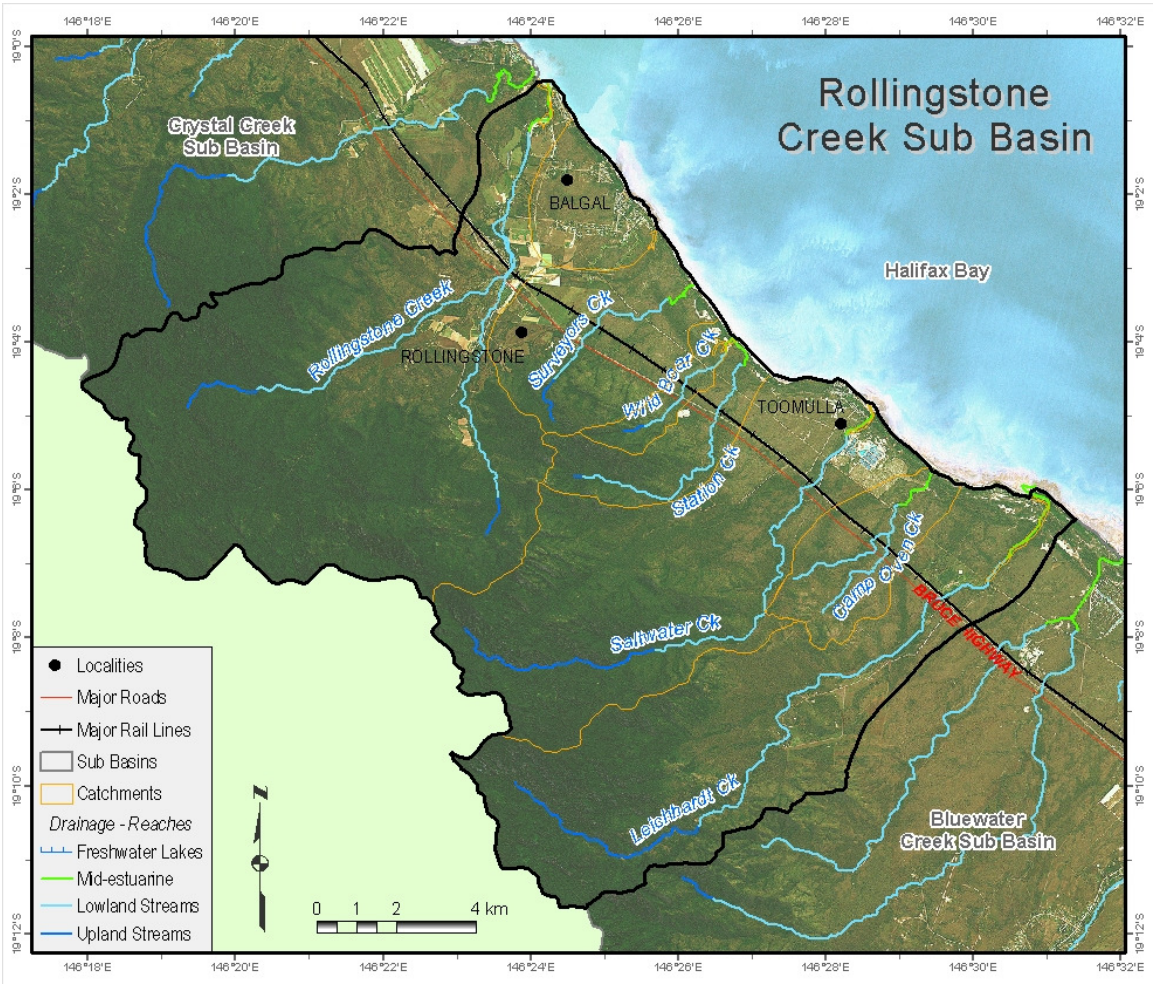
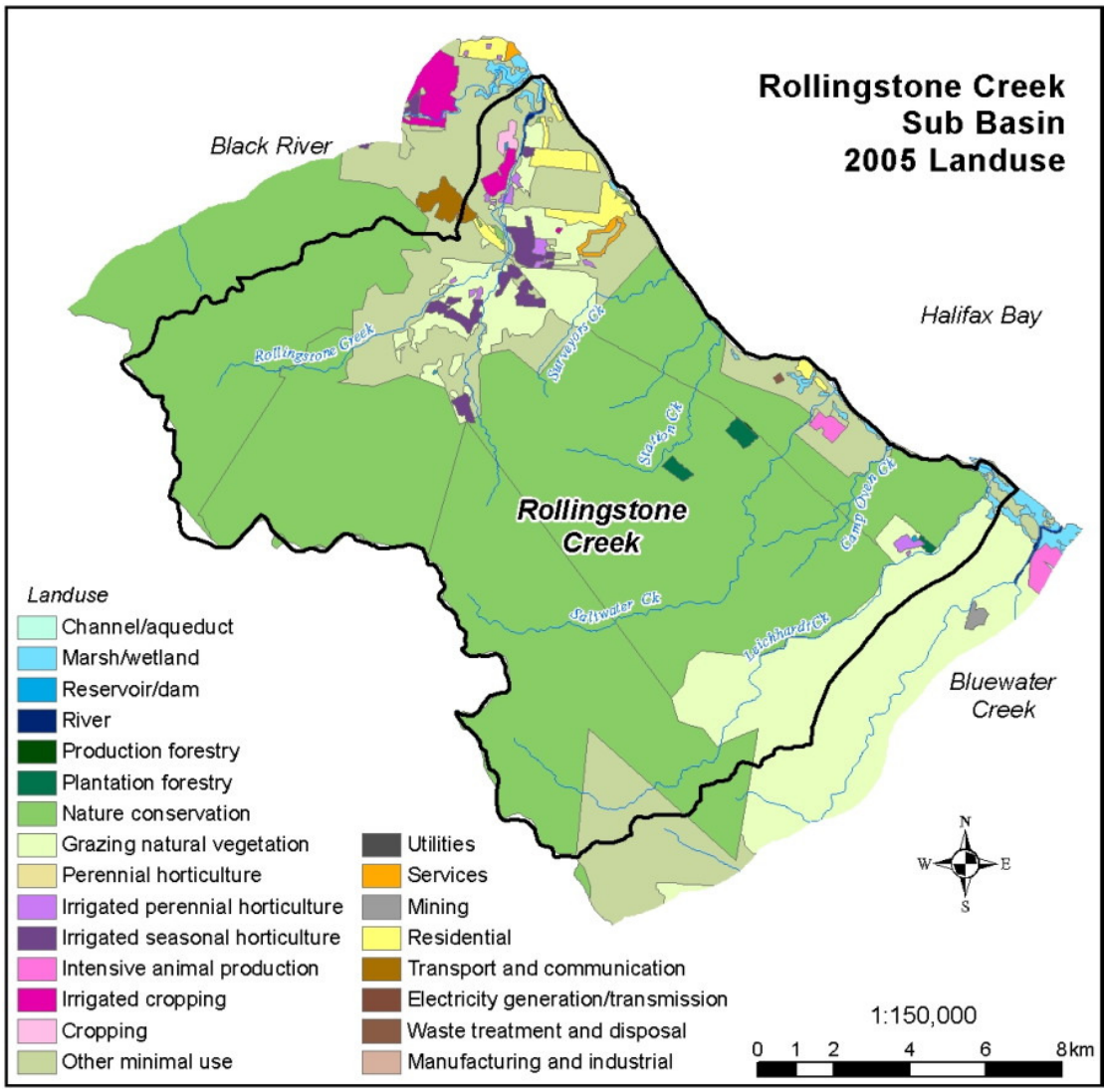


Figure 6-3 Rollingstone Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 6-1 Rollingstone Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping (Dryland)	28	0.13	28	0.13
Grazing Natural Vegetation	2392	10.81	2382	10.82
Intensive animal prod./Aquaculture	0	0.00	40	0.18
Irrigated Cropping	50	0.23	52	0.24
Irrigated Perennial Horticulture	70	0.32	70	0.32
Irrigated Seasonal Horticulture	210	0.95	215	0.98
Marsh/Wetland	95	0.43	96	0.43
Nature Conservation	15997	72.27	15865	72.10
Other Minimal Use	2906	13.13	2863	13.01
Plantation Forestry	70	0.32	70	0.32
Production Forestry	2	0.01	2	0.01
Reservoir/Dam	5	0.02	5	0.02
Residential	247	1.12	253	1.15

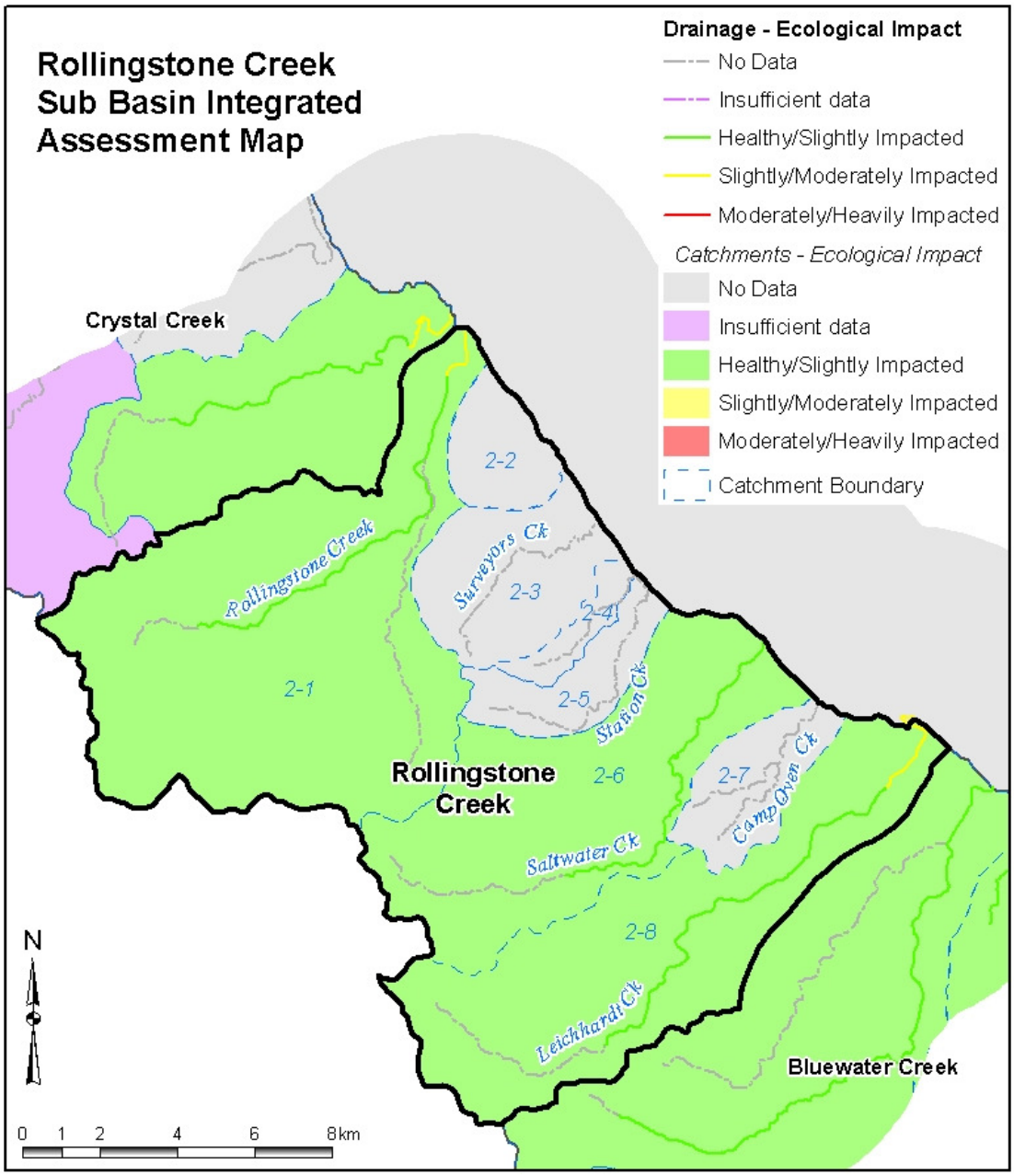
River	10	0.05	10	0.04
Services	34	0.15	34	0.16
Transport and Communication	15	0.07	15	0.07
Waste Treatment and Disposal	5	0.02	5	0.02
	22,136	100.00	22,003	100.00

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

6.2 Rollingstone Creek Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of this sub-basin was generally indicative of an ecologically healthy lowland stream system (see Figure 6-4. However the data also suggested that dissolved oxygen was consistently low and total suspended sediment was generally high across all the catchments of the sub basin.

Figure 6-4 Rollingstone Creek Sub Basin Ecological Impact



6.2.1 2-1 Rollingstone Creek catchment

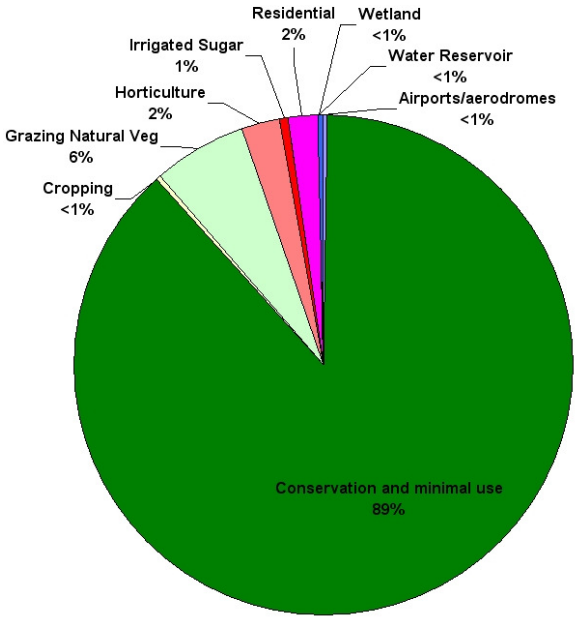
The Rollingstone Creek catchment is approximately 7,8273 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 6-2 Rollingstone Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	2554.19	32.7
		Natural feature protection	2842.30	36.4
		Other conserved area	435.15	5.6
	Other minimal use		6.36	0.1
		Remnant native cover	1200.57	15.4
Production from relatively natural environments	Grazing natural vegetation		425.87	5.4
Production from dryland agriculture and plantations	Cropping		27.95	0.4
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	50.04	0.6
	Irrigated perennial horticulture	Irrigated tree fruits	31.75	0.4
	Irrigated seasonal horticulture	Irrigated fruits	151.63	1.9
Intensive uses	Residential		21.09	0.3
		Rural residential	26.19	0.3
	Transport and communication	Airports/aerodromes	14.60	0.2
Water	Reservoir/dam		3.00	0.0
	River		9.54	0.1
	Marsh/wetland		0.0	0.0
		Marsh/W Conservation	18.04	0.2
		Total	7818.27	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 6-5 Rollingstone Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description

Average river flow	35.572 Gl/Year
Flow modification	No
Number of fish barriers	1
Presence of EVR species or ecosystems	7
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	10%
Estuarine vegetation cleared	0%
OzEstuary 2000	
Type	WDD
Bryce Heap	Tidal Estuary
Condition	Largely unmodified
Page & Hoolihan 2002	
Naturalness Estuary	High
Naturalness Catchment	Moderate
Habitat Diversity	Moderate
International Significance	High
Level of protection	Low

Source: EPA – Estuary and Marine HEV profiles

6.2.2 2-2 Unnamed Creek

The unnamed creek catchment is approximately 751 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 6-3 Unnamed Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	4.62	0.6
	Other minimal use		32.01	4.4
		Remnant native cover	327.84	44.9
Production from relatively natural environments	Grazing natural vegetation		139.95	19.2
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	7.88	1.1
	Irrigated seasonal horticulture	Irrigated fruits	3.87	0.5
Intensive uses	Residential		111.61	15.3
		Rural residential	68.02	9.3
	Services	Recreation and culture	31.44	4.3
Water	Marsh/wetland		3.54	0.5
		Total	730.28	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

6.2.3 2-3 Surveyors Creek

The Surveyors Creek catchment is approximately 1,691 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 6-4 Surveyors Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	434.15	25.9
		Other conserved area	448.22	26.8
	Other minimal use		0.74	0.0
		Remnant native cover	370.84	22.2

Production from relatively natural environments	Grazing natural vegetation		353.14	21.1
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	9.63	0.6
	Irrigated seasonal horticulture	Irrigated fruits	54.99	3.3
Intensive uses	Services	Recreation and culture	2.34	0.1
		Total	1674.05	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

6.2.4 2-4 Wild Boar Creek

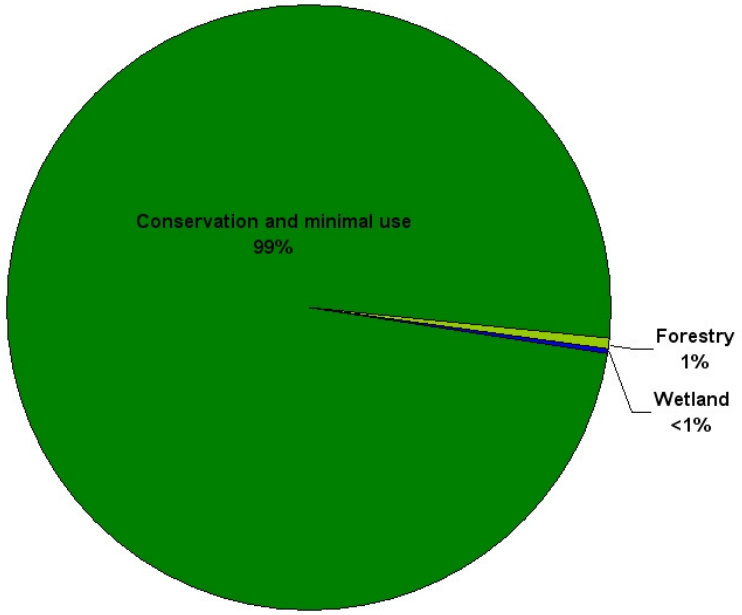
The Wild Boar Creek catchment is approximately 346 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation.

Table 6-5 Wild Boar Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	156.61	45.5
	Nature conservation	Other conserved area	187.55	54.5
		Total	344.16	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 6-6 Wild Boar Creek catchment land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	Not known
Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	2
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	3%
Estuarine vegetation cleared	0%

Source: EPA – Estuary and Marine HEV profiles

6.2.5 2-5 Station Creek

The Station Creek catchment is approximately 891 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 6-6 Station Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	160.17	18.2
	Nature conservation	Other conserved area	687.24	77.9
	Other minimal use	Remnant native cover	25.79	2.9
Production from dryland agriculture and plantations	Plantation forestry		6.39	0.7
Water	Marsh/wetland		2.28	0.3
		Total	881.88	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

6.2.6 2-6 Saltwater Creek

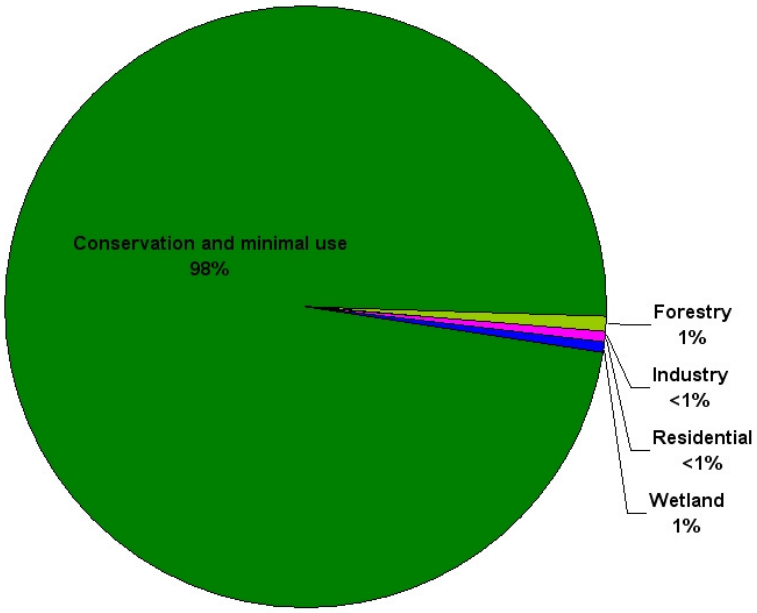
The Saltwater Creek catchment is approximately 4,699 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 6-7 Saltwater Creek Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Natural feature protection	1775.31	37.9	1753.4	37.6
	Other conserved area	2386.20	50.9	2386.4	51.2
Other minimal use		50.73	1.1	11.9	0.3
	Remnant native cover	356.83	7.6	353.5	7.6
Production forestry		2.04	0.0	2.0	0.0
Plantation forestry		54.29	1.2	54.3	1.2
				39.8	0.9
Residential		20.07	0.4	22.4	0.5
Waste treatment and disposal		4.68	0.1	4.7	0.1
Marsh/wetland		16.22	0.3	16.2	0.3
	Marsh/W Conservation	17.84	0.4	17.8	0.4
		4684.2		4662.4	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)
Aquaculture area not included.

Figure 6-7 Saltwater Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	Not known
Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	19
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	4%
Estuarine vegetation cleared	4%

Source: EPA – Estuary and Marine HEV profiles

6.2.7 2-7 Cassowary Creek

The Cassowary Creek catchment is approximately 997 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 6-8 Cassowary Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	279.00	28.0
		Other conserved area	639.60	64.2
	Other minimal use	Remnant native cover	75.92	7.6
Water	Marsh/wetland	Marsh/W Conservation	2.09	0.2
		Total	996.61	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

6.2.8 2-8 Leichhardt Creek

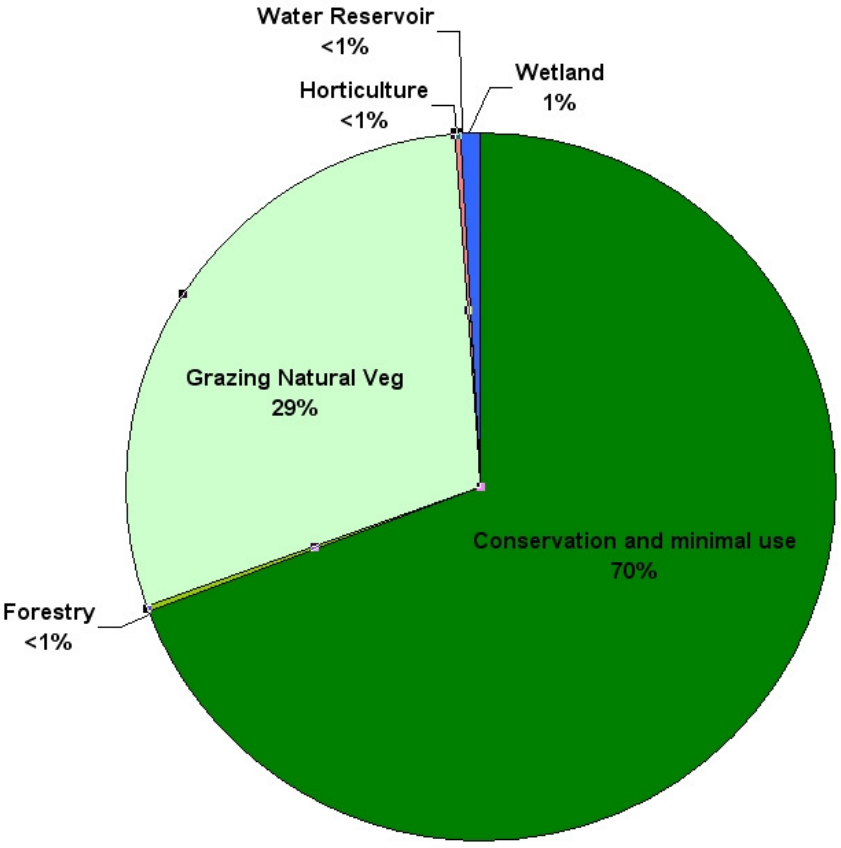
The Leichhardt Creek catchment is approximately 5,006 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being nature conservation and minimal use.

Table 6-9 Leichhardt Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	2227.96	44.5
		Other conserved area	778.86	15.6
	Other minimal use	Remnant native cover	458.78	9.2
Production from relatively natural environments	Grazing natural vegetation		1473.11	29.4
Production from dryland agriculture and plantations	Plantation forestry		9.78	0.2
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	20.42	0.4
Water	Reservoir/dam		1.77	0.0
	Marsh/wetland		5.43	0.1
		Marsh/W Conservation	29.83	0.6
		Total	5005.94	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 6-8 Leichhardt Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	25.933 Gl/Year

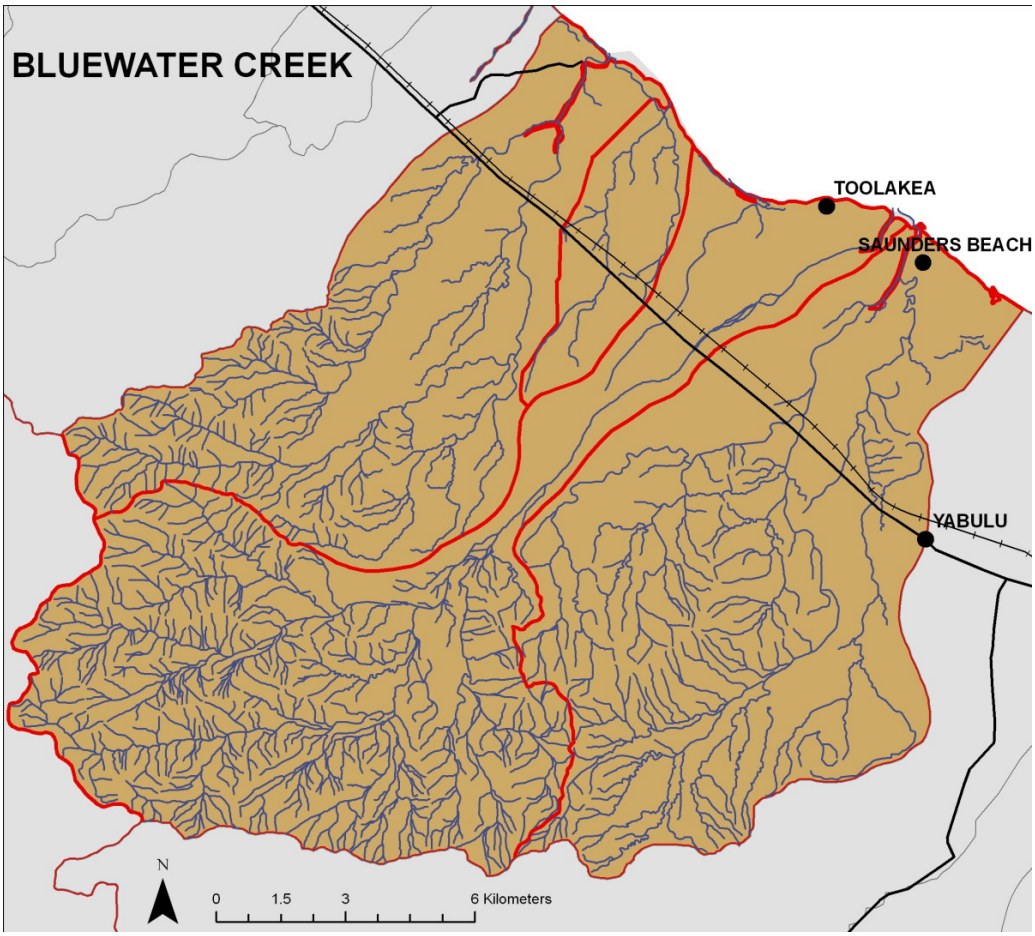
Flow modification	No
Number of fish barriers	2
Presence of EVR species or ecosystems	10
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	9%
Estuarine vegetation cleared	0%
OzEstuary 2000	
Type	WDD
Bryce Heap	Tidal Estuary
Condition	Near Pristine
Page & Hoolihan 2002	
Naturalness Estuary	High
Naturalness Catchment	Moderate
Habitat Diversity	High
International Significance	High
Level of protection	Low

Source: EPA – Estuary and Marine HEV profiles

7. Bluewater Creek Sub Basin

The Bluewater Creek sub basin includes the Sleeper Log Creek, Two Mile Creek, Bluewater Creek and Deep Creek catchments. There are also a number of smaller waterways that have been included in the catchments of these larger creeks (see Figure 7-1).

Figure 7-1 Bluewater Creek Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\Bluewater_Creek_300

7.1 Bluewater Creek Sub Basin Land Use

The Bluewater Creek sub basin is approximately 290 square kilometres in size (29,000 hectares). Land use in the Bluewater Creek sub basin is dominated by grazing. Nature conservation and other minimal use is the next most prolific land use followed by residential (see Table 7-1 and Figure 7-3).

Land use summaries and other physical features of the main catchments of the Bluewater Creek sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 7-2 Bluewater Creek Sub Basin Imagery

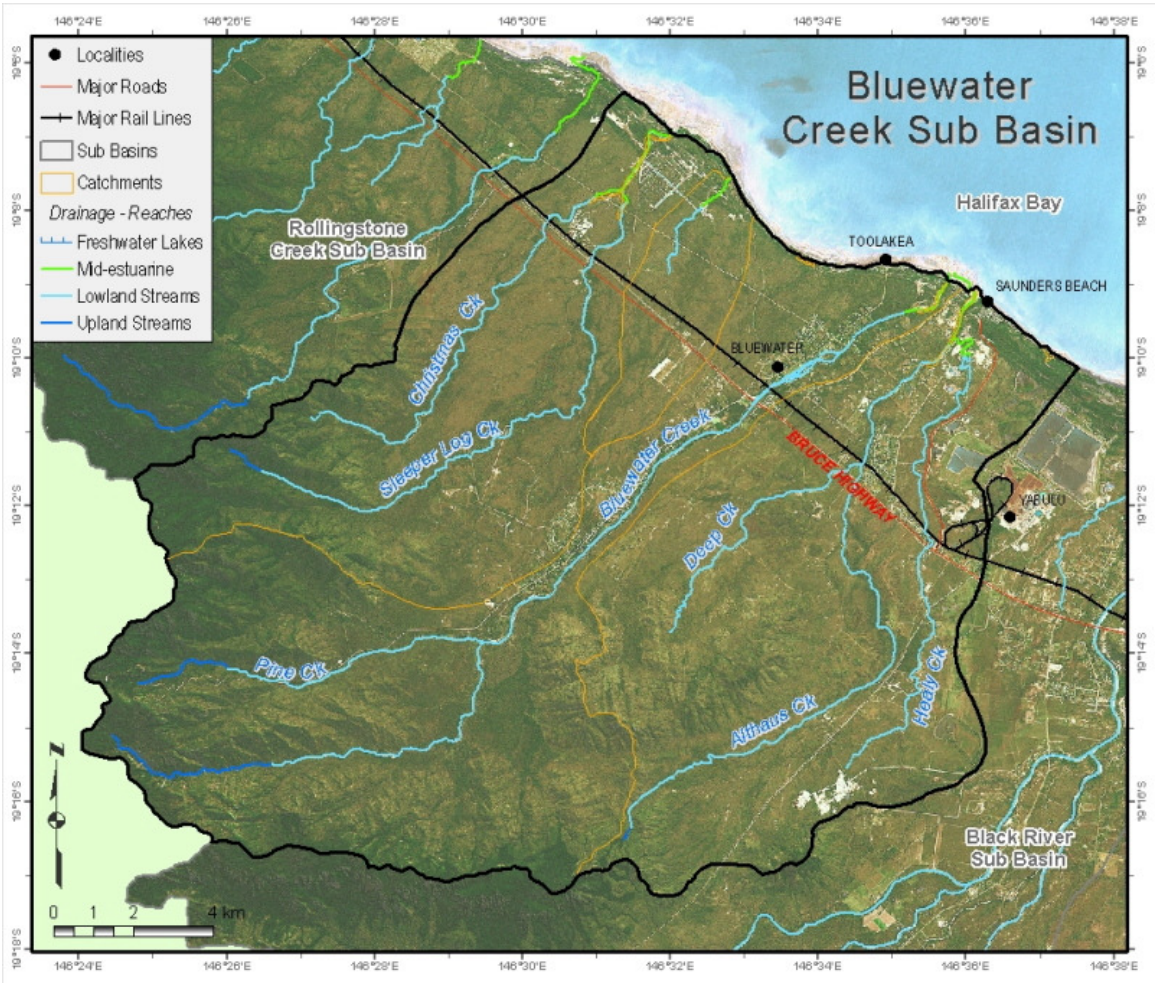
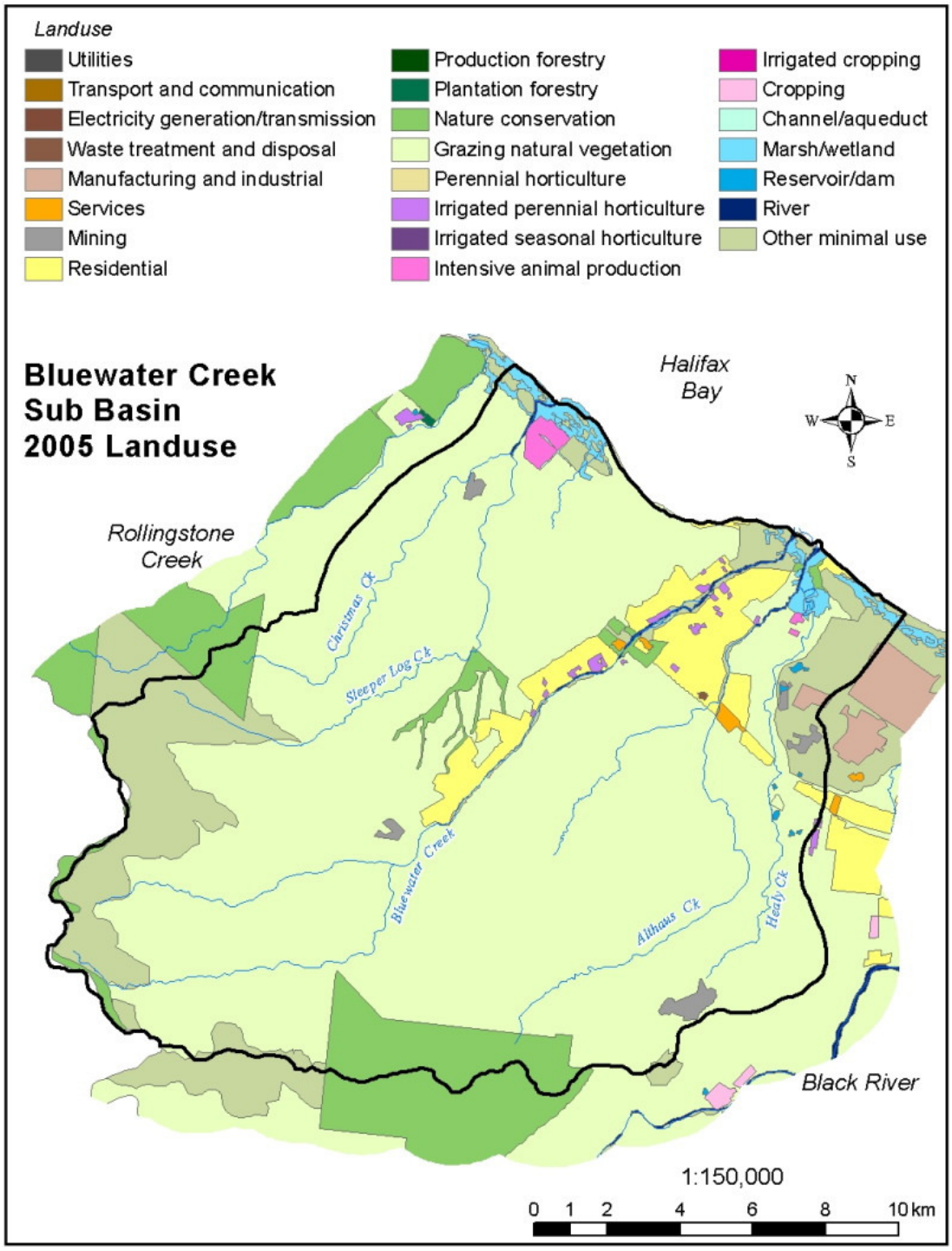


Figure 7-3 Bluewater Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 7-1 Bluewater Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Channel/Aquaduct	7	0.02	7	0.02
Grazing Natural Vegetation	21912	75.31	21893	75.39

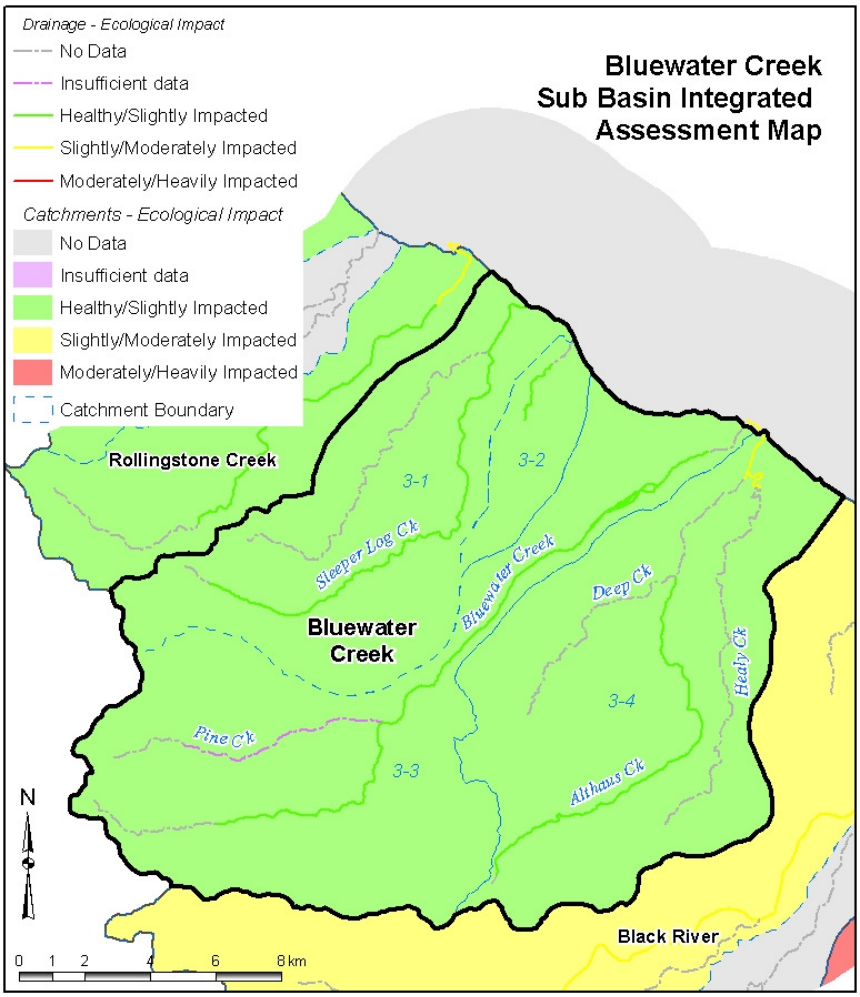
Intensive animal prod./Aquaculture	105	0.36	117	0.40
Irrigated Perennial Agriculture	77	0.26	77	0.27
Manufacturing and industrial	0	0	48	0.17
Marsh/Wetland	352	1.21	341	1.17
Mining	169	0.58	177	0.61
Nature Conservation	1682	5.78	1645	5.67
Other Minimal Use	3185	10.95	3133	10.79
Reservoir/Dam	27	0.09	20	0.07
Residential	1473	5.06	1473	5.07
River	58	0.20	58	0.20
Services	45	0.15	45	0.16
Waste Treatment and Disposal	4	0.01	4	0.01
	29,096	100	29,037	100

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

7.2 Bluewater Creek Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of this sub-basin was generally indicative of an ecologically healthy lowland stream system (see Figure 7-4). However similar to the Rollingstone Creek sub basin the total suspended sediment was found to be generally high for this sub-basin while dissolved oxygen was generally low. Recent data for Bluewater Creek shows that the dissolved oxygen is still low while total suspended sediment now falls within the guideline limit.

Figure 7-4 Bluewater Creek Sub Basin Ecological Impact



7.2.1 3-1 Sleeper Log Creek

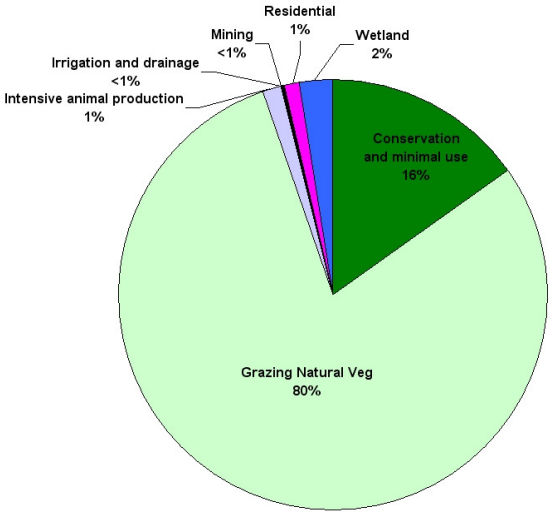
The Sleeper Log Creek catchment is approximately 7,169 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 7-2 Sleeper Log Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	227.61	3.2
		Other conserved area	132.17	1.8
	Other minimal use	Remnant native cover	884.04	12.3
Production from relatively natural environments	Grazing natural vegetation		5527.80	77.1
Intensive uses	Intensive animal production	Aquaculture	104.98	1.5
	Residential	Rural residential	98.00	1.4
	Mining		33.25	0.5
Water	River		7.58	0.1
	Channel/aqueduct		6.59	0.1
	Marsh/wetland		37.78	0.5
		Marsh/W Conservation	108.44	1.5
		Total	7168.25	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 7-5 Sleeper Log Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	29.473 Gl/Year
Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	No
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	8%
Estuarine vegetation cleared	6%
OzEstuary 2000	
Type	WDD
Bryce Heap	Tidal Estuary

Condition	Largely unmodified
Page & Hoolihan 2002	
Naturalness Estuary	High
Naturalness Catchment	Moderate
Habitat Diversity	High
International Significance	High
Level of protection	Low

Source: EPA – Estuary and Marine HEV profiles

7.2.2 3-2 Two Mile Creek

The Two Mile Creek catchment is approximately 1,338 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 7-3 Two Mile Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	21.17	1.6
	Other minimal use	Remnant native cover	49.44	3.7
Production from relatively natural environments	Grazing natural vegetation		1235.10	92.3
Water	Channel/aqueduct		0.62	0.0
	Marsh/wetland		17.77	1.3
		Marsh/W Conservation	14.27	1.1
		Total	1338.36	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

7.2.3 3-3 Bluewater Creek

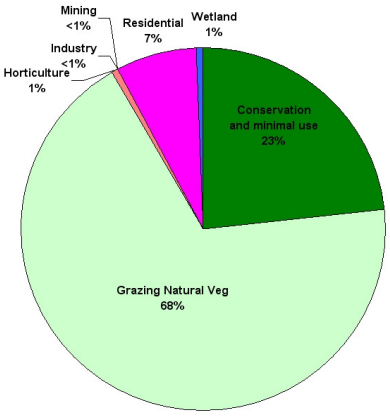
The Bluewater Creek catchment is approximately 10,534 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 7-4 Bluewater Creek Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Natural feature protection	130.76	1.2	97.8	0.9
	Other conserved area	847.53	8.0	847.5	8.1
Other minimal use		85.18	0.8	85.2	0.8
	Remnant native cover	1380.68	13.1	1373.7	13.1
Grazing natural vegetation		7188.55	68.3	7188.6	68.5
Irrigated perennial horticulture		1.95	0.0	1.9	0.0
	Irrigated tree fruits	58.77	0.6	58.8	0.6
Residential		23.38	0.2	23.4	0.2
	Rural residential	725.28	6.9	725.3	6.9
Services		3.97	0.0	4.0	0.0
	Recreation and culture	7.34	0.1	7.3	0.1
Mining		15.82	0.2	15.8	0.2
River		43.32	0.4	43.3	0.4
Marsh/wetland		3.52	0.0	3.5	0.0
	Marsh/W Conservation	16.30	0.2	16.3	0.2
		10532.33		10492.4	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 7-6 Bluewater Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	72.474 Gl/Year
Flow modification	No
Number of fish barriers	1
Presence of EVR species or ecosystems	No
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	11%
Estuarine vegetation cleared	<1%
OzEstuary 2000	
Type	WDD
Bryce Heap	Tidal Estuary
Condition	Largely unmodified
Page & Hoolihan 2002	
Naturalness Estuary	High
Naturalness Catchment	Moderate
Habitat Diversity	Moderate
International Significance	High
Level of protection	Low

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	Low	Low	V. Low	Low
Chronic or Storm	(Storm)	(Storm)	(Storm)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

7.2.4 3-4 Deep Creek

The Deep Creek catchment is approximately 10,060 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 7-5 Deep Creek Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	322.77	3.2	322.8	3.2
Other minimal use		653.02	6.5	610.3	6.1
	Remnant native cover	132.52	1.3	132.5	1.3
Grazing natural vegetation		7960.60	79.2	7941.5	79.0
Irrigated perennial horticulture		2.92	0.0	2.9	0.0
	Irrigated tree fruits	13.38	0.1	13.4	0.1
Intensive animal production	Aquaculture			12.2	0.1
Manufacturing and industrial				47.9	0.5
Residential		149.80	1.5	149.8	1.5
	Rural residential	476.16	4.7	476.2	4.7
Services		2.31	0.0	2.3	0.0
	Recreation and culture	31.47	0.3	31.5	0.3
Mining		119.78	1.2	127.6	1.3
Waste treatment and disposal	Landfill	4.26	0.0	4.3	0.0
Reservoir/dam		21.37	0.2	20.5	0.2
	Reservoir – intensive use	5.23	0.1		
River		6.95	0.1	6.9	0.1
Marsh/wetland		83.78	0.8	83.8	0.8
	Marsh/W Conservation	70.50	0.7	70.5	0.7
		10056.81		10056.8	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

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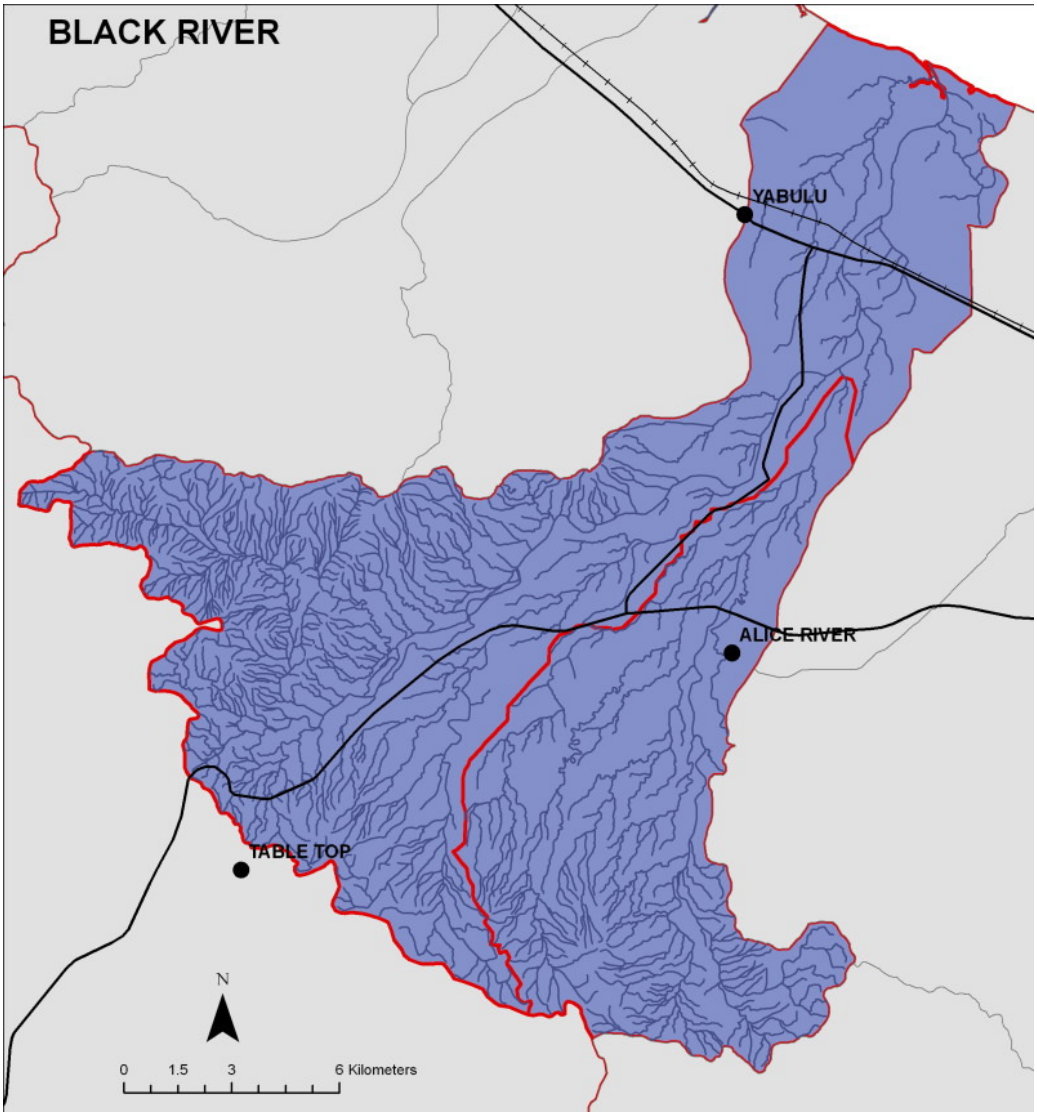
8. Black River Sub Basin

The Black River sub basin (see Figure 8-1) includes the Black River and Alice River catchments. There are also a number of smaller waterways that have been included in the catchments of these larger creeks.

Figure 8-1 Black River Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\Black_River_300

8.1 Black River Sub Basin Land Use

The Black River sub basin is approximately 306 square kilometres in size (30,600 hectares). Land use in the Black River sub basin is dominated by grazing. Nature conservation and other minimal use is the next most prolific land use followed by residential (see Figure 8-3 and Table 8-1).

Land use summaries and other physical features of the main catchments of the Black River sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 8-2 Black River Sub Basin Imagery

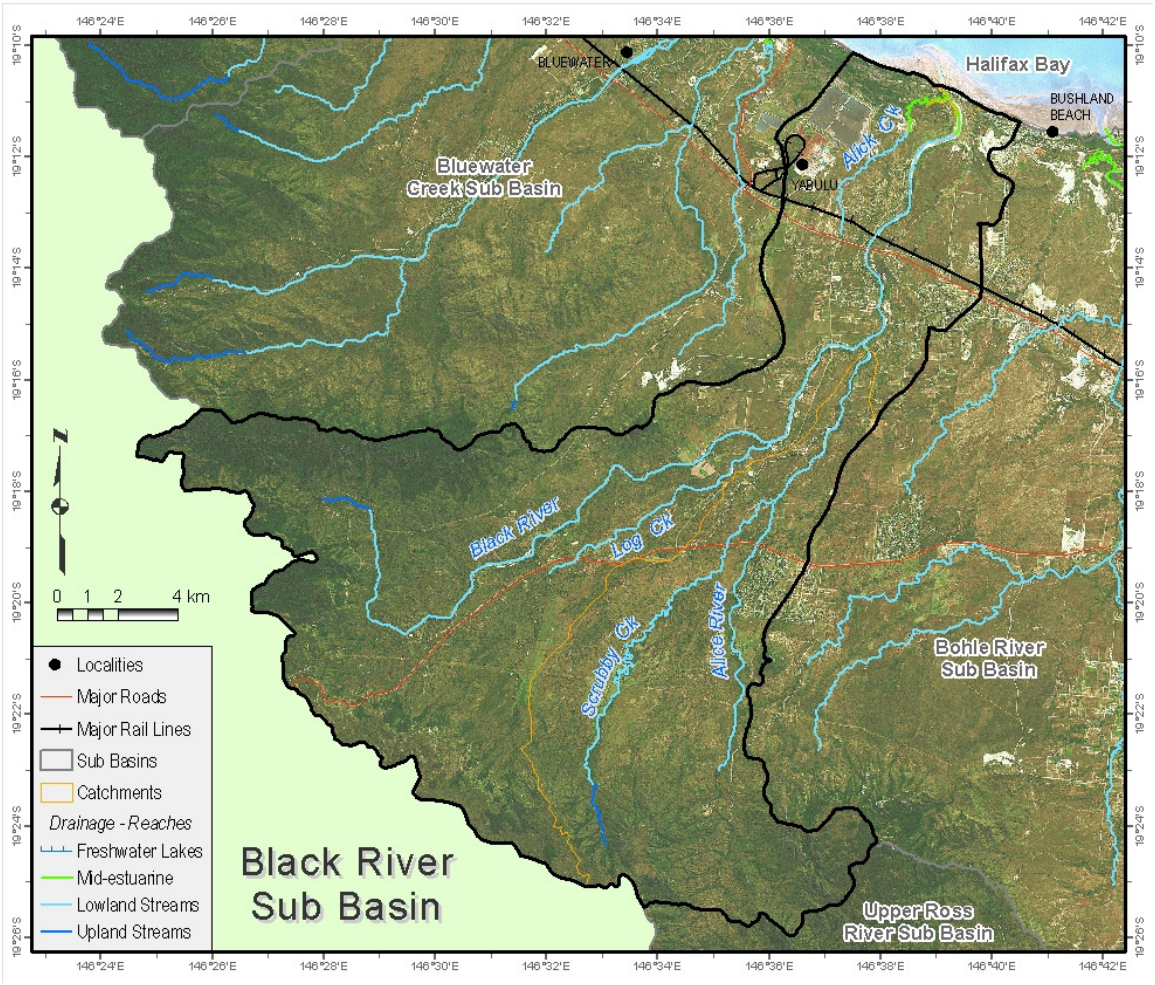
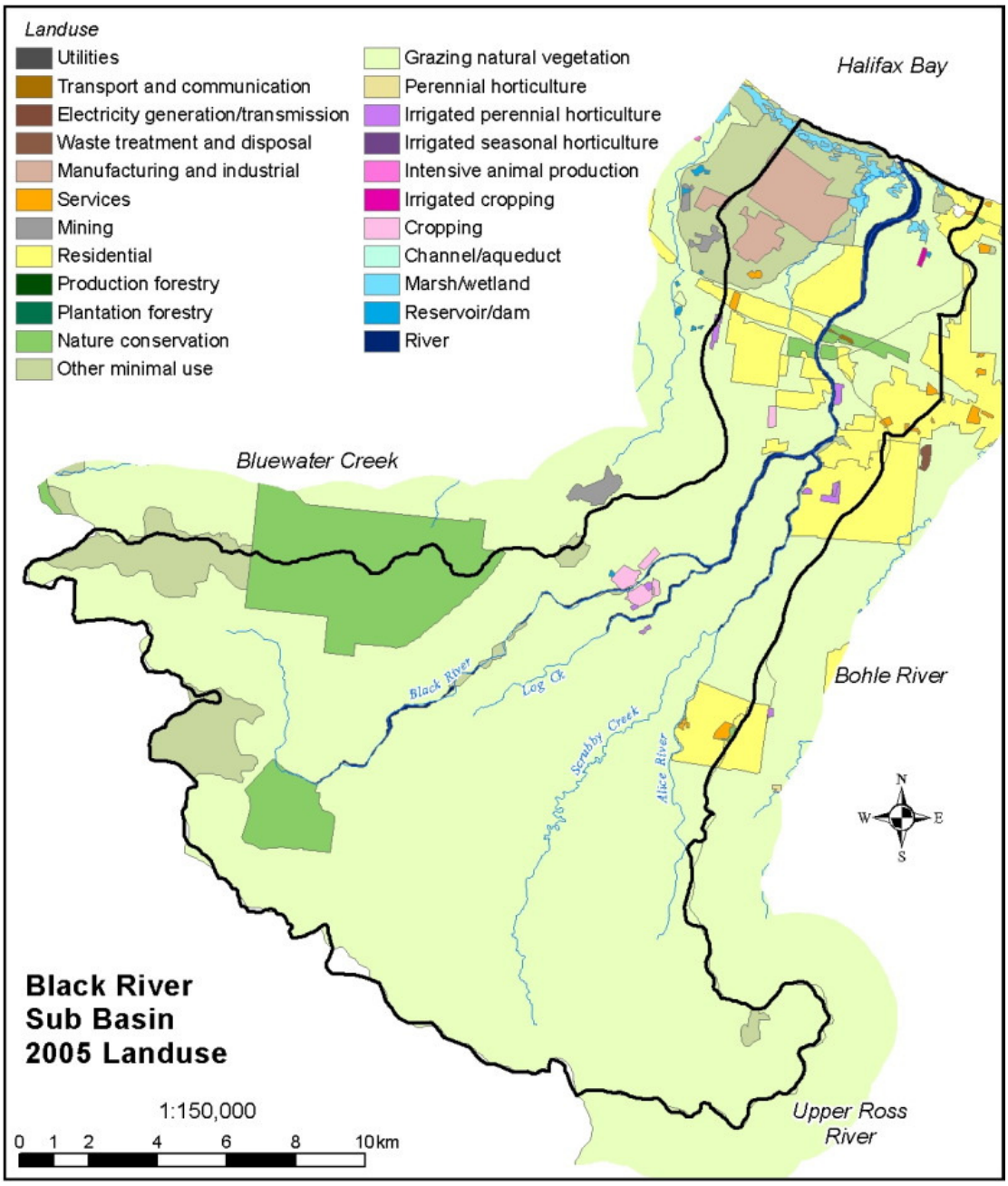


Figure 8-3 Black River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 8-1 Black River Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping	103	0.34	103	0.34
Grazing Natural Vegetation	23295	76.23	23063	75.92
Irrigated Cropping	7	0.02	7	0.02
Irrigated Perennial Agriculture	58	0.19	58	0.19
Manufacturing and industrial	119	0.39	564	1.86
Marsh/Wetland	165	0.54	165	0.54

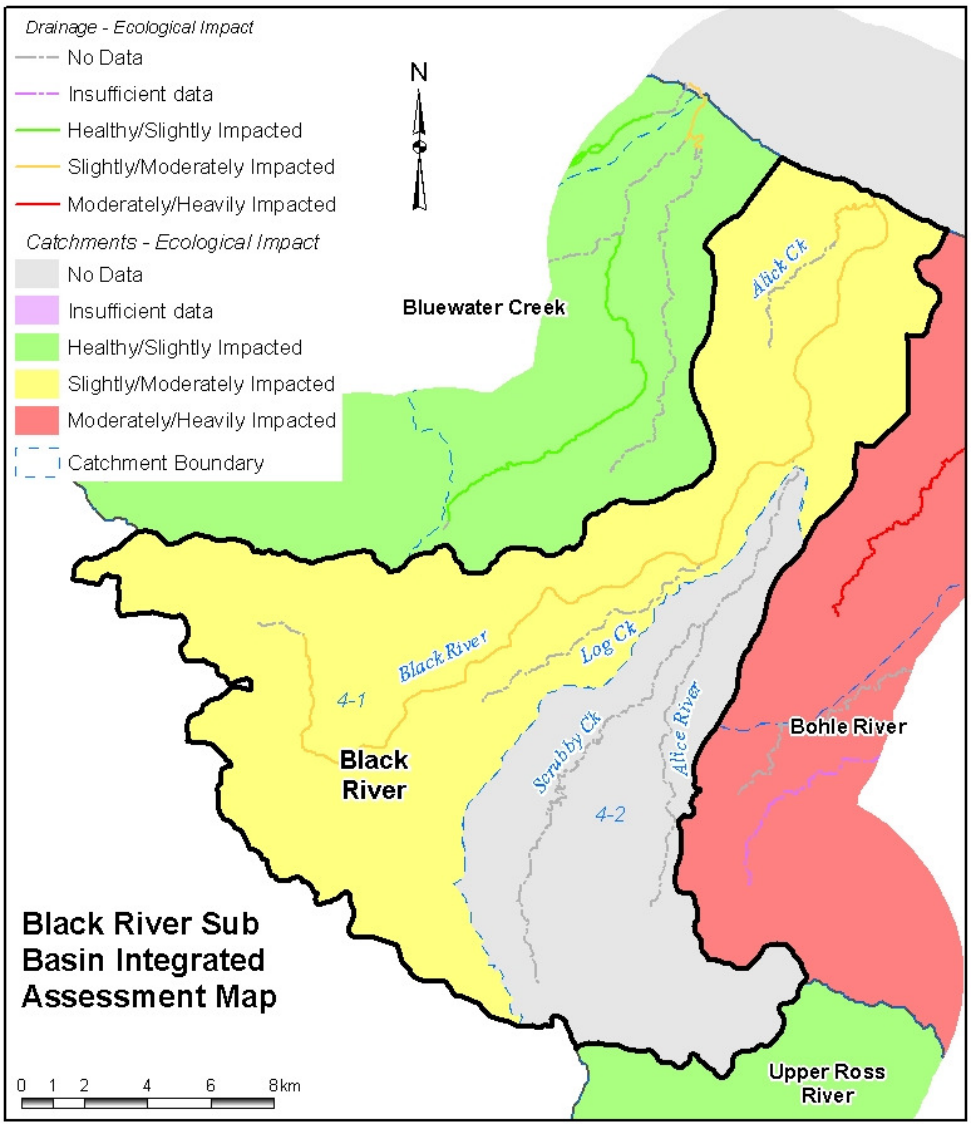
Nature Conservation	1963	6.42	1962	6.46
Other Minimal Use	2284	7.47	1962	6.46
Reservoir/Dam	183	0.60	5	0.01
Residential	1979	6.48	2081	6.85
River	343	1.12	343	1.13
Services	53	0.17	58	0.19
Transport and Communication	7	0.02	7	0.02
	30,559	100	30,377	100

Source: CSIRO generated data from QLUMP 1999and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

8.2 Black River Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of this sub basin was slightly impacted (see Figure 8-4). The limited data available for this sub-basin showed that total suspended sediment for the Black River was above the guideline. Recent data for Black River indicates that total suspended sediment is trending higher however confirmation of this assessment through additional water quality monitoring is recommended.

Figure 8-4 Black River Sub Basin Ecological Impact



8.2.1 4-1 Black River Catchment

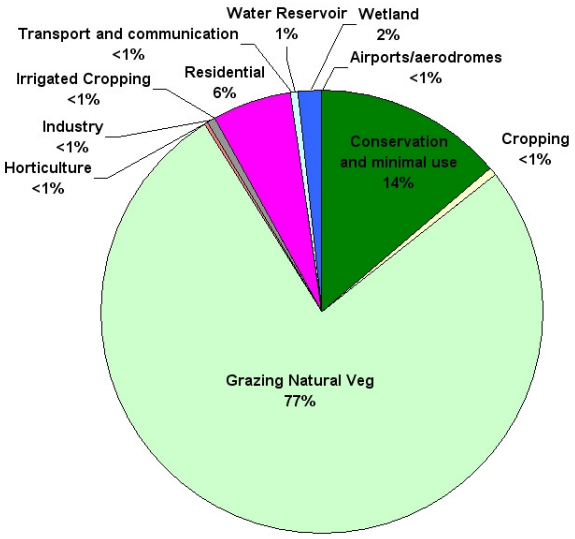
The Black River catchment is approximately 20,557 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 8-2 Black River Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	1953.3	9.6
	Other minimal use		594.5	2.9
		Remnant native cover	1322.9	6.5
Production from relatively natural environments	Grazing natural vegetation		13645.8	66.9
Production from dryland agriculture and plantations	Cropping		102.7	0.5
Production from irrigated agriculture and plantations	Irrigated cropping		7.3	0.0
	Irrigated perennial horticulture		35.2	0.2
		Irrigated tree fruits	17.6	0.1
Intensive uses	Manufacturing and industrial		564.4	2.8
	Residential		649.6	3.2
		Rural residential	979.3	4.8
	Services	Recreation and culture	28.6	0.1
			6.9	0.0
	Transport and communication	Railways	6.6	0.0
Water	Reservoir/dam		4.5	0.0
	River		304.4	1.5
	Marsh/wetland		82.2	0.4
		Marsh/W Conservation	83.3	0.4
		Total	20,389.4	

Source: Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 8-5 Black River Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description

Average river flow	141.566 Gl/Year
Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	3
Presence of STP point source	Yes
Presence of other point source	Yes
Catchment cleared	23%
Estuarine vegetation cleared	1%
OzEstuary 2000	
Type	WDD
Bryce Heap	Tidal Estuary
Condition	Modified
Page & Hoolihan 2002	
Naturalness Estuary	Moderate
Naturalness Catchment	Moderate
Habitat Diversity	High
International Significance	High
Level of protection	Low

Note: Groundwater extraction is a significant factor that modify flow. Not enough information to determine impacts.

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	High	Moderate	Moderate/High	V. Low
Chronic or Storm	(Storm)	(Storm/Chronic)	(Storm/Chronic)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

8.2.2 4-2 Alice River

The Alice River catchment is approximately 10,007 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 8-3 Alice River Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	8.46	0.1	8.4	0.1
Other minimal use	Remnant native cover	44.09	0.4	44.1	0.4
Grazing natural vegetation		9452.82	94.5	9417	94.3
Irrigated perennial horticulture		5.17	0.1	5.2	0.1
Residential		294.92	2.9	312.1	3.1
Residential	Rural residential	139.92	1.4	139.8	1.4
Services	Recreation and culture	22.73	0.2	22.7	0.2
River		38.67	0.4	38.7	0.4
		10,007		9,988	

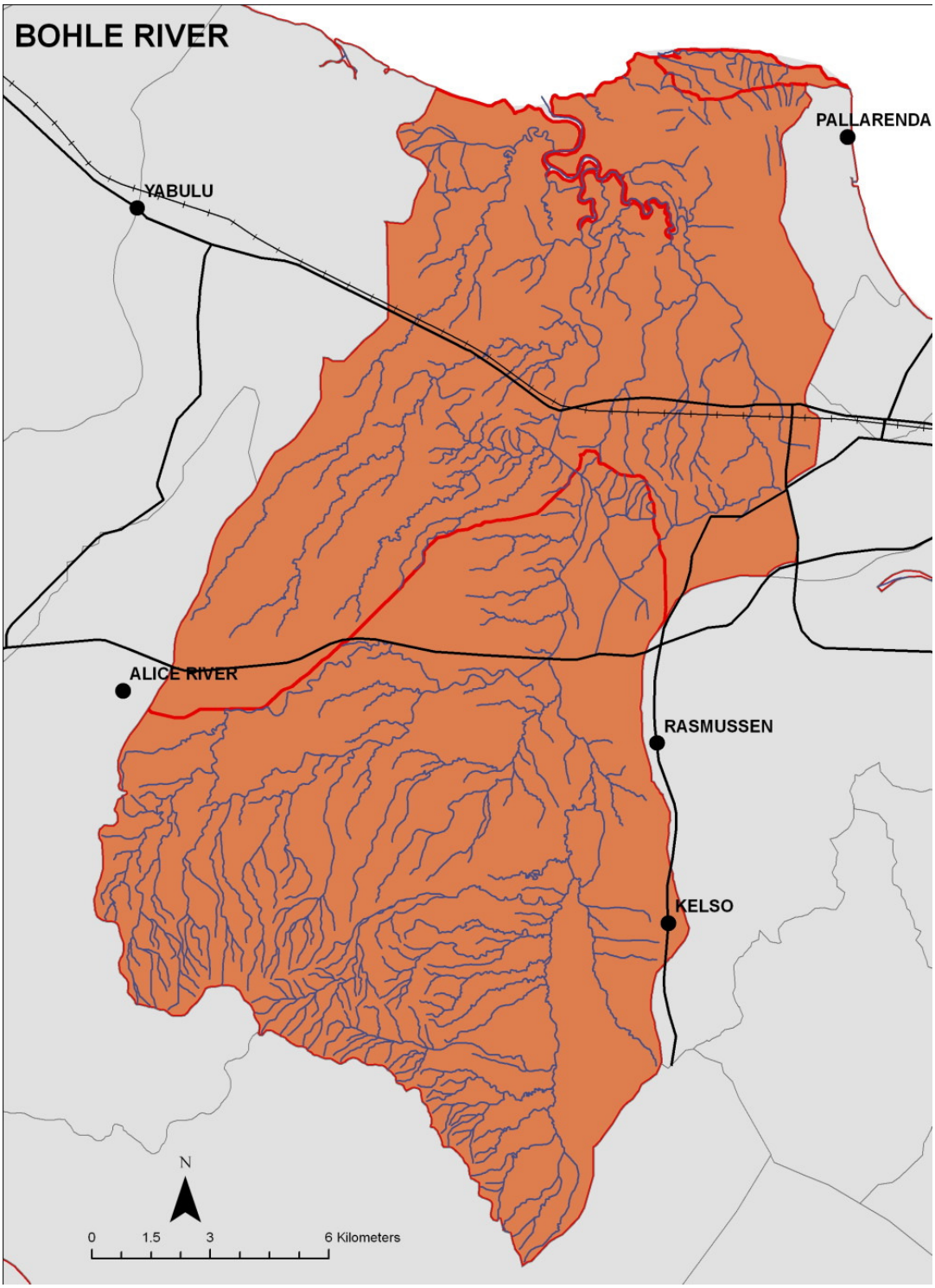
Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Source:

9. Bohle River Sub Basin

The Bohle River sub basin is dominated by the Bohle River and its tributaries including the Little Bohle River. The Bohle River sub basin includes the Shelly Beach catchment. There are also a number of smaller waterways in the sub basin (see Figure 9-1).

Figure 9-1 Bohle River Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\Bohle_River_300

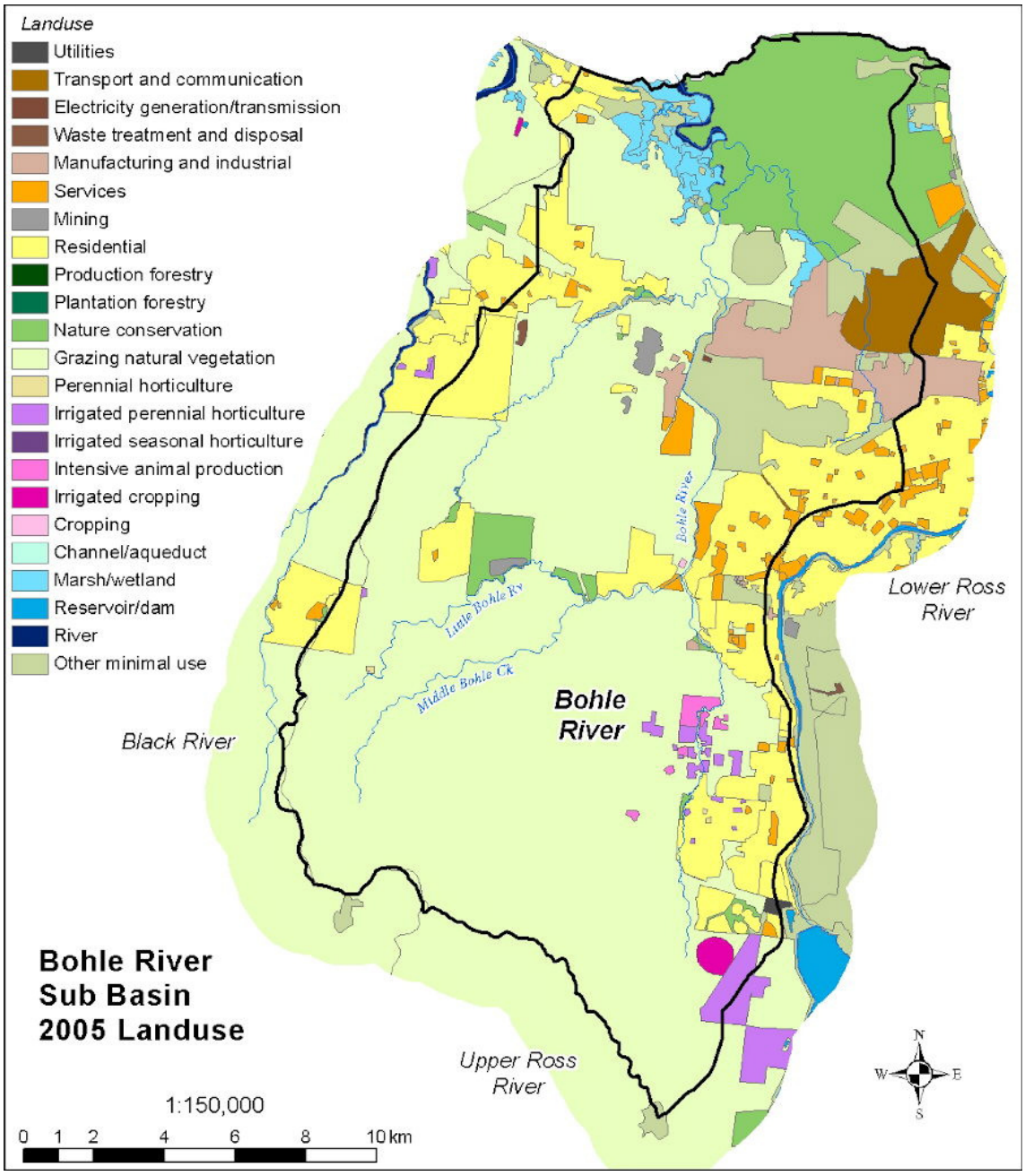
Figure 9-2 Bohle River Sub Basin Imagery

9.1 Bohle River Sub Basin Land Use

The Bohle River sub basin is approximately 320 square kilometres in size (32,000 hectares). Land use in the Bohle River sub basin is dominated by grazing and nature conservation and other minimal use. Residential and associated urban land uses are also a significant land use in the Bohle sub basin (see Figure 9-3 and Table 9-1).

Land use summaries and other physical features of the main catchments of the Bohle River sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 9-3 Bohle River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 9-1 Bohle River Sub Basin Land Use

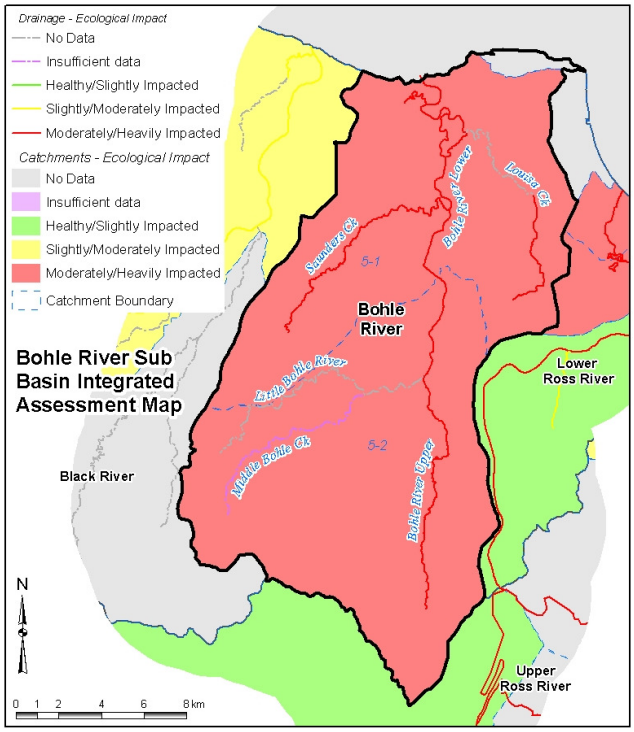
Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping	4	0.01	4.3	0.01
Grazing Natural Vegetation	19965	61.95	19018.5	59.01
Intensive Animal Production	90	0.28	100.6	0.31
Irrigated cropping			88.1	0.27
Irrigated Perennial Agriculture	254	0.79	299.4	0.93
Manufacturing and industrial	837	2.60	1007.2	3.13
Marsh/Wetland	529	1.64	513.7	1.59
Mining	95	0.29	109.5	0.34
Nature Conservation	3185	9.88	3197.1	9.92
Other Minimal Use	2115	6.56	2053.2	6.37
Perennial Horticulture	27	0.08	9.9	0.03
Reservoir/Dam	3	0.01	2.6	0.01
Residential	3944	12.24	4754.8	14.75
River	16	0.05	15.8	0.05
Services	694	2.15	531.8	1.65
Transport and Communication	443	1.37	485.0	1.50
Utilities	17	0.05	20.8	0.06
Waste Treatment and Disposal	12	0.04	17.0	0.05
	32230	100	32229	100

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

9.2 Bohle River Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of the Bohle River sub-basin was heavily impacted (see Figure 9-4).

Figure 9-4 Bohle River Sub Basin Ecological Impact



Data indicates that nutrients, in particular dissolved reactive (inorganic) phosphorus is at very high levels. This trend is consistent across all of the lowland stream reaches where monitoring occurred but it was much lower in the mid-estuarine reaches. Recent data for water clarity and pH confirm this assessment however there is no recent data for nutrients in this sub basin.

9.2.1 5-1 Bohle River

The lower Bohle River catchment is approximately 14,596 hectares in area with the upper catchment being 17,291 hectares (CSIRO calculation from QLUMP 1999). The main land use is grazing in native pasture.

Table 9-2 Bohle River (lower) Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Natural feature protection	2437.28	16.7	2451.1	16.81
	Other conserved area	246.96	1.7	255.2	1.75
Other minimal use		1452.05	10.0	1477.9	8.84
	Remnant native cover	166.08	1.1	144.3	1.30
Grazing natural vegetation		5978.76	41.0	5529.1	0.99
Perennial horticulture		1.82	0.0	1.8	37.92
Irrigated perennial horticulture		2.99	0.0	3.8	0.01
Manufacturing and industrial		822.90	5.6	990.2	0.03
Residential		1542.51	10.6	1922.2	6.79
	Rural residential	455.12	3.1	455.1	13.18
Services		76.93	0.5	79.1	3.12
	Commercial services	194.64	1.3	28.5	0.54
	Recreation and culture	131.43	0.9	130.8	0.20
Utilities - Electricity generation/transmission				3.8	0.90
Transport and communication	Airports/aerodromes	436.50	3.0	478.0	0.03
	Railways	1.37	0.0	1.4	3.28
Mining		77.04	0.5	81.5	0.01
Waste treatment and disposal - Landfill		11.77	0.1	17.0	0.56
Reservoir/dam		2.56	0.0	2.6	0.12
River		15.77	0.1	15.8	0.02
Marsh/wetland		289.98	2.0	274.6	0.11
	Marsh/W Conservation	239.03	1.6	239.0	1.88
	Total	14,583.49		14,582.8	

Source: CSIRO calculation from QLUMP 1999 Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

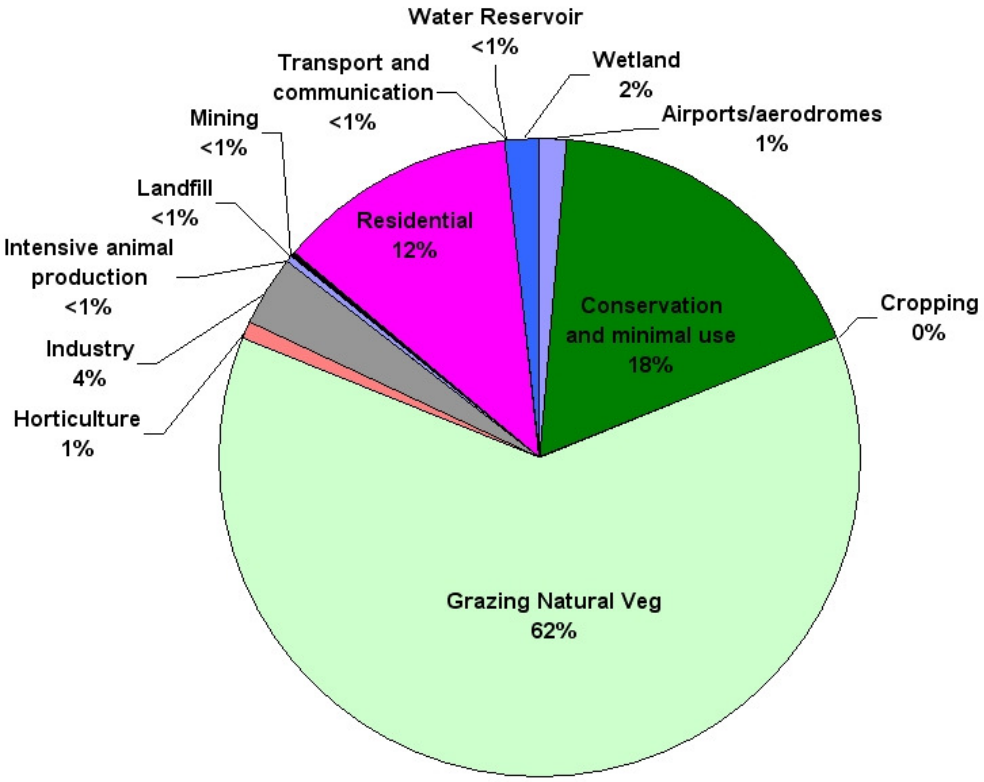
Table 9-3 Bohle River (upper) Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	178.10	1.0	167.7	0.97
Other minimal use		447.69	2.6	381.9	2.21
	Remnant native cover	15.06	0.1	15.1	0.09
Grazing natural vegetation		13986.53	80.9	13489.4	78.02
Cropping		4.34	0.0	4.3	0.03
Perennial horticulture		24.72	0.1	8.1	0.05
Irrigated perennial horticulture		102.83	0.6	88.1	0.51
	Irrigated tree fruits	139.10	0.8	125.1	0.72
	Irrigated tree nuts	8.60	0.0	170.5	0.99
Intensive animal production	Poultry	9.52	0.1	12.3	0.07
	Aquaculture	80.58	0.5	88.3	0.51
Manufacturing and industrial		14.59	0.1	17.0	0.10
Residential		1347.78	7.8	1643.1	9.50
	Rural residential	598.94	3.5	734.4	4.25

Services		76.51	0.4	78.4	0.45
	Commercial services	24.27	0.1	24.3	0.14
	Recreation and culture	190.55	1.1	190.8	1.10
Utilities - Electricity generation/transmission		16.95	0.1	17.0	0.10
Transport and communication - Railways		5.58	0.0	5.6	0.03
Mining		18.27	0.1	27.9	0.16
	Total	17290.52		17289.1	

Source: CSIRO calculation from QLUMP 1999 Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 9-5 Bohle River Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	72.114 Gl/Year
Flow modification	Yes
Number of fish barriers	6
Presence of EVR species or ecosystems	416
Presence of STP point source	Yes
Presence of other point source	Yes
Catchment cleared	34%
Estuarine vegetation cleared	10%
OzEstuary 2000	
Type	TDD
Bryce Heap	Strand plain
Condition	Modified
Page & Hoolihan 2002	
Naturalness Estuary	Moderate
Naturalness Catchment	Low

Habitat Diversity	Moderate
International Significance	High
Level of protection	High

Note: STP discharge supplements stream flow

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	High/V.High	Moderate/High	High/V.High	V. Low
Chronic or Storm	(Storm)	(Storm/Chronic)	(Storm/Chronic)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

9.2.2 5-3 Shelley Beach

The Shelley Beach catchment is approximately 358 hectares in area. The main land use is nature conservation.

Table 9-4 Shelly Beach Catchment Land Use 2005

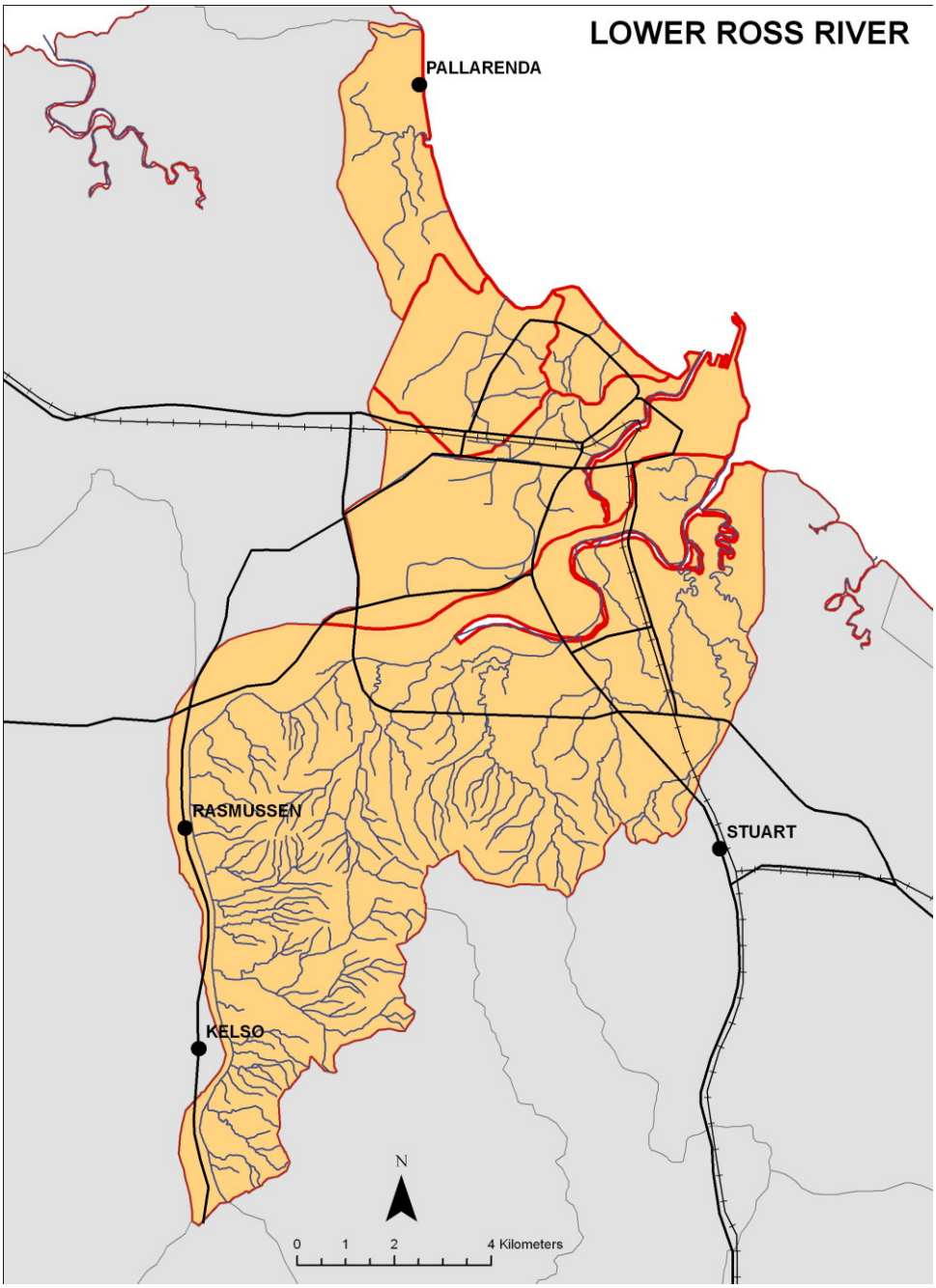
Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	323.10	90.4
	Other minimal use		34.16	9.6
		Total	357.26	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

10. Lower Ross River Sub Basin

The Lower Ross River sub basin (see Figure 10-1) includes the Pallarenda, Mundy Creek, Esplanade, Ross Creek and Ross River (below the dam) catchments. There are also a number of smaller waterways that have been included in the catchments of the larger creeks.

Figure 10-1 Lower Ross River Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\Lower_Ross_River_300

10.1 Lower Ross River Sub Basin Land Use

The Lower Ross River sub basin is approximately 135 square kilometres in size (13,500 hectares). Residential and associated urban land uses are dominant in the Lower Ross River sub basin. Other minimal use (Defence land) and nature conservation (Town Common and Castle Hill) and are also significant land uses in the Lower Ross sub basin (see Table 10-1 and Figure 10-3).

Land use summaries and other physical features of the main catchments of the Lower Ross River sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 10-2 Lower Ross River Sub Basin Imagery

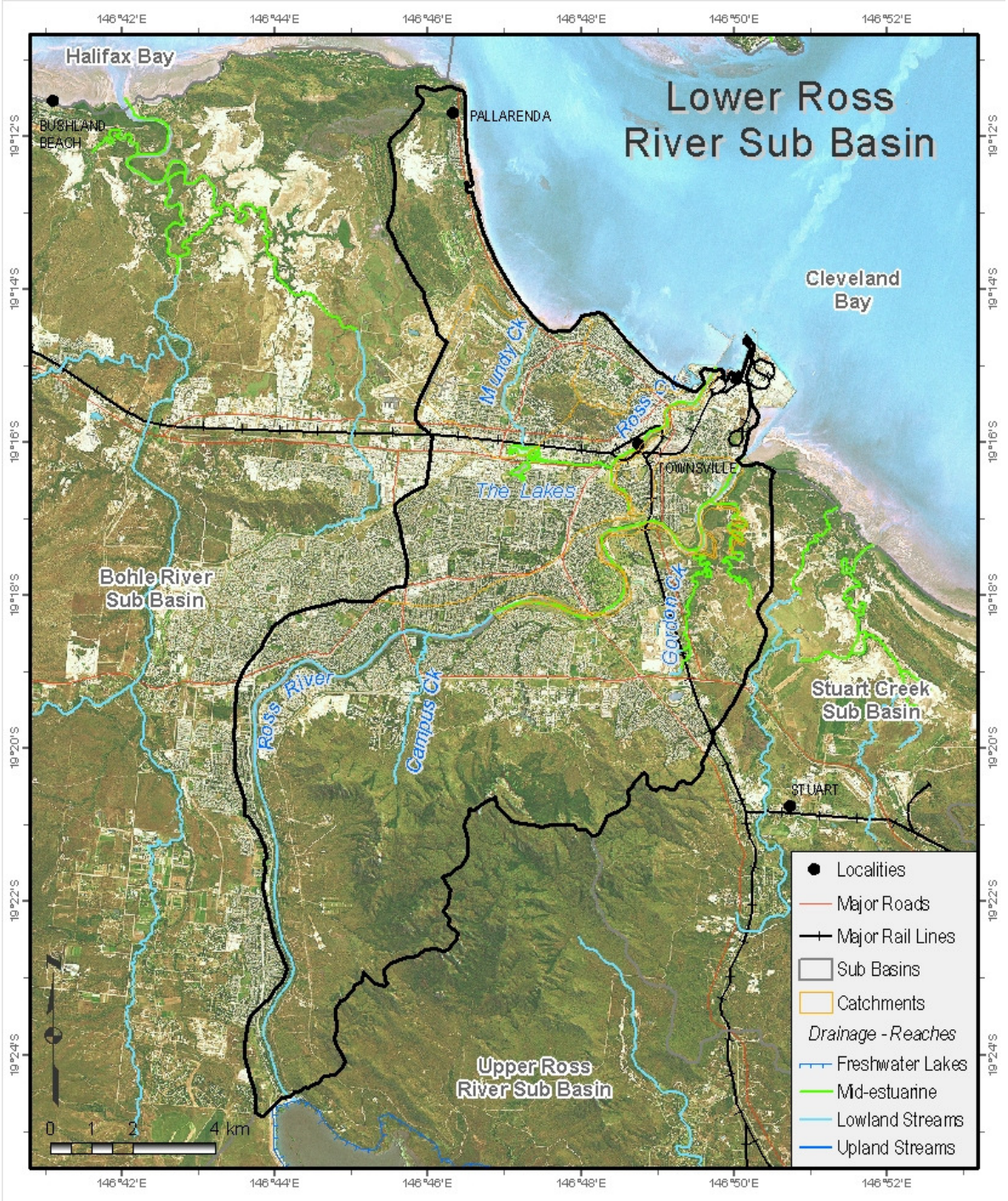
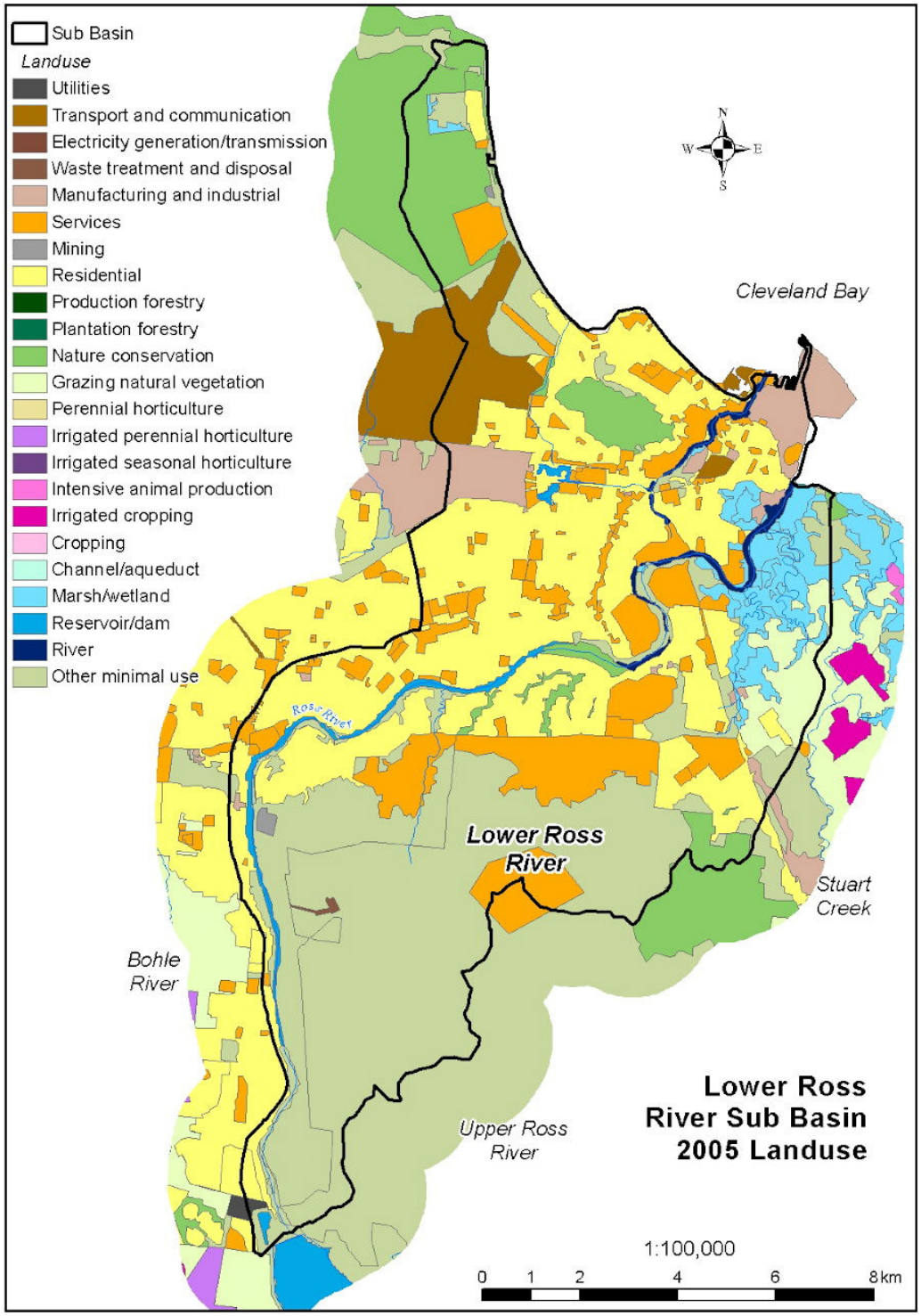


Figure 10-3 Lower Ross River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 10-1 Lower Ross River Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Grazing Natural Vegetation	316	2.35	316	2.35
Manufacturing and industrial	268	1.99	381	2.82

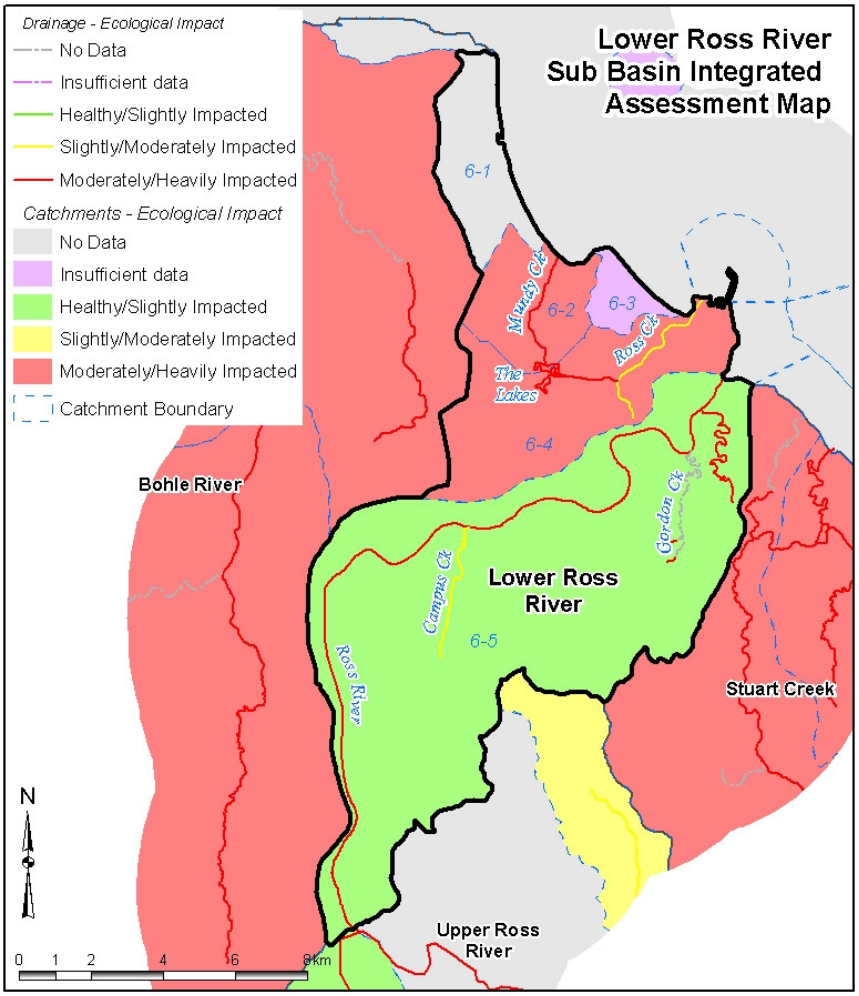
Marsh/Wetland	516	3.83	515	3.82
Mining	21	0.16	21	0.15
Nature Conservation	944	7.01	944	7.00
Other Minimal Use	5016	37.22	4584	34.02
Reservoir/Dam	149	1.11	149	1.11
Residential	3737	27.73	4046	30.03
River	92	0.68	91	0.67
Services	2017	14.97	2004	14.87
Transport and Communication	390	2.89	416	3.09
Utilities	9	0.07	9	0.07
	13475	100	13475	100

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

10.2 Lower Ross River Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of the Ross River sub-basin was moderately to heavily impacted (see Figure 10-4). Poor water quality in The Lakes was the main reason that the Lower Ross Creek catchment was assessed as heavily impacted. Historic data suggests that the Ross River catchment below the dam was slightly impacted but this is not consistent with recent data, which indicates that the Ross River catchment is now moderately to heavily impacted. This is reflective of the continual expansion of urban land uses within this catchment.

Figure 10-4 Lower Ross River Sub Basin Ecological Impact



10.2.1 6-1 Pallarenda

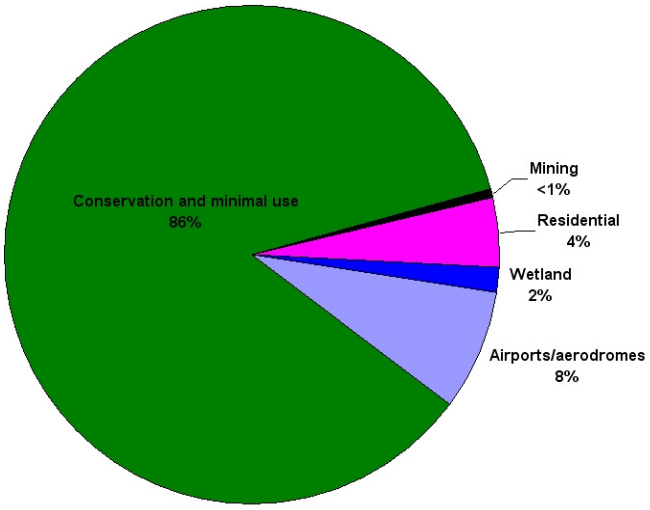
The Pallarenda catchment is approximately 960 hectares in area with the main land use being conservation and minimal use.

Table 10-2 Pallarenda Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Natural feature protection	519.9	54.0
		Other conserved area	24.1	2.5
	Other minimal use		164.7	17.1
Intensive uses	Residential		43.1	4.5
	Services	Recreation and culture	91.6	9.5
	Transport and communication	Airports/aerodromes	99.6	10.3
	Mining		3.5	0.4
Water	Marsh/wetland		16.9	1.7
		Total	963.4	

Source: Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 10-5 Pallarenda Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	
Flow modification	No
Number of fish barriers	0
Presence of EVR species or ecosystems	55
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	30%
Estuarine vegetation cleared	35%

Source: EPA – Estuary and Marine HEV profiles

10.2.2 6-2 Mundy Creek

The Mundy Creek catchment is approximately 970 hectares in area. The main land use is residential.

Table 10-3 Mundy Creek Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	93.67	9.6	92.8	9.6
Other minimal use		143.04	14.7	117.5	12.1
	Remnant native cover	15.15	1.6	15.2	1.6
Manufacturing and industrial		12.97	1.3	31.5	3.2
Residential		364.58	37.5	366.1	37.7
Services		4.95	0.5	5.0	0.5
	Commercial services	31.55	3.2	13.9	1.4
	Recreation and culture	37.51	3.9	62.5	6.4
Transport and communication	Airports/aerodromes	260.15	26.8	260.1	26.8
Reservoir/dam		7.63	0.8	6.4	0.7
	Total	971.2		970.9	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

10.2.3 6-3 Esplanade

The Mundy Creek catchment is approximately 290 hectares in area. The main land use is residential.

Table 10-4 Esplanade Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	44.2	15.1
	Other minimal use	Remnant native cover	8.0	2.7
Intensive uses	Residential		179.0	61.2
	Services		38.2	13.1
		Commercial services	12.0	4.1
		Recreation and culture	11.0	3.8
		Total	292.17	

Source: Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

10.2.4 6-4 Ross Creek

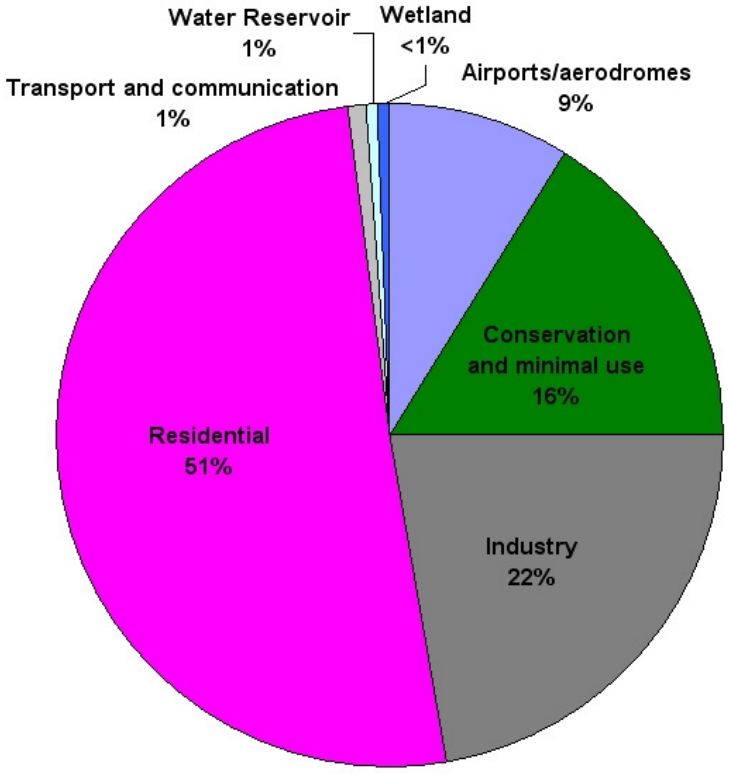
The Ross Creek catchment is approximately 2,242 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being residential.

Table 10-5 Ross Creek Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	76.63	3.4	76.6	3.4
Other minimal use		18.35	0.8	15.5	0.7
Manufacturing and industrial		201.37	9.1	295.6	13.3
Residential		1314.51	59.1	1273.5	57.2
Services		59.55	2.7	63.8	2.9
	Commercial services	300.95	13.5	235.3	10.6
	Recreation and culture	147.73	6.6	159.1	7.2
Transport and communication	Airports/aerodromes	32.41	1.5	32.4	1.5
	Railways	23.89	1.1	23.9	1.1
Reservoir/dam		12.68	0.6	14.2	0.6
River		35.79	1.6	34.1	1.5
Marsh/wetland	Marsh/W conservation	0.92	0.0	0.9	0.0
	Total	2224.79		2225.0	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 10-6 Ross Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	

Flow modification	Yes (stormwater network)
Number of fish barriers	1
Presence of EVR species or ecosystems	17
Presence of STP point source	No
Presence of other point source	No (but urban stormwater)
Catchment cleared	92%
Estuarine vegetation cleared	95%

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	Low	Moderate	V.High	Moderate
Chronic or Storm	(Storm/Chronic)	(Storm/Chronic)	(Storm/Chronic)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

10.2.5 6-5 Ross River (below dam)

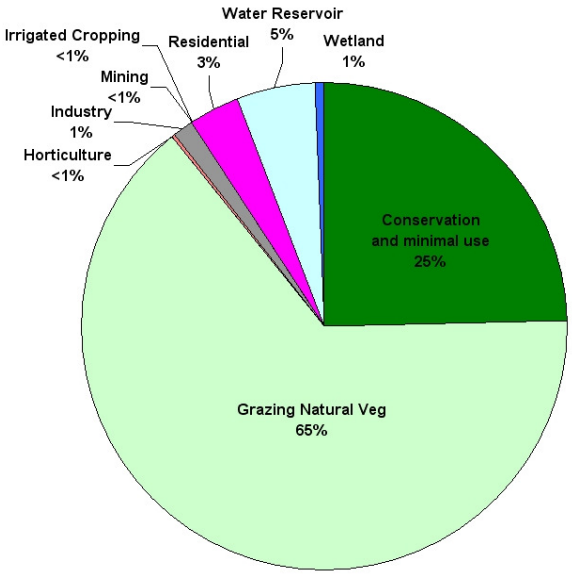
The Ross River catchment below the dam is approximately 9,020 hectares in area with the largest single land use being minimal use (defence).

Table 10-6 Ross River (below the dam) Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	186.21	2.1	186.2	2.1
Other minimal use		1696.71	18.8	1352.6	15.0
	Defence	2853.05	31.6	2823.3	31.3
	Remnant native cover	90.89	1.0	87.2	1.0
Grazing natural vegetation		316.21	3.5	316.2	3.5
Manufacturing and industrial		53.41	0.6	53.4	0.6
Residential		1804.25	20.0	2154.1	23.9
	Rural residential	30.49	0.3	30.5	0.3
Services		431.49	4.8	430.0	4.8
	Commercial services	51.17	0.6	48.3	0.5
	Recreation and culture	384.91	4.3	380.9	4.2
	Defence facilities	351.72	3.9	370.8	4.1
	Research facilities	63.67	0.7	71.2	0.8
Utilities	Electricity generation/transmission	8.89	0.1	8.9	0.1
Mining		17.28	0.2	17.3	0.2
Waste treatment and disposal				10.6	0.1
Reservoir/dam		128.99	1.4	128.7	1.4
River		56.49	0.6	56.5	0.6
Marsh/wetland		221.82	2.5	221.8	2.5
	Marsh/W Conservation	276.66	3.1	275.0	3.0
	Total	9,026		9,023	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 10-7 Lower Ross River Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	307.927 Gl/Year
Flow modification	Yes (Ross Dam and Weirs)
Number of fish barriers	19
Presence of EVR species or ecosystems	253
Presence of STP point source	No
Presence of other point source	No (but urban stormwater)
Catchment cleared	18%
Estuarine vegetation cleared	30%
OzEstuary 2000	
Type	TFC
Bryce Heap	Tidal Flat
Condition	Modified
Page & Hoolihan 2002	
Naturalness Estuary	Low
Naturalness Catchment	Low
Habitat Diversity	Moderate
International Significance	High
Level of protection	Low

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	Moderate/High	Low/Moderate	Low/Moderate	Low
Chronic or Storm	(Storm)	(Storm)	(Storm)	(Storm)

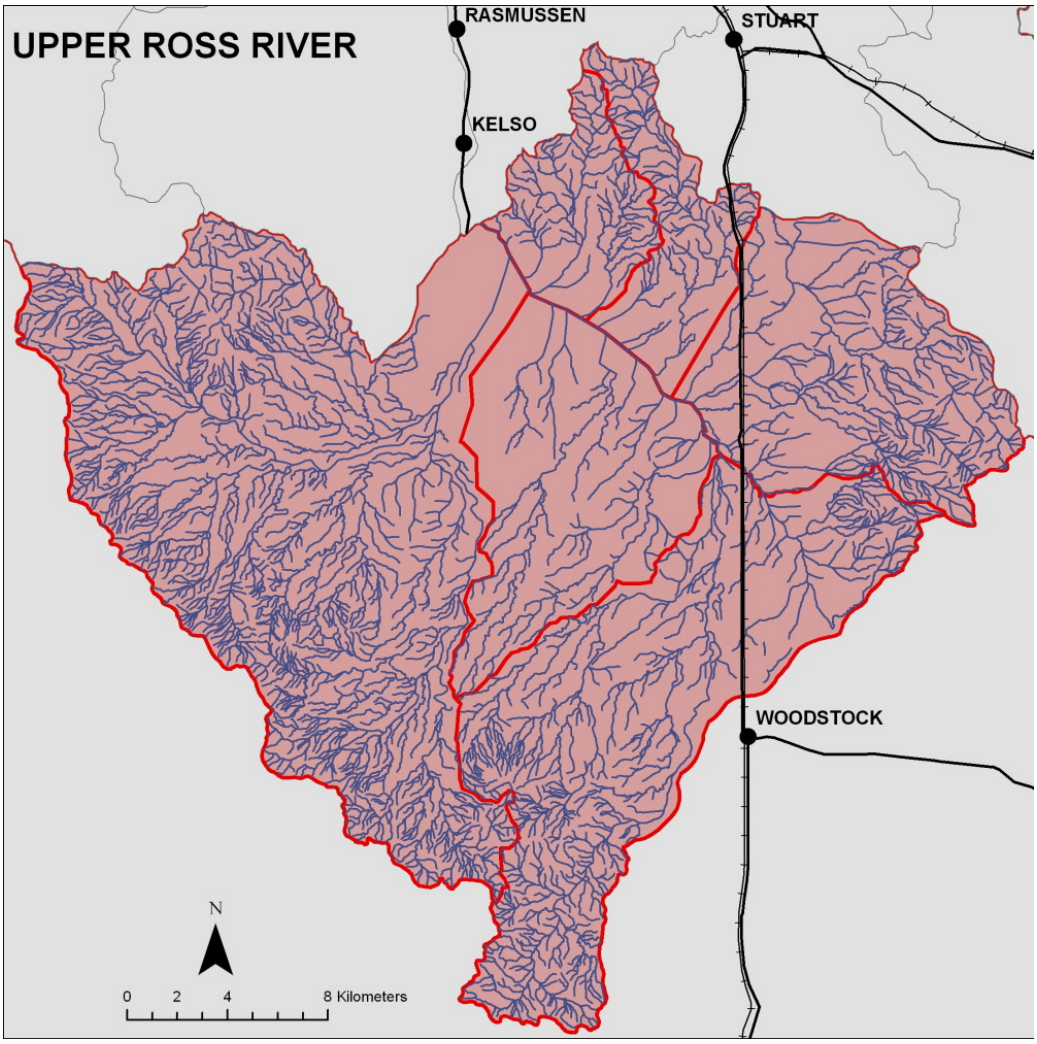
Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

11. Upper Ross River Sub Basin

The Upper Ross River sub basin includes the Ross river (above the dam), Six Mile Creek, Toonpan Lagoon, Antill Plains, Sachs Creek and Mt Stuart catchments. There are also a number of smaller waterways that have been included in the catchments of these larger creeks (see Figure 11-1).

Figure 11-1 Upper Ross River Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\Upper_Ross_River_300

11.1 Upper Ross River Sub Basin Land Use

The Upper Ross River sub basin is 760 square kilometres in size (76,000 hectares). in the Upper Ross sub basin (see Figure 11-3 and Table 11-1).

Land use summaries and other physical features of the main catchments of the Upper Ross River sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 11-2 Upper Ross River Sub Basin Imagery

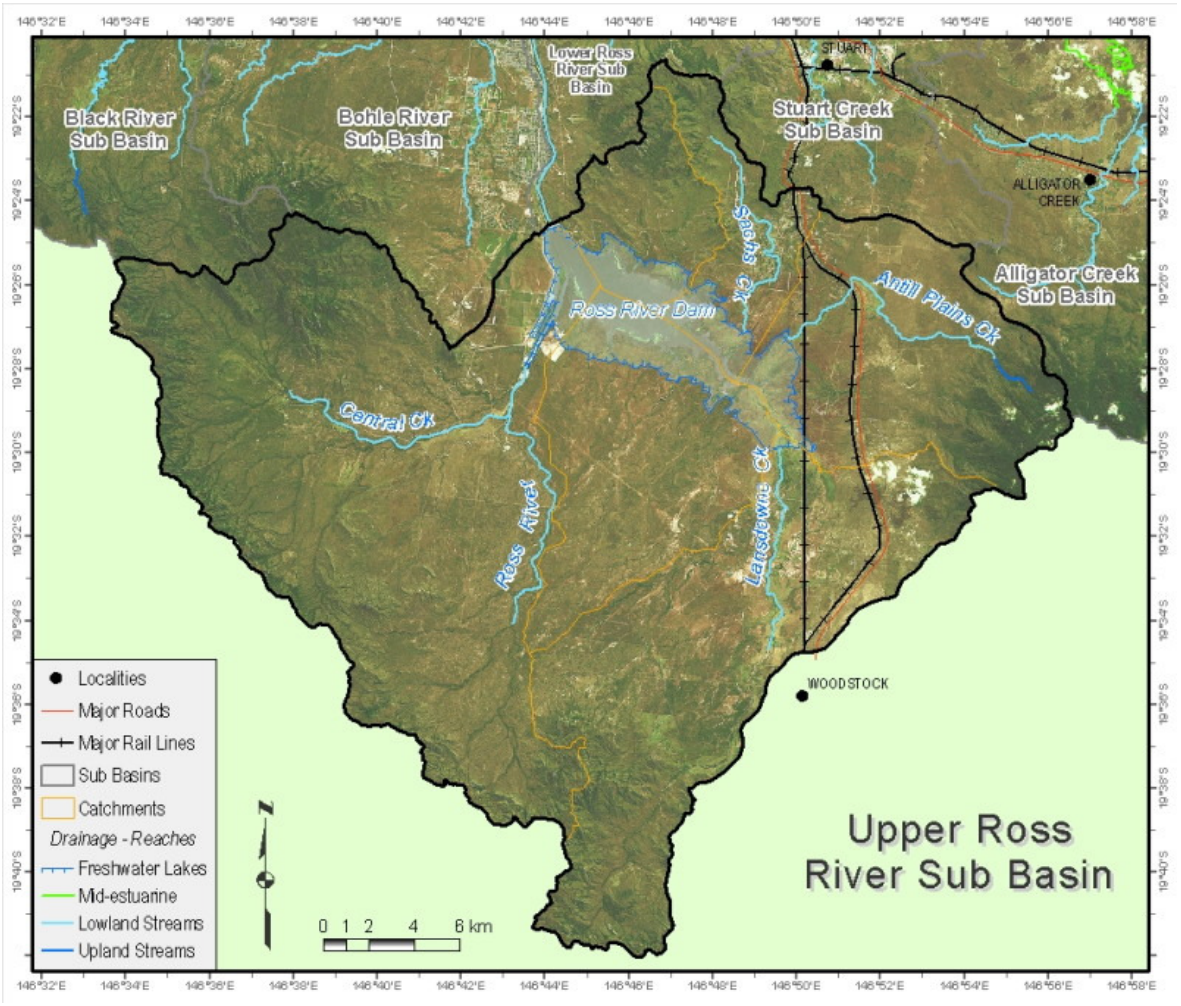
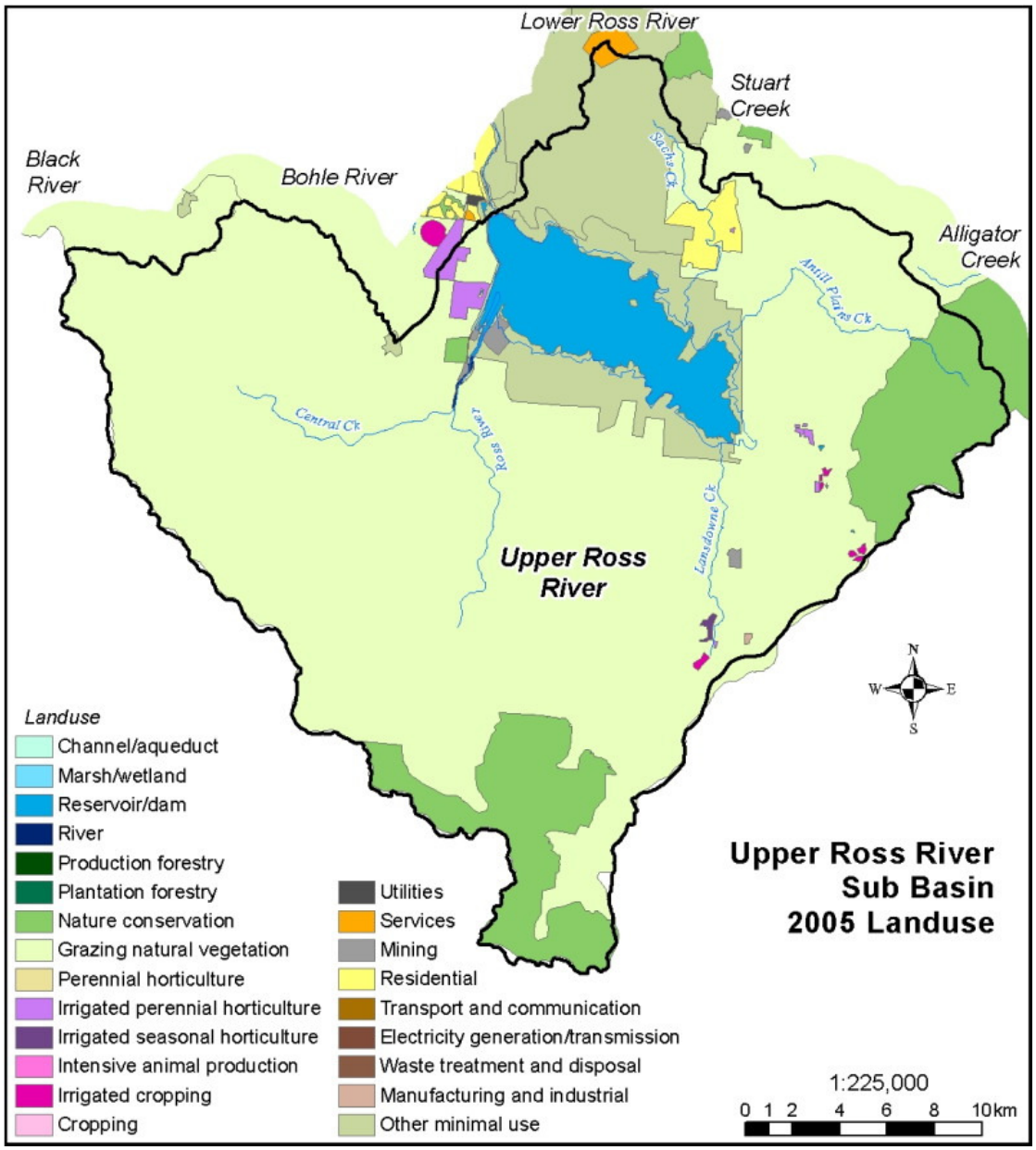

Black River Sub Basin
Bohle River Sub Basin
Lower Ross River Sub Basin
Stuart Creek Sub Basin
STUART
ALLIGATOR CREEK
Alligator Creek Sub Basin
Ross River Dam
Sachs Ck
Antill Plains Ck
Central Ck
Ross River
Lansdowne Ck
WOODSTOCK
Upper Ross River Sub Basin
Localities
Major Roads
Major Rail Lines
Sub Basins
Catchments
Drainage - Reaches
Freshwater Lakes
Mid-estuarine
Lowland Streams
Upland Streams
N
0 1 2 4 6 km

Figure 11-3 Upper Ross River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 11-1 Upper Ross River Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Grazing Natural Vegetation	54437	71.67	54082	71.67
Irrigated Cropping	63	0.08	63	0.08
Irrigated Perennial Horticulture	323	0.43	323	0.43
Irrigated Seasonal Horticulture	35	0.05	35	0.05
Manufacturing and industrial	11	0.01	11	0.01
Marsh/wetland			12	0.02
Mining	53	0.07	173	0.23
Nature Conservation	8367	11.02	8218	10.89

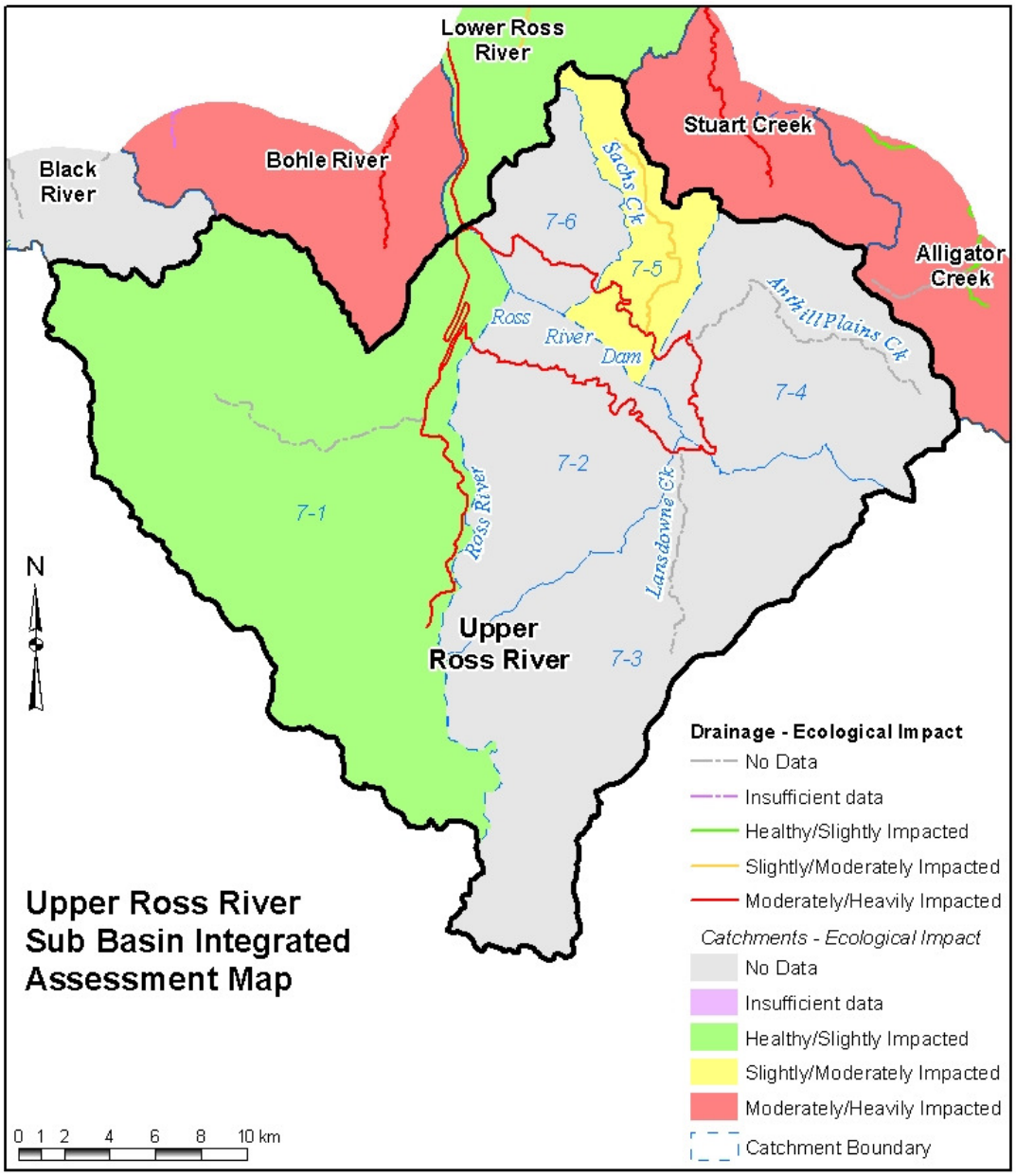
Other Minimal Use	7580	9.98	7461	9.89
Reservoir/Dam	4335	5.71	4332	5.74
Residential	647	0.85	647	0.86
River	27	0.04	27	0.04
Services	75	0.10	75	0.10
	75953	100	75460	100

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

11.2 Upper Ross River Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that despite a very limited dataset the water quality of this sub-basin was most likely to be slightly to moderately impacted (see Figure 11-4). The data associated with the Ross Dam catchment was all taken from within the Ross Dam so it was not considered to be representative of the catchment area however recent data from Sachs Creek generally confirmed the rating for this sub basin.

Figure 11-4 Upper Ross River Sub Basin Ecological Condition



11.2.1 7-1 Ross River (above dam)

The Ross River catchment above the dam is approximately 30,520 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 11-2 Ross River (upper) Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	1443.13	4.7	1419.4	4.7
Other minimal use		239.50	0.8	146.5	0.5
	Remnant native cover	59.93	0.2	59.9	0.2
Grazing natural vegetation		27736.61	90.9	27487.5	90.9
Irrigated perennial horticulture	Irrigated tree fruits	278.53	0.9	278.5	0.9
Residential		0.15	0.0	0.1	0.0
Mining		13.34	0.0	108.5	0.4
Reservoir/dam		721.70	2.4	719.4	2.4
River		27.32	0.1	27.3	0.1
	Totals	30520.20		30247.3	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

11.2.2 7-2 Six Mile Creek

The Six Mile Creek catchment is approximately 9,625 hectares in area (CSIRO calculation from QLUMP 1999) with the main land use being grazing in native pasture.

Table 11-3 Six Mile Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary	Area (ha)	%
Conservation and natural environments	Other minimal use		1846.95	19.2
Production from relatively natural environments	Grazing natural vegetation		6076.76	63.1
Water	Reservoir/dam		1700.96	17.7
		Total	9624.66	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

11.2.3 7-3 Toonpan Lagoon

The Toonpan Lagoon catchment is approximately 16,900 hectares in area with the main land use being grazing in native pasture.

Table 11-4 Toonpan Lagoon Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	721.0	4.3
	Other minimal use		3173.7	18.7
		Remnant native cover	88.1	0.5
Production from relatively natural environments	Grazing natural vegetation		12756.6	75.3
Production from irrigated agriculture and plantations	Irrigated cropping		63.2	0.4
	Irrigated perennial horticulture	Irrigated tree fruits	13.0	0.1
		Irrigated vegetables & herbs	35.4	0.2
Intensive uses	Manufacturing and industrial		11.2	0.1

	Mining		38.3	0.2
Water	Reservoir/dam		22.4	0.1
	Marsh/wetland	Marsh/wetland conserve	11.8	0.1
		Total	16,934.7	

Source: Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

11.2.4 7-4 Antill Plains Creek

The Antill Plains Creek catchment is approximately 10,760 hectares in area with the main land use being grazing in native pasture.

Table 11-5 Antill Plains Creek Catchment Land use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National Park	2937.82	27.3
	Other minimal use		410.45	3.8
Production from relatively natural environments	Grazing natural vegetation		6888.25	64.0
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	28.58	0.3
Intensive uses	Residential	Rural residential	10.55	0.1
Water	Reservoir/dam		483.85	4.5
		Total	10759.5	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

11.2.5 7-5 Sachs Creek

The Sachs Creek catchment is approximately 4,130 hectares in area with the main land use being minimal use (defence).

Table 11-6 Sachs Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	0.01	0.0
	Other minimal use		720.62	17.5
		Defence	1152.29	27.9
Production from relatively natural environments	Grazing natural vegetation		871.67	21.1
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	2.93	0.1
Intensive uses	Residential	Rural residential	634.29	15.4
	Services		74.57	1.8
Water	Reservoir/dam		673.11	16.3
		Total	4129.5	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

11.2.6 7-6 Mt Stuart

The Mt Stuart catchment is approximately 3,800 hectares in area with the main land use being grazing in native pasture.

Table 11-7 Mt Stuart Catchment land Use 2005

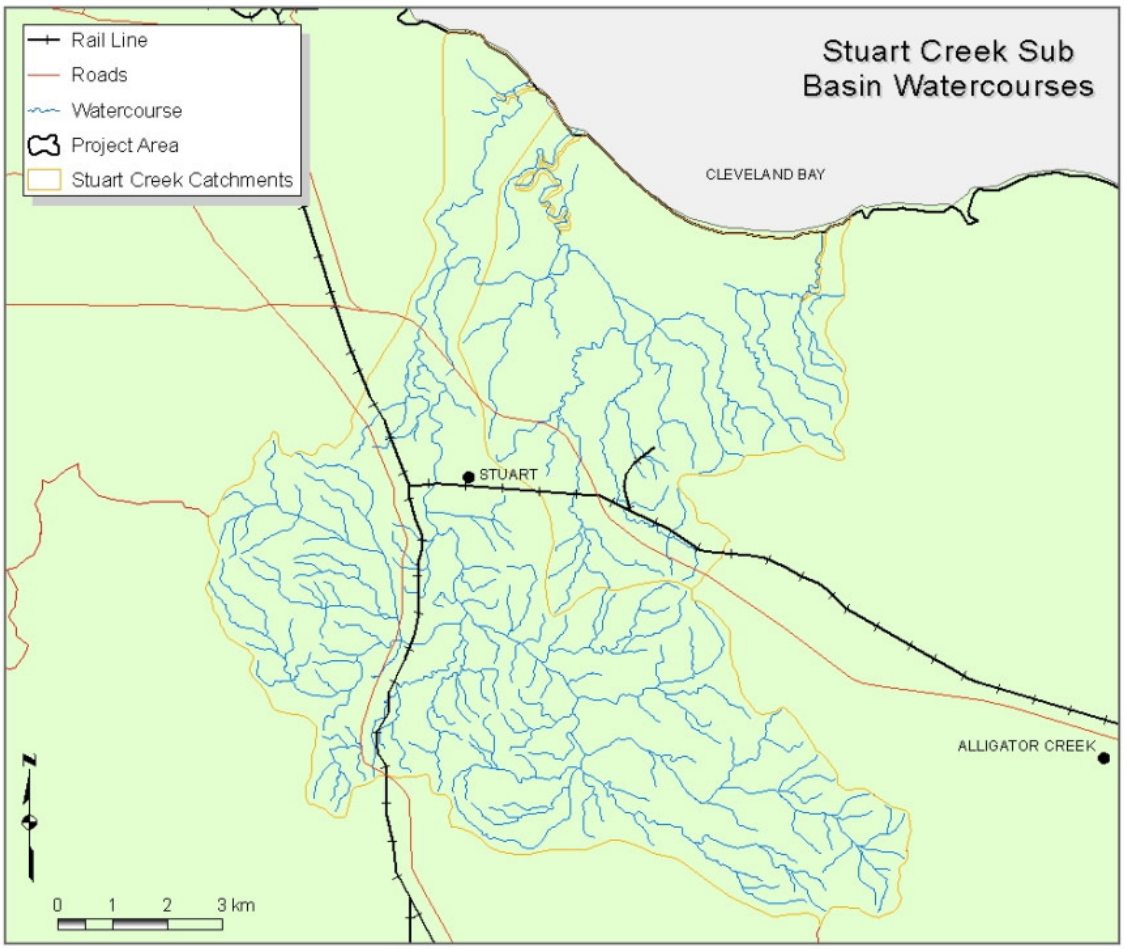
Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Other minimal use		500.80	13.2
		Defence	2561.56	67.4
Production from relatively natural environments	Grazing natural vegetation		1.45	0.0
Intensive uses	Residential	Rural residential	1.52	0.0
Water	Reservoir/dam		732.77	19.3
		Total	3798.1	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

12. Stuart Creek Sub Basin

The Stuart Creek sub basin includes the Stuart Creek and Sandfly Creek catchments. There are also a number of smaller waterways that have been included in the catchments of these larger creeks (see Figure 12-1).

Figure 12-1 Stuart Creek Sub Basin and Drainage



12.1 Stuart Creek Sub Basin Land Use

The Stuart Creek sub basin is approximately 104 square kilometres in size (10,400 hectares). Grazing is the main land use in the Stuart Creek sub basin followed by other minimal use (including Defence land) and nature conservation. While being a significant economic driver for Townsville the manufacturing and industrial sector accounts for less than 4% of the land use in the Stuart Creek sub basin (see Table 12-1 and Figure 12-3).

Land use summaries and other physical features of the main catchments of the Stuart Creek sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 12-2 Stuart Creek Sub Basin Imagery

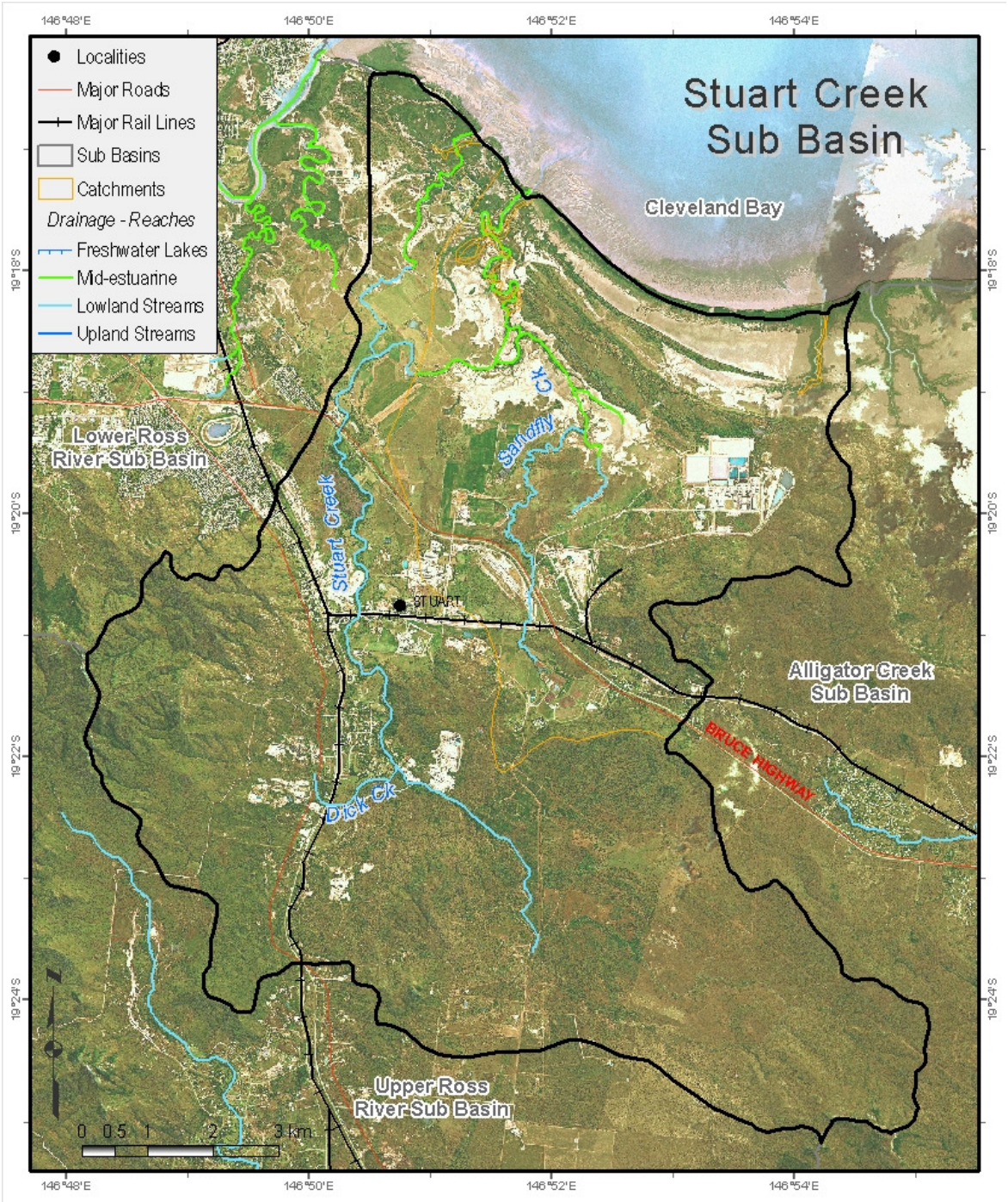
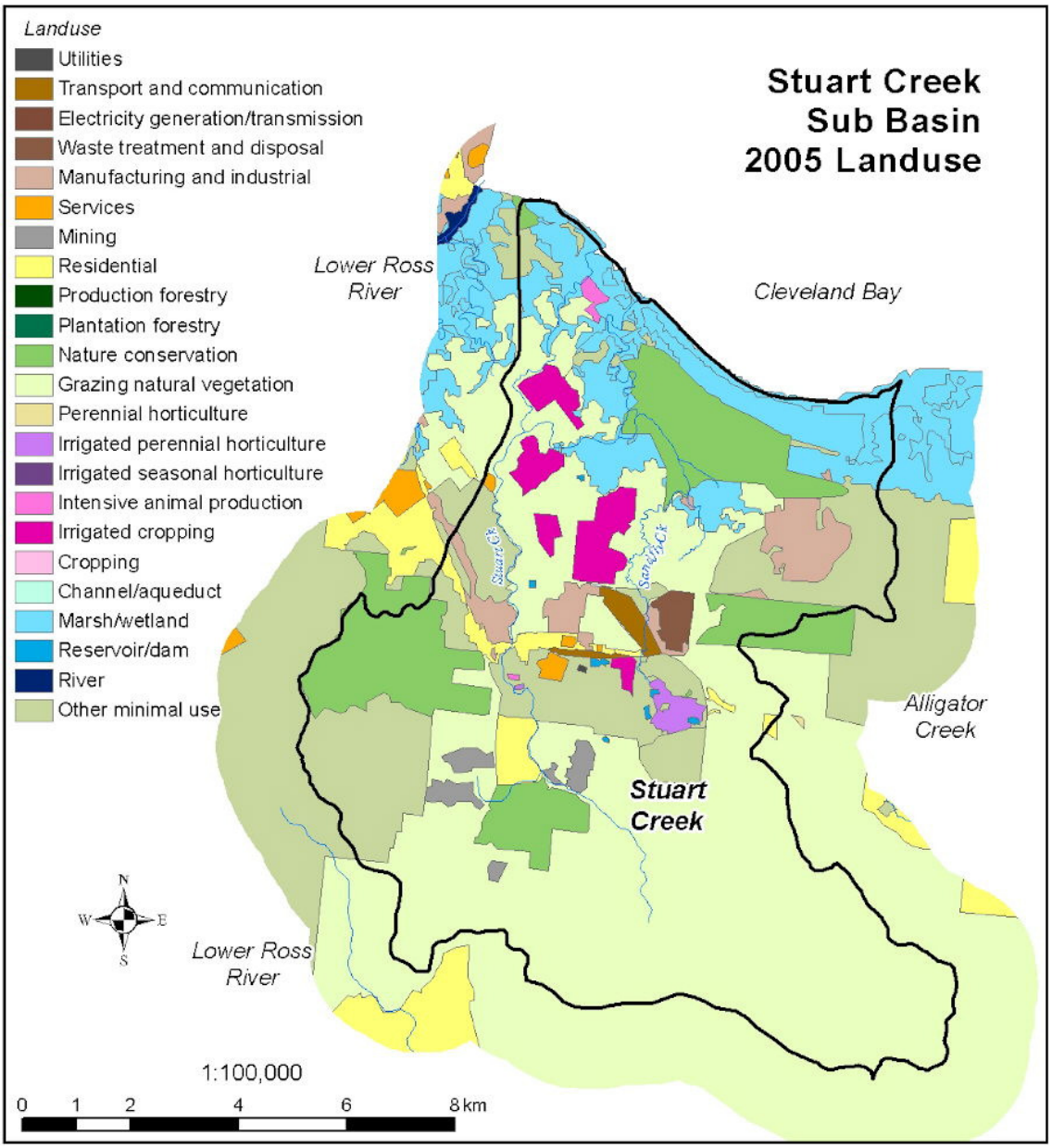


Figure 12-3 Stuart Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 12-1 Stuart Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Grazing Natural Vegetation	5203	50.15	5054	48.73
Intensive Animal Production	23	0.22	23	0.22
Irrigated Cropping	234	2.26	299	2.88
Irrigated Perennial Horticulture	56	0.54	56	0.54
Manufacturing and industrial	359	3.46	353	3.41
Marsh/wetland	1033	9.96	1033	9.96
Mining	109	1.05	116	1.11
Nature Conservation	1366	13.17	1366	13.17

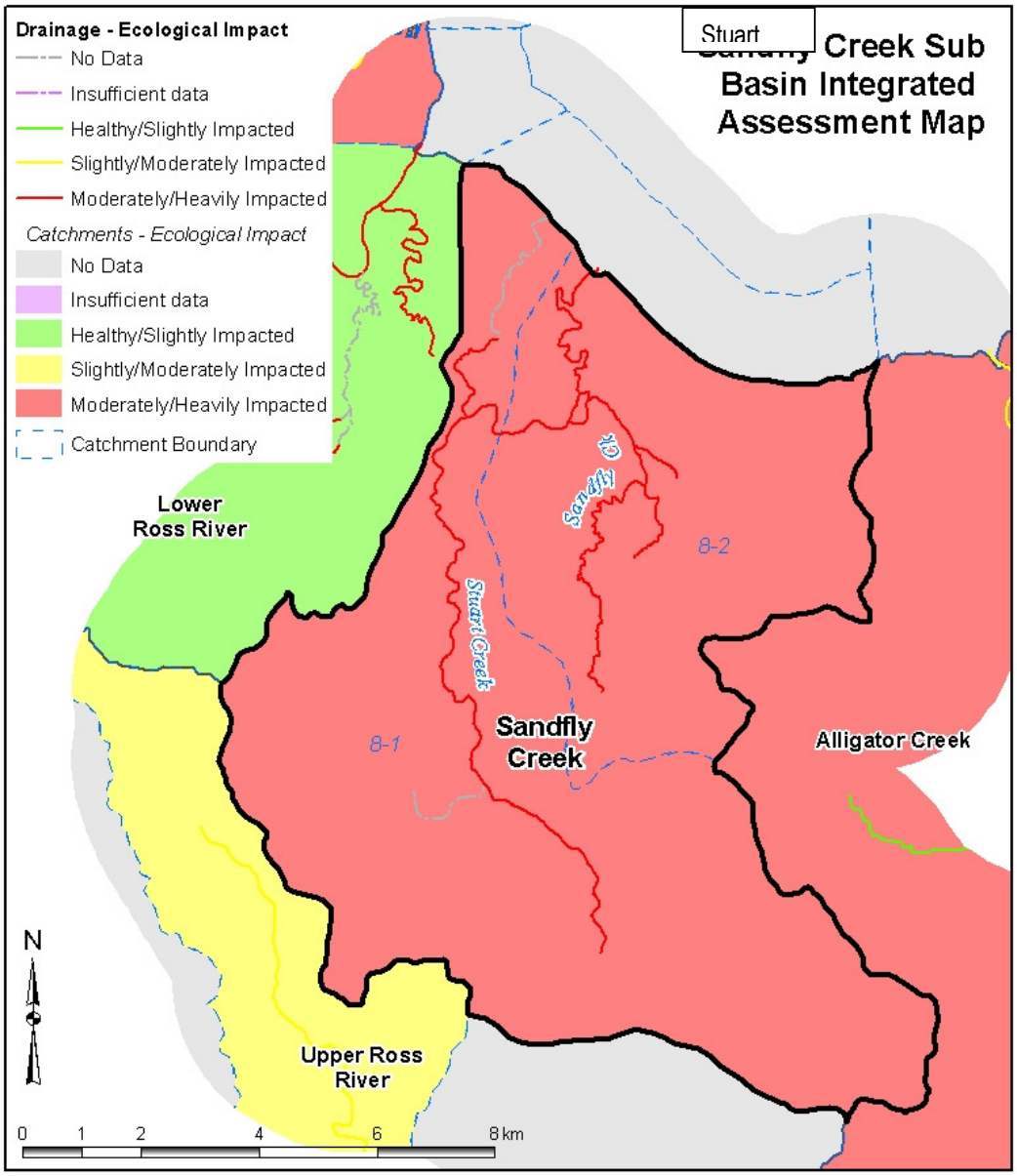
Other Minimal Use	1753	16.90	1704	16.43
Reservoir/Dam	16	0.15	14	0.13
Residential	173	1.67	191	1.84
Services	33	0.32	32	0.31
Transport and Communication	14	0.13	68	0.66
Utilities	2	0.02	2	0.02
Waste treatment and disposal			62	0.59
	10,374	100	10,371	100

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

12.2 Stuart Creek Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of this sub-basin was heavily impacted, with high levels of nutrients and suspended solids. However this data is unlikely to be representative of the entire sub-basin as the main data contributor for this area is the water quality monitoring associated with the Cleveland Bay sewerage treatment plant.

Figure 12-4 Stuart Creek Sub Basin Ecological Condition



12.2.1 8-1 Stuart Creek

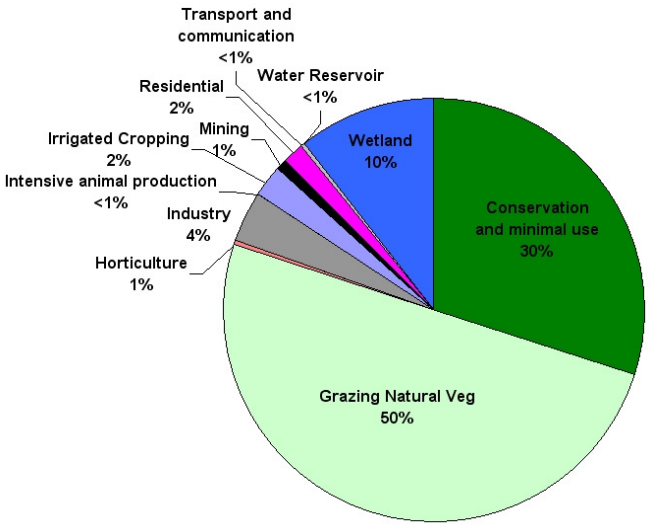
The Stuart Creek catchment is approximately 6,700 hectares in area with the main land use being grazing in native pasture. Catchment boundaries were relocated to more closely match drainage patterns and the Stuart Creek boundary may need to be relocated again to include the connecting creek that flows to Ross River. Drainage patterns have been altered over time through human influence and the flow paths are uncertain.

Table 12-2 Stuart Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	714.2	10.6
	Other minimal use		514.1	7.6
		Defence	514.6	7.7
		Remnant native cover	65.4	1.0
Production from relatively natural environments	Grazing natural vegetation		4130.2	61.4
Production from irrigated agriculture and plantations	Irrigated cropping		106.1	1.6
	Irrigated perennial horticulture		1.4	0.0
Intensive uses	Intensive animal production	Poultry	1.9	0.0
		Aquaculture	19.3	0.3
	Manufacturing and industrial		98.8	1.5
	Residential		83.9	1.2
		Rural residential	86.9	1.3
	Services		21.4	0.3
		Recreation and culture	10.4	0.2
	Utilities	Electricity generation/transmission	1.8	0.0
	Transport and communication	Railways	11.8	0.2
	Mining		115.6	1.7
Water	Reservoir/dam		6.3	0.1
	Marsh/wetland		87.4	1.3
		Marsh/W Conservation	135.4	2.0
		Total	6726.7	

Source: Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 12-5 Stuart Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	60.557 Gl/Year
Flow modification	No
Number of fish barriers	1
Presence of EVR species or ecosystems	42
Presence of STP point source	Yes
Presence of other point source	No (but urban stormwater)
Catchment cleared	23%
Estuarine vegetation cleared	5%
OzEstuary 2000	
Type	TFC
Bryce Heap	Tidal Flat
Condition	Modified
Page & Hoolihan 2002	
Naturalness Estuary	Moderate
Naturalness Catchment	Low
Habitat Diversity	Moderate
International Significance	High
Level of protection	Low

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	High	Moderate	High	Low
Chronic or Storm	(Storm)	(Storm)	(Storm)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

12.2.2 8-2 Sandfly Creek

The Sandfly Creek catchment is approximately 3,640 hectares in area with the main land use being nature conservation and other minimal use.

Table 12-3 Sandfly Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	Other conserved area	651.4	17.9
	Other minimal use		519.4	14.3
		Remnant native cover	90.1	2.5
Production from relatively natural environments	Grazing natural vegetation		923.3	25.3
Production from irrigated agriculture and plantations	Irrigated cropping		192.8	5.3
	Irrigated perennial horticulture		54.7	1.5
Intensive uses	Intensive animal production	Aquaculture	1.3	0.0
	Manufacturing and industrial		254.5	7.0
	Residential		6.7	0.2
		Rural residential	13.8	0.4
	Services	Commercial services	0.3	0.0
	Transport and communication	Railways	56.5	1.6
	Waste treatment and disposal	Landfill	61.7	1.7
Water	Reservoir/dam		7.3	0.2

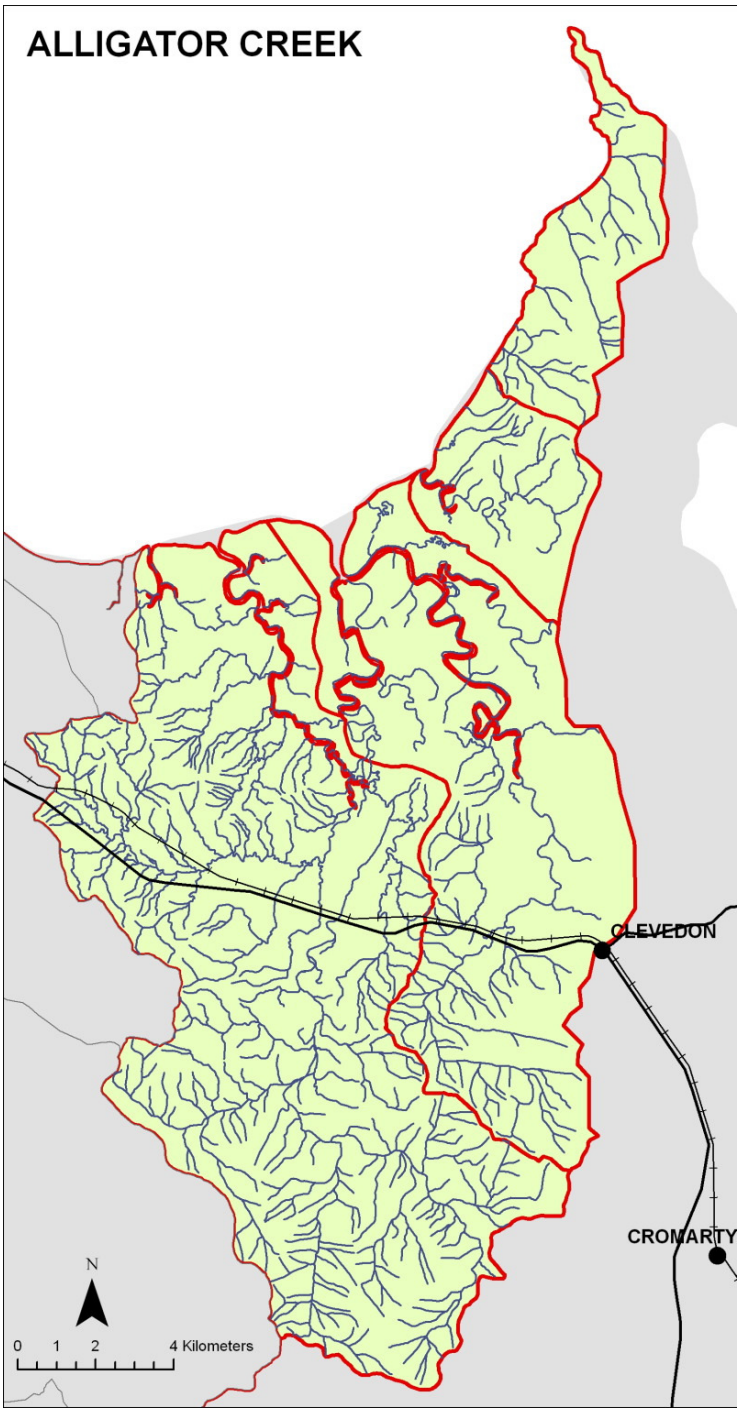
	Marsh/wetland		628.3	17.2
		Marsh/W Conservation	181.9	5.0
		Total	3644.3	

Source: Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

13. Alligator Creek Sub Basin

The Alligator Creek sub basin (see Figure 13-1) includes the Alligator Creek, Crocodile Creek, Cocoa Creek and Cape Cleveland catchments. There are also a number of smaller waterways that have been included in the catchments of these larger creeks.

Figure 13-1 Alligator Creek Sub Basin and Drainage



Source file: \csiro\Final Products\Maps\Sub-basins and Rivers\smalls\Alligator_Creek_300

13.1 Alligator Creek Sub Basin Land Use

The Alligator Creek sub basin is 265 square kilometres in size (26,500 hectares). Residential and associated urban land uses are dominant in the Stuart Creek sub basin. Other minimal use (Defence land) and nature conservation and are also significant land uses in the Stuart Creek sub basin (see Table 13-1 and Figure 13-3).

Land use summaries and other physical features of the main catchments of the Alligator Creek sub basin are provided below (additional information kindly provided by EPA, Townsville). Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided.

Figure 13-2 Alligator Creek Sub Basin Imagery

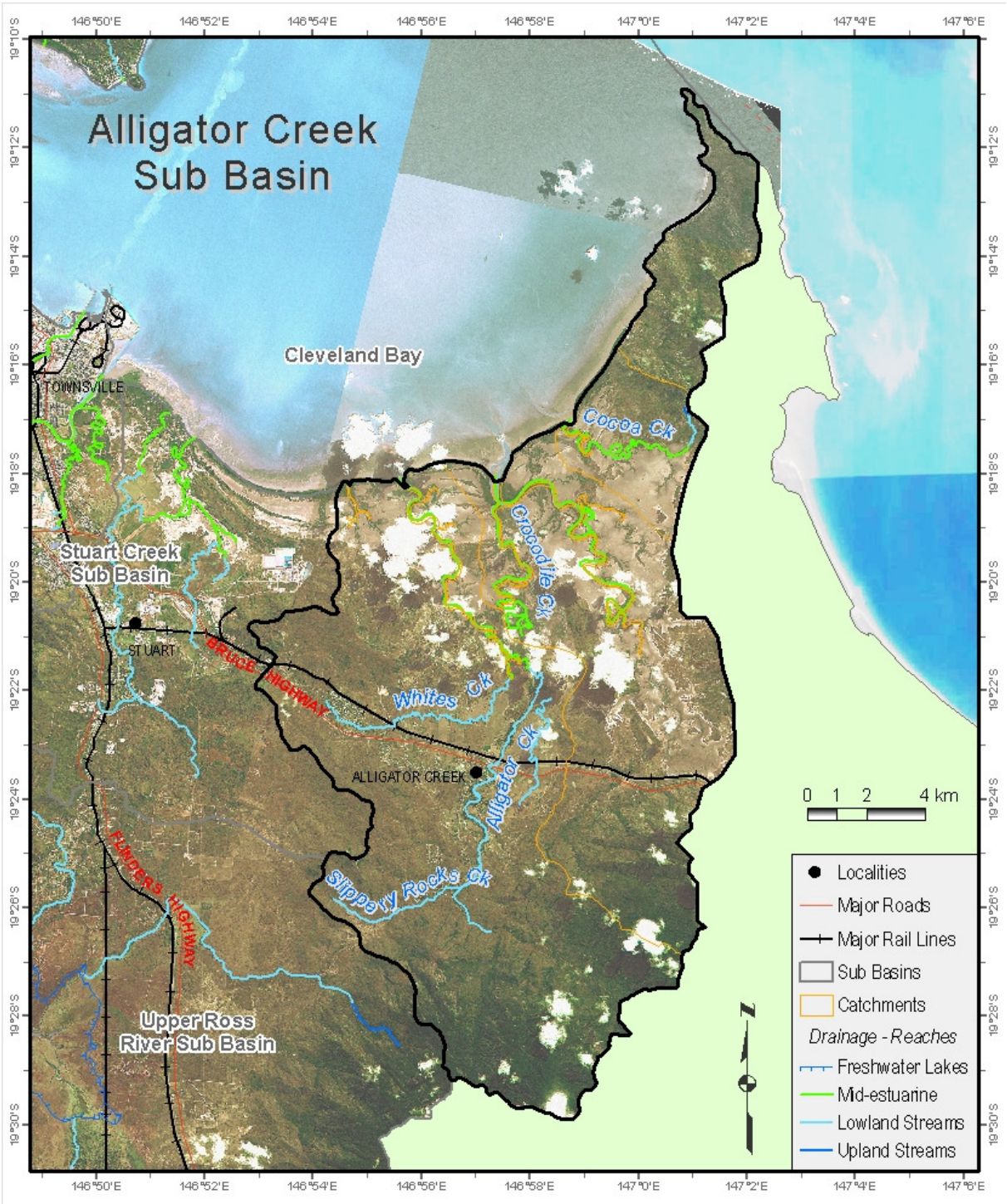
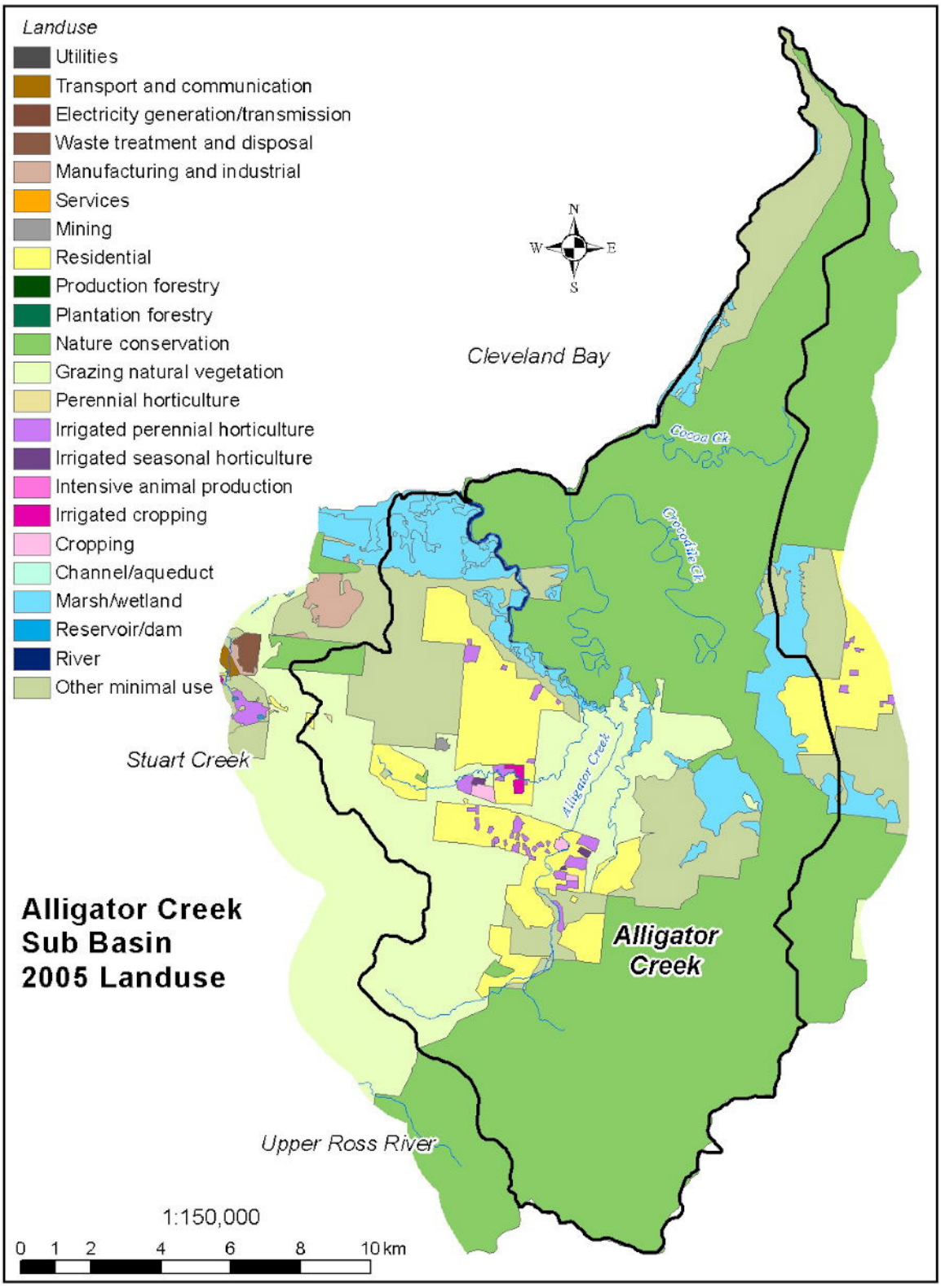


Figure 13-3 Alligator Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data and SPOT imagery (BDT NRM)

Table 13-1 Alligator Creek Sub Basin Land Use

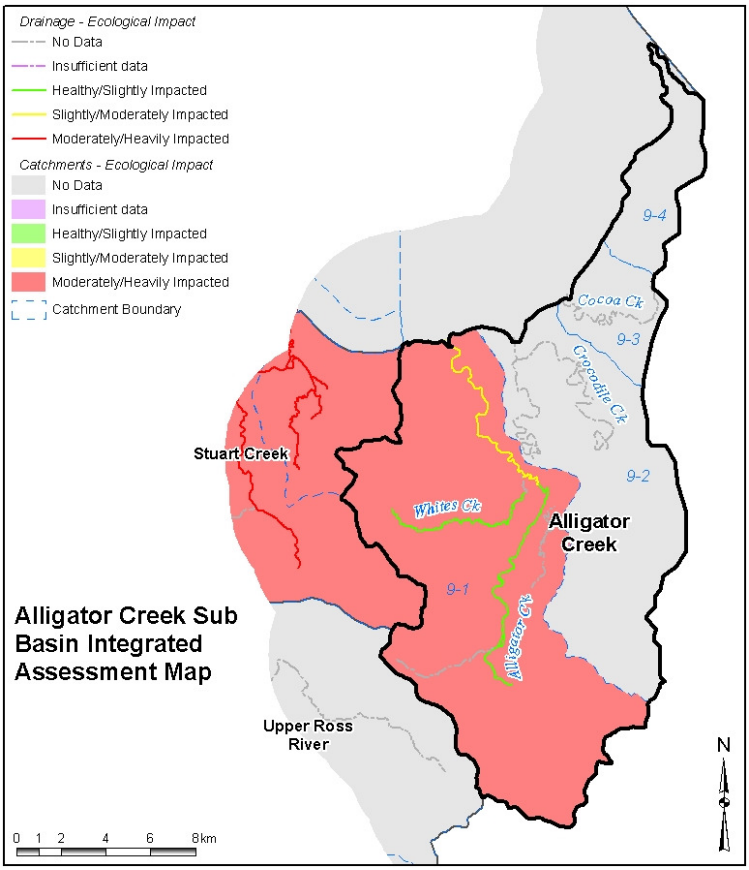
Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping	43	0.16	43	0.16
Grazing Natural Vegetation	4111	15.50	4111	15.52
Irrigated Cropping	26	0.10	26	0.10
Irrigated Perennial Horticulture	184	0.69	185	0.70
Irrigated Seasonal Horticulture	15	0.06	15	0.06
Marsh/wetland	1755	6.62	1755	6.62
Mining	11	0.04	11	0.04
Nature Conservation	14229	53.65	14194	53.59
Other Minimal Use	3676	13.86	3663	13.83
Perennial Horticulture	3	0.01	3	0.01
Residential	2427	9.15	2439	9.21
River	43	0.16	43	0.16
	26,523	100	26,489	100

Source: CSIRO generated data from QLUMP 1999. 2005 data generated by Connell Wagner from updated QLUMP 1999

13.2 Alligator Creek Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of this sub basin was ecologically healthy however this result is skewed by a distinct lack of data in all catchments except Alligator Creek (see Figure 13-4). Recent data for the Alligator Creek catchment indicates that there has been a significant deterioration in water quality over the last 5 years when compared with the previous decade.

Figure 13-4 Alligator Creek Sub Basin Ecological Impact



13.2.1 9-1 Alligator Creek

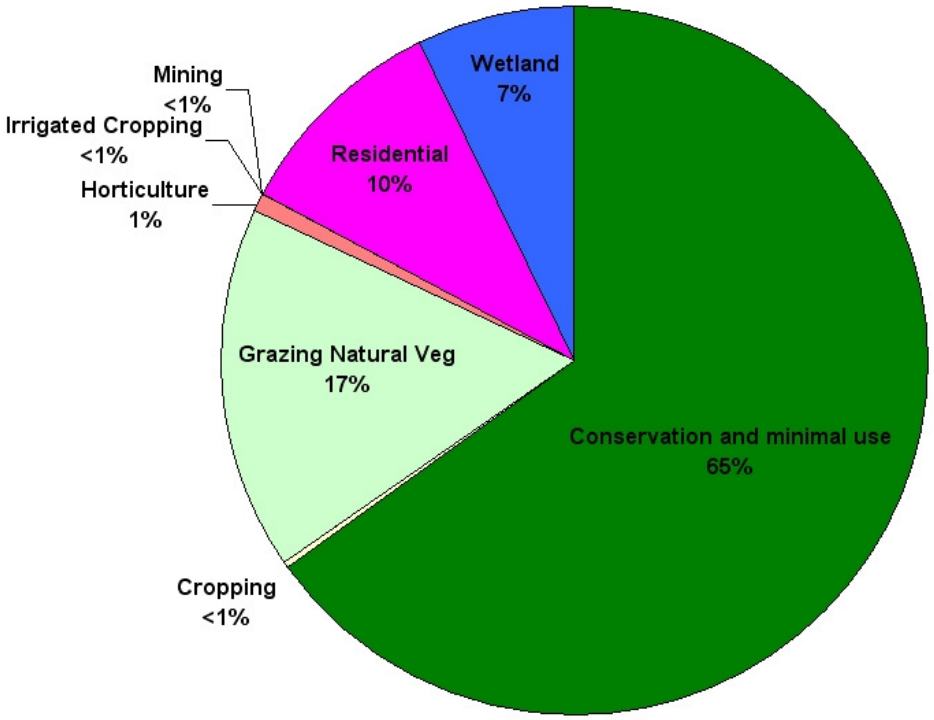
The Alligator Creek catchment is approximately 14,800 hectares in area with the main land use being conservation and minimal use.

Table 13-2 Alligator Creek Catchment Land Use 1999 and 2005

Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	National park	5684.15	38.4	5649.2	38.3
	Other conserved area	133.39	0.9	133.4	0.9
Other minimal use		1281.90	8.7	1281.9	8.7
	Remnant native cover	492.60	3.3	479.8	3.2
Grazing natural vegetation		3815.80	25.8	3815.8	25.8
Cropping		43.22	0.3	43.2	0.3
Perennial horticulture		2.52	0.0	2.5	0.0
Irrigated cropping		25.73	0.2	25.7	0.2
Irrigated perennial horticulture	Irrigated tree fruits	184.45	1.2	185.1	1.3
Irrigated seasonal horticulture	Irrigated vegetables & herbs	15.34	0.1	15.3	0.1
Residential	Rural residential	2195.56	14.8	2207.6	14.9
Mining		11.44	0.1	11.4	0.1
River		43.20	0.3	43.2	0.3
Marsh/wetland		658.84	4.5	658.9	4.5
	Marsh/W Conservation	213.91	1.4	213.9	1.4
	Total	14802.05		14755.7	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 13-5 Alligator Creek Catchment Land Use



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	
Flow modification	No
Number of fish barriers	8
Presence of EVR species or ecosystems	15
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	14%
Estuarine vegetation cleared	1%
OzEstuary 2000	
Type	TDD
Bryce Heap	Strand plain
Condition	Largely unmodified
Page & Hoolihan 2002	
Naturalness Estuary	High
Naturalness Catchment	Low
Habitat Diversity	Moderate
International Significance	Very High
Level of protection	Moderate

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	Low	Low	Low/Moderate	Low
Chronic or Storm	(Storm)	(Storm)	(Storm)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

13.2.2 9-2 Crocodile Creek

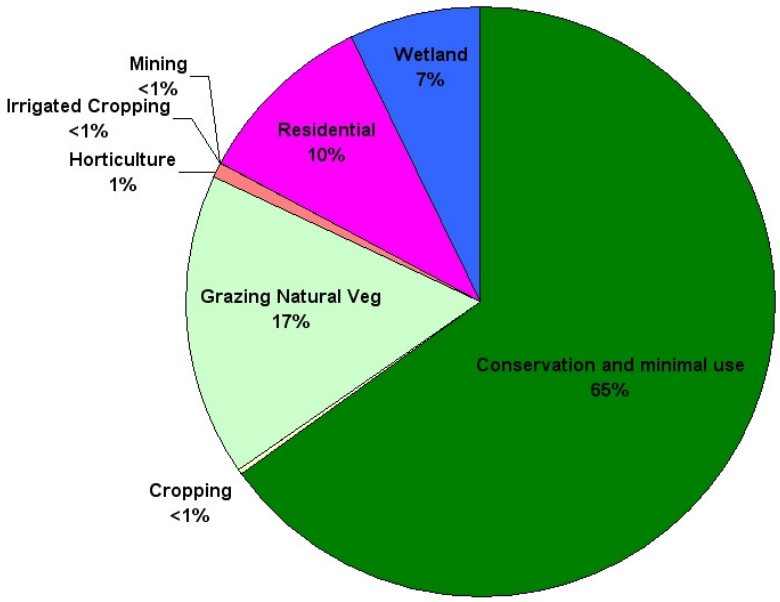
The Crocodile Creek catchment is approximately 8,000 hectares in area with the main land use being conservation and minimal use.

Table 13-3 Crocodile Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National Park	5793.78	72.5
	Other minimal use	Remnant native cover	903.23	11.3
Production from relatively natural environments	Grazing natural vegetation		288.57	3.6
Intensive uses	Residential	Rural residential	231.77	2.9
Water	Marsh/wetland		768.06	9.6
		Marsh/W conservation	9.68	0.1
		Total	7995.09	

Source: CSIRO calculation from QLUMP 1999and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Figure 13-6 Crocodile Creek Catchment Land Use 1999



Source: EPA – Estuary and Marine HEV profiles

Catchment Characteristic	Description
Average river flow	
Flow modification	No
Number of fish barriers	8
Presence of EVR species or ecosystems	15
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	14%
Estuarine vegetation cleared	1%
OzEstuary 2000	
Type	TDD
Bryce Heap	Strand plain

Condition	Near Pristine
Page & Hoolihan 2002	
Naturalness Estuary	V. High
Naturalness Catchment	Low
Habitat Diversity	Moderate
International Significance	V. High
Level of protection	Moderate

Water Quality Exposure

	Sediment	Nitrogen	Phosphorus	Pesticides
Contaminant Exposure Risk	Low	Low	Low/Moderate	Low
Chronic or Storm	(Storm)	(Storm)	(Storm)	(Storm)

Derived from information in Maughan et al 2008; Bainbridge et al 2007; Liessman et al 2007 Vol. 1 & 2; Lewis et al 2007; Moss et al (unpubl.)

Source: EPA – Estuary and Marine HEV profiles

13.2.3 9-3 Cocoa Creek

The Crocodile Creek catchment is approximately 1,717 hectares in area with the main land use being conservation and minimal use.

Table 13-4 Cocoa Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National Park	1596.97	93.0
	Other minimal use	Remnant native cover	39.36	2.3
Production from relatively natural environments	Grazing natural vegetation		5.00	0.3
Water	Marsh/wetland		19.64	1.1
		Marsh/W conservation	55.53	3.2
		Total	1716.5	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

13.2.4 9-4 Cape Cleveland

The Crocodile Creek catchment is approximately 2,010 hectares in area with the main land use being conservation and minimal use.

Table 13-5 Cape Cleveland Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National Park	1021.20	50.8
	Other minimal use	Remnant native cover	958.92	47.7
Production from relatively natural environments	Grazing natural vegetation		1.83	0.1
Water	Marsh/wetland		9.37	0.5
		Marsh/W conservation	19.62	1.0
		Total	2010.95	

Source: CSIRO calculation from QLUMP 1999 and Connell Wagner calculation from updated QLUMP 1999 data using 2005 aerial photographs (TCC) and SPOT imagery (BDT NRM)

Catchment Characteristic	Description
Average river flow	
Flow modification	No

Number of fish barriers	0
Presence of EVR species or ecosystems	No
Presence of STP point source	No
Presence of other point source	No
Catchment cleared	0%
Estuarine vegetation cleared	0%

Source: EPA – Estuary and Marine HEV profiles

14. Magnetic Island Sub Basin

The Magnetic Island sub basin includes the West Coast, Picnic Bay, Nelly Bay, Arcadia, Radical Bay, Horseshoe Bay, Five Beach Bay and Rollingstone Bay catchments (see Figure 14-1).

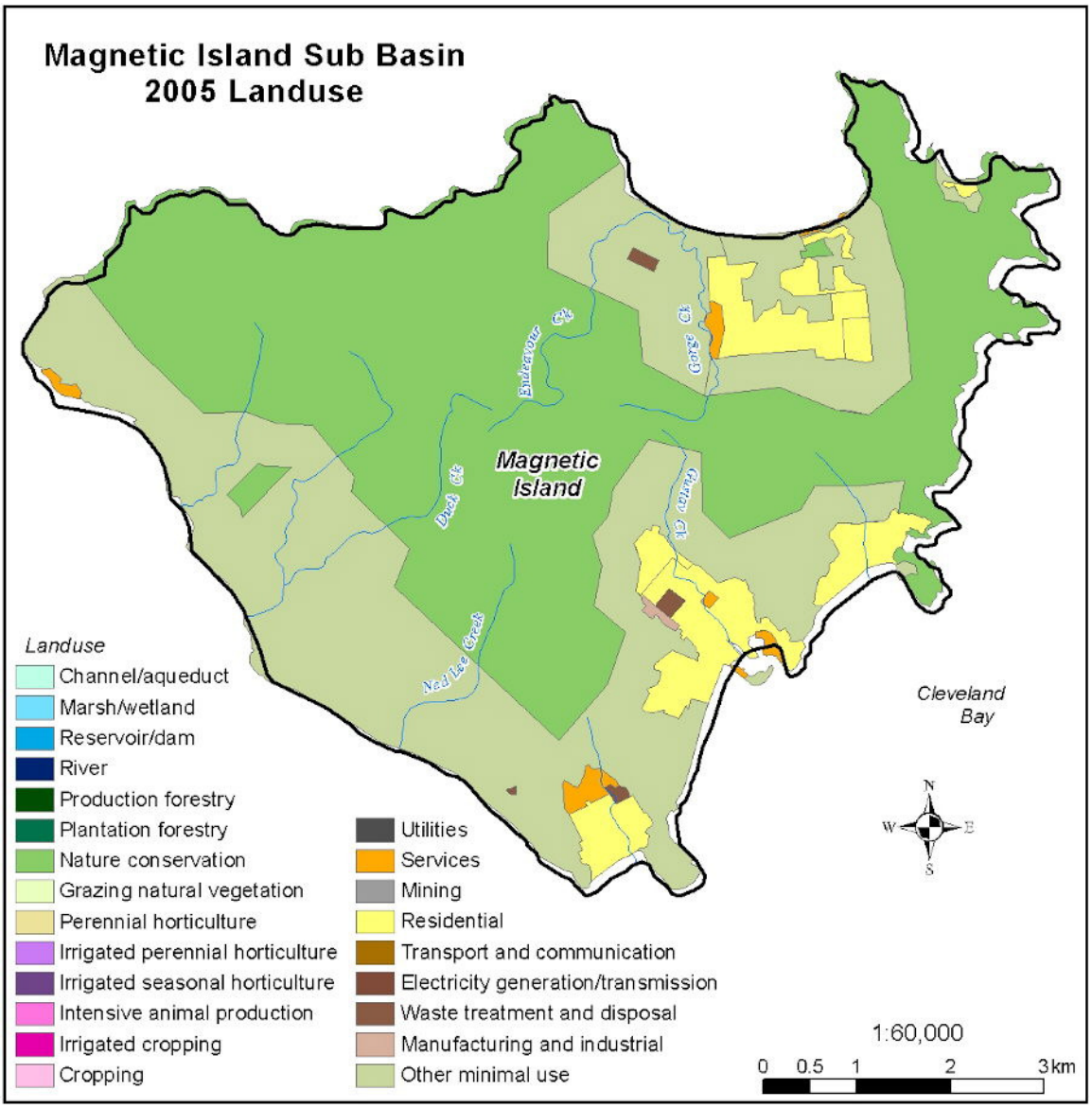
Figure 14-1 Magnetic Island Sub Basin Imagery

14.1 Magnetic Island Sub Basin Land Use

The Magnetic Island sub basin is approximately 51 square kilometres in size (5,100 hectares). Nature conservation and minimal use are the main land uses of the Magnetic Island sub basin (see Figure 14-2 and Table 14-1).

Land use summaries and other physical features of the main catchments of the Magnetic Island sub basin are provided below. 1999 land use mapping was not available for Magnetic Island so 2005 land use information was generated specifically for the purposes of the Black Ross WQIP using data provided by Townsville City Council and Burdekin Dry Tropics NRM.

Figure 14-2 Magnetic Island Sub Basin Land Use



Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

Table 14-1 Magnetic Island Sub Basin Land Use

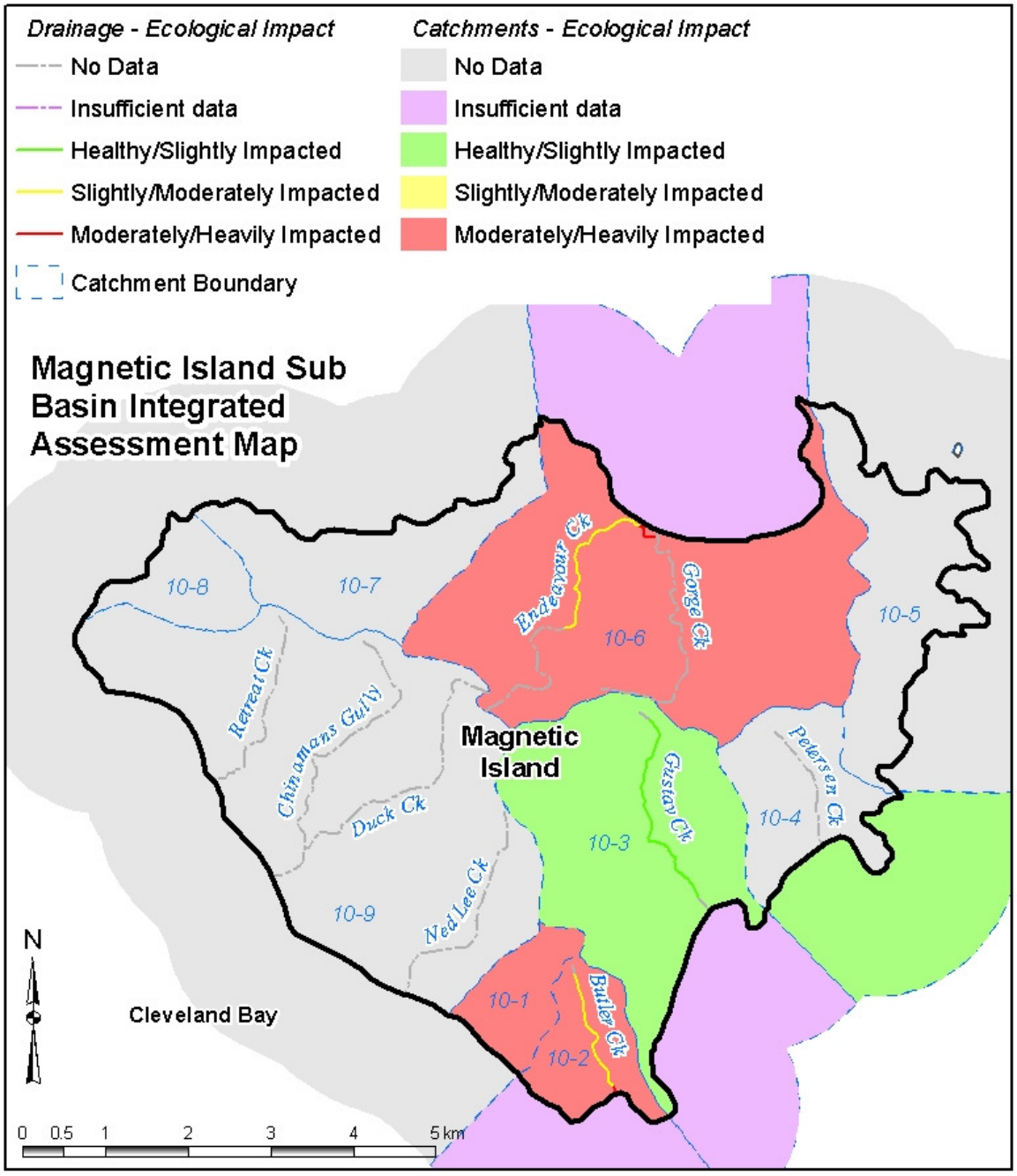
Land Use	Area (ha)	Area (%)
Manufacturing and industrial	5	0.09
Nature Conservation	2639	52.88
Other Minimal Use	1924	38.55
Residential	383	7.67
Services	27	0.54
Waste treatment and disposal	13	0.27
	4,990	100

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2 Magnetic Island Sub Basin Resource Condition

The water quality condition analysis (Connell Wagner 2008) indicated that the water quality of this area and particularly three of the nine catchments are heavily impacted while one catchment is slightly impacted. There is insufficient data to assess the remaining catchments.

Figure 14-3 Magnetic Island Sub Basin Ecological Impact



14.2.1 10-1 West Coast

The West Coast catchment is approximately 1,655 hectares in area (CSIRO calculation) with the main land use being conservation and minimal use.

Table 14-2 West Coast Catchment land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	701.6	42.98
		Other conserved area	16.6	1.02
	Other minimal use		908.2	55.63
Intensive uses	Residential		5.2	0.32
	Service	Recreation and culture	0.3	0.02
	Waste treatment and disposal	Sewage	0.6	0.04
		Total	1632.5	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2.2 10-2 Picnic Bay

The Picnic Bay catchment is approximately 180 hectares in area with the main land uses being residential and minimal use.

Table 14-3 Picnic Bay Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	0.3	0.2
	Other minimal use		109.1	61.8
Intensive uses	Residential		48.7	27.6
	Service	Recreation and culture	15.3	8.7
	Waste treatment and disposal	Landfill	3.2	1.8
		Total	176.6	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2.3 10-3 Nelly Bay

The Nelly Bay catchment is approximately 800 hectares in area (CSIRO calculation) with the main land uses being nature conservation and minimal use.

Table 14-4 Nelly Bay Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	302.7	39.09
	Other minimal use		318.8	41.16
Intensive uses	Manufacturing and industrial		4.6	0.59
	Residential		122.0	15.75
		Rural residential	19.6	2.53
	Service	Commercial services	4.3	0.56
		Recreation and culture	0.2	0.03
	Waste treatment and disposal	Sewage	5.2	0.68
		Total	777.4	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2.4 10-4 Arcadia

The Arcadia catchment is approximately 292 hectares in area (CSIRO calculation) with the main land use being conservation and minimal use.

Table 14-5 Arcadia Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	117.1	44.4
	Other minimal use		92.0	34.8
		Defence	2.8	1.0
Intensive uses	Residential		52.0	19.7
		Total	263.9	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2.5 10-5 Radical Bay

The Radical Bay catchment is approximately 431 hectares in area (CSIRO calculation) with the main land use being conservation and minimal use.

Table 14-6 Radical Bay Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	354.0	95.1
	Other minimal use		15.0	4.0
Intensive uses	Residential	Rural residential	3.3	0.9
		Total	372.3	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2.6 10-6 Horseshoe Bay

The Horseshoe Bay catchment is approximately 1,230 hectares in area (CSIRO calculation) with the main land use being conservation and minimal use.

Table 14-7 Horseshoe Bay Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	614.9	50.3
		Other conserved area	4.5	0.4
	Other minimal use		460.2	37.6
Intensive uses	Residential		39.2	3.2
		Rural residential	97.9	8.0
	Service	Commercial services	1.6	0.1
	Waste treatment and disposal	Sewage	4.3	0.4
		Total	1222.5	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2.7 10-7 Five Beach Bay

The Five Beach Bay catchment is approximately 386 hectares in area (CSIRO calculation) with the main land use being conservation and minimal use.

Table 14-8 Five Beach Bay Catchment land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	385.6	100
		Total	385.6	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

14.2.8 10-8 Rollingstone Bay

The Five Beach Bay catchment is approximately 159 hectares in area (CSIRO calculation) with the main land use being conservation and minimal use.

Table 14-9 Rollingstone Bay Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Nature conservation	National park	141.2	89
	Other minimal use		17.7	11
		Total	158.9	

Source: 2005 data generated by Connell Wagner from Townsville City Council (TCC) Planning Scheme Precinct maps, aerial photographs (TCC) and SPOT imagery (BDT NRM)

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Appendix A

Report Card Summary

Extracts from *Development of a Report Card Format for the Waterways of the Black/Ross Basins* (Connell Wagner 2009)

The draft report card developed by Gunn (2006) is based on the State of the Environment (SOE) reporting with an indication of the Pressures, State and Responses for the waterway and its catchment.

The objective of a report card is to present condition assessment data in a non-technical format and to provide a consistent and repeatable way to measure progress made in water quality management. The non-technical format allows broader community groups to easily understand the current health status of the waterway. Report cards provide a one-off measurement that can be used to compare the present condition with respect to the ideal or natural condition of the creek. The generation of a report card for each waterway is essential in the ongoing development of effective management strategies for the Black/Ross Basins, as an integral component of an adaptive management framework. The publication of an annual report card also plays an important role in raising awareness of changes in condition of waterways and focusing management efforts to the protect the environmental values identified by the community.

The key indicators for the Report Card are grouped into the following categories:

- Water quality
- Freshwater fish
- Aquatic invertebrates
- Aquatic vegetation
- Riparian vegetation
- Channel and floodplain features

(Connell Wagner 2009, p.3)

There is a range of assessment information that has or is currently being collected within the Black/Ross Basins and adjacent marine environment. Although the report cards incorporate a range of indicators, there are significant data gaps and variability within datasets collected for the Black/Ross Basins and adjacent marine environment. In the development of the Report Card format, the scoring scheme must be able to account for the variable and sparse data sources available in different areas of the region.

Although there is a wide range of water quality data currently being gathered for the region, considerable gaps exist within the data sets of a number of waterways within the Black/Ross Basins (Connell Wagner 2007).

Other condition assessment information that is incorporated into the Report Card format for the freshwater environment include fish, macroinvertebrates, riparian condition and channel and floodplain features. Currently there is limited data collected for such indicators.
(Connell Wagner 2009, p.5)

The scoring system adopted enables available information to be utilised in the absence of one or more of the indices for each indicator type. In the event that no information is available for an indicator type this is noted and the indicator type is left out of the overall report card calculations. The combination of indicator types are aggregated to give separate scores for water quality (physical and chemical measure, freshwater fish and aquatic invertebrates) and waterway and riparian landscapes which, when combined, give an overall ecosystem/catchment condition score (see table below). The scoring system for each indicator type is described below. Testing is required to determine relevance to the Townsville region and develop an appropriate range of scores for report card ratings.

Grade	Description
A	**Excellent.** Conditions meet all set ecosystem health values; all key processes are functional and all critical habitats are in near pristine condition.

B	**Very Good.** Conditions meet all set ecosystem health values in most of the reporting region; most key processes are functional and most critical habitats are intact.
C	**Good.** Most conditions just meet set ecosystem health values. Most key processes are functional, but some critical habitats may be under threat.
D	**Fair.** Conditions meet some of the set ecosystem health values in most of the reporting region; some key processes are functional but some critical habitats are impacted.
E	**Poor.** Conditions are unlikely to meet set ecosystem health values in most of the reporting region; many key processes are not functional and many critical habitats are impacted.
F	**Very Poor.** Conditions do not meet set ecosystem health values; most key processes are not functional and most critical habitats are severely impacted.

(Connell Wagner 2009, p.6)

The report card format (see table below) generates an annual A (excellent) to F (fail) rating for each category, with a combined total score provided for the catchment as a whole. Each ecological indicator is rated and weighted according to relevance and the degree of importance on an ecosystem-wide scale. The weightings of some indices in the scoring system have been revised from those initially suggested by Gunn (2006). For example, nutrients are considered more relevant in terms of ecosystem processes than some physio-chemical parameters, such as conductivity and temperature. For some parameters, such as fecal coliforms, only limited data (if any) is likely to be available, so the scoring system excludes missing values and adjusts the relevant weightings accordingly.

An assessment of aquatic vegetation (i.e. plants living in the water column) has also been included in the report card, as a separate component to riparian vegetation (i.e. land plants growing on the river banks). For macrophytes, a high score would indicate sufficient biomass and/or coverage of beneficial aquatic plants that would be expected in a healthy waterway. Whereas a low score would be recorded for algae if a bloom was present (reported as Chlorophyll-a, cyanobacterial counts or a visual assessment of algal biomass).

A summary of the 'catchment condition' has been included with the Channel and Floodplain Features component. This includes an assessment of the extent of clearing and types of land uses within the catchment (industrial, agricultural, residential etc). Such information can generally be derived from topographic maps or GIS data.
(Connell Wagner 2009, p.7)

Group	Key Indicators	Maximum Score	Individual Grade
Water Quality - Physical and Chemical Measures	Dissolved oxygen	5	**A-F**
	pH	5	
	Total Suspended Solids or Turbidity	5	
	Nitrogen (Total N, NO_3^--N, NH_3-N)	6	
	Phosphorus (Total P or PO_4^{3-}-P)	6	
	Total (sum)	**27**	
Freshwater Fish	Native species richness	5	**A-F**
	Exotic Individuals	6	
	Fish assemblage/community composition	5	
	Total (sum)	**16**	
Aquatic Invertebrates	Invertebrate family richness	6	**A-F**
	PET richness	5	
	Signal Score	5	
	Total (sum)	**16**	
Aquatic Vegetation	Chlorophyll-*a*	3	**A-F**
	Nuisance algal blooms	3	
	"Healthy" macrophytes	5	
	Total (sum)	**11**	
Riparian Vegetation	Structural integrity/disturbance	5	**A-F**
	Remnant Veg (%) - Canopy	2	
	- Understorey	2	
	- Ground Cover	2	
	- Leaf Litter	2	
	Weeds (%)	5	
	Total (sum)	**18**	
Channel and Floodplain Features	Undercutting and slump erosion	3	**A-F**
	Gully erosion	3	
	Channel clearing (logs/snags/habitat)	3	
	Channel modification	1	
	Natural floodplain features	1	
	Floodplain modification	3	
	Catchment condition	3	
	Total (sum)	**17**	
All Indicators	**Total (sum)**	**105**	**A-F**

Notes:

- A high score is 'better'.
- The total for each category is the sum of the raw score divided by the sum of the maximum possible score. Scores are adjusted for missing data - if a parameter has not been measured it is not included in the equation (i.e. missing values do not equal zero).
- Each indicator is weighted according to their importance in the ecosystem assessment process. For example, water quality is given a higher weighting than channel and floodplain features. In the attached spreadsheet, weighting is automatically adjusted for missing values.

(Connell Wagner 2009, p.8)

Water Quality

Assessment of water quality within the study area has been undertaken by Connell Wagner for the Creek to Coral program (Water Quality Condition Report). The assessment used the *Queensland Water Quality Guidelines 2006* (QWQG, 2006) for slightly-moderately disturbed systems in Tropical Australia[1]. The assessment compared the median, 20th an 80th percentiles against the guideline value for a given water type. The assessment used a three rank system however this has been modified for the report card format.

Criteria	Score
The median, 20th and 80th percentiles all within the guideline	5
The median and (20th OR 80th) percentiles within the guideline	4
The 20th OR 80th percentile is within the guideline and the median is outside the guideline	3
The median is outside the guideline, the 20th percentile is less than the guideline and the 80th percentile is greater than the guideline	1
The median, 20th and 80th percentile are either all more or all less than the guideline	0

Only those parameters, which have a guideline limit, have been included in the report card assessment. (Connell Wagner 2009, p.8)

[1] Queensland Environmental Protection Agency (2006). *Queensland Water Quality Guidelines 2006.*

Macroinvertebrates

The macroinvertebrate assessment consists of three indices recommended by the *Southeast Queensland Regional Water Quality Management Strategy*[2] – invertebrate family richness, PET richness and the SIGNAL score for pollution sensitivity. Scoring systems are shown in the tables below. [The scoring needs to be tested for local relevance.]

Invertebrate Family Richness	
Number of Families	**Scoring**
0	0
1 – 5	1
6 – 10	2
11 - 16	3
17 – 25	4
26 – 32	5
> 32	6

PET richness	
Number of 'PET' Families	**Scoring**
0	0
1	1
2 – 3	2
4 – 6	3
7 – 11	4
> 11	5

Description	SIGNAL Score	Scoring
Very poor water quality, no habitat, only pollution-tolerant bugs remain.	< 1	0
Poor water quality and significant habitat disturbance, few pollution-sensitive bugs remain.	1 – 2	1
Fair water quality, potential loss of habitat, average biodiversity and some loss of pollution-sensitive bugs.	3 – 4	2
Excellent water quality, high biodiversity and many high-scoring sensitive water bugs present.	5 – 6	3
Pristine water quality and habitat, with very high biodiversity and many sensitive species.	7 – 8	4
	9 – 10	5

(Connell Wagner 2009, pp.10-11)

[2] For further details, see: Bunn, S.E. and Smith, M.J. Design and implementation of an ecosystem health monitoring program for streams and rivers in Southeast Queensland, Australia: an overview. *Southeast Queensland Regional Water Quality Management Strategy.* Available URL: http://www98.griffith.edu.au/dspace/bitstream/10072/9103/1/21471.pdf

Freshwater Fish

The scoring system for freshwater fish is adapted from methodology described in the *Southeast Queensland Regional Water Quality Management Strategy* and Gunn (2006).

Parameter	Description	Percentage	Scoring
Native Species Richness	Percentage of Native Species Expected (PONSE): the number of native fish species present at each site compared to the number of fish species expected at the site if it were healthy.	No native species	0
		1 – 20%	1
		20 – 40%	2
		40 – 60%	3
		60 – 80%	4
		> 80%	5
Exotic Species	The proportion of fish at each site that were exotic/introduced species. The relative abundance of exotic species is a measure of increasing environmental stress and degraded water quality and habitat conditions.	> 45%	0
		25 – 45%	2
		5 – 25%	4
		< 5%	6
Fish Community Composition	Fish assemblage O/E ratio: a comparison of the fish community expected (E) with the species composition of the community observed (O) during sampling gives a score reflecting the health of the fish community.	< 15%	0
		15 – 35%	1
		35 – 55%	2
		55 – 65%	3
		65 – 85%	4
		> 85%	5

(Connell Wagner 2009, p.12)

Aquatic Vegetation (Connell Wagner 2009, p.13)
Aquatic vegetation includes submerged, emergent or floating macrophytes (i.e. plants visible to the naked eye, including macroalgae) and microalgae, including cyanobacteria (blue-green algae).

As all aquatic plants, including algae, contain Chlorophyll-a, this parameter is often used to indicate plant biomass and the potential for algal blooms.

For large aquatic macrophytes, percentage cover, leaf length, biomass and the proportion of dead/dying leaves are often used to assess plant health, but these survey methods are labour intensive and often destructive to the macrophyte beds. Biomass and leaf length are usually species-specific measures and may be applied where detailed knowledge of each species is known. In place of detailed data, however, a general visual assessment can be made of macrophyte health using the table below.

Aquatic Vegetation	Description	Score
'Healthy' macrophytes	Degraded: no native species present, greater than 50% coverage of exotic aquatic species (e.g., water hyacinth, water lettuce, salvinia)	0
	Below expected natural extent: some exotic species present, less than 50% coverage of beneficial submerged or emergent macrophytes (excluding winter die-back).	1
	Expected natural extent: no exotic species present, 50 - 75% coverage of native submerged macrophytes.	3
	Above expected natural extent: no exotic species present, greater than 75% cover of submerged or emergent native macrophyte species (e.g. families Hydrocharitaceae, Characeae, Cyperaceae, Lemnaceae, Potamogetonaceae, etc).	5
Nuisance Algal Blooms (macroalgae, phytoplankton cyanobacteria)	Eutrophic - Excessive nuisance algal growth: thick scum of >80% coverage OR microalgae levels >15,000 cells/mL OR free-floating macroalgal bloom OR toxic cyanobacterial bloom. Waterways are choked, beneficial aquatic plants are smothered and fish kills are likely to occur.	0
	Medium algal growth: light scum of < 80% coverage OR microalgae levels 5,000-15,000 cells/mL OR toxic cyanobacterial species (e.g., Microcystis) < 10,000 cells/mL OR heavy filamentous algal growth on native macrophytes, with the potential to detach and result in free-floating blooms.	1
	Light algal growth: sufficient macroalgae and microalgae present to provide a food source for aquatic fauna. For example, some growth of filamentous algae on macrophytes, rocks and other hard substrate. No nuisance algal blooms or toxic cyanobacterial species present.	3
Chlorophyll-*a*	The median, 20th and 80th percentiles all within the guideline	3
	The 20th OR 80th percentile is within the guideline and the median is outside the guideline	2
	The median is outside the guideline, the 20th percentile is less than the guideline and the 80th percentile is greater than the guideline	1
	The median, 20th and 80th percentile are either all more or all less than the guideline	0
Maximum Score		**11**

* Note: 1 - 2 μg/L is a common limit of detection for Chlorophyll-*a* at many analytical laboratories.

Riparian Vegetation

Riparian vegetation incorporates terrestrial plants growing on, or near, the banks of rivers, streams and other watercourses and water bodies. The scoring system is described in the tables below.

Structural Integrity and Level of Disturbance

Proportion of Riparian Zone Disturbed	Description	Score
100% Modified	Riparian zone is significantly modified and/or cleared. Natural vegetation has been replaced by exotic species, mown or grazed areas, or is bare, paved or built on. Very few natural features remain.	0
Highly Disturbed	A sparse density of original native tree species remain (< 50%), clearing has occurred, with major infestation of weeds (> 50%) in the understorey.	1
Moderate disturbance	A moderate density of remnant native tree species remains (50 – 75%). Landscape may have been cleared, but regrowth of native tree species has occurred, with major infestation of exotic species in the understorey (> 50%).	2
Moderate disturbance	Native vegetation remains but understorey or canopy have been disturbed or invaded by exotic tree species. Weeds or exotic species comprise less than 25% of the total area of the understorey or < 25% of tree stems.	3
Minor Disturbance	Some minor alterations may have occurred to the landscape due to the removal of individual trees, minor encroachment of exotic species or other minor disturbance of the creek edges.	4
Undisturbed	Native vegetation appears undisturbed and intact. Exotic species are minimal.	5

Exotic Species (Weeds) Presence

Description	Weeds (% cover)	Score
Weed species likely to occur in North Queensland (Townsville region) catchments include: para grass, guinea grass, hymenachne, rubber vine, Chinee apple, lantana and African tulips.	> 75%	0
	50 – 75%	2
	25 – 50%	3
	< 25%	5

Note: Presence of weeds is not an indication that water quality may be compromised and in fact the presence of certain weeds may contribute to water quality improvement. Weed presence is generally an indication of previous disturbance to natural systems enabling the establishment of exotic species.

Riparian Vegetation	Description	Percent Cover of Native Riparian Species	Score
Canopy (> 5m high)	Native vegetation (remnant or regrowth), usually 5 – 18m high. Canopy is important for habitat, bank stability and shading to prevent growth of weeds and algae.	< 25%	0
		25 – 50%	1
		> 50%	2
Understorey (1 – 5m high)	Provides shading and important habitat for terrestrial fauna (birds, mammals, etc).	< 25%	0
		25 – 50%	1
		> 50%	2
Ground Cover (< 1m high)	Provides shading, terrestrial habitat and a source of food (berries, etc) for aquatic fauna, such as fish and turtles	< 25%	0
		25 – 50%	1
		> 50%	2
Leaf Litter	Important as a source of decaying organic matter and nutrients for growth of vegetation. Also provides protection from raindrop impact and reduces sediment erosion.	< 25%	0
		25 – 50%	1
		> 50%	2
Maximum Score			**8**

Note: The percentage vegetation cover for each of the structural components needs to be related to the Regional Ecosystems (REs) that naturally occur/would have occurred, in the riparian zone and the scoring system adjusted accordingly to suit the characteristics of the REs. For example the percentage cover for the various structural components of a closed forest community is different to that of a woodland community. It should also be noted that the presence and condition of native vegetation in the riparian zone is not a water quality health indicator but rather a terrestrial biodiversity health indicator i.e. catchment condition. If ground cover is greater than 60% there is considerably less likelihood of erosion than in systems where groundcover is <50%. Whether the groundcover consists of native or exotic is generally not important from a water quality perspective.
(Connell Wagner 2009, pp.14-15)

Channel and floodplain features

The channel and floodplain features component of the scorecard incorporates clearing and modification of creek channel itself, the surrounding floodplain and land uses in the broader catchment. The major land uses in catchments of the Townsville region are likely to be clearing for urban or commercial developments and agriculture (e.g. grazing or cropping, predominantly sugar cane). The proportion of catchment cleared and various land uses can generally be derived from topographic maps, aerial photographs or GIS data (e.g. Geoscience Australia).

Indices	Description	Scoring
Undercutting and slump erosion	Major U & S erosion	0
	Moderate U & S erosion	1
	Minor U & S erosion	2
	No U & S visible	3
Gully erosion	Major gully erosion	0
	Moderate gully erosion	1
	Minor gully erosion	2
	No gully erosion	3
Channel clearing (logs/snags, habitat etc)	All of channel cleared (concrete-lined drains, etc)	0
	Significant channel clearing (>50%)	1
	Some channel clearing (<25 %)	2
	Pristine, no channel clearing has occurred	3
Channel modification (weirs etc)	Weir or dam present at site or nearby	0
	No weirs at site or within 1 km upstream or downstream of site	1
Natural floodplain features	No natural floodplain features present	0
	Natural floodplain features present	1
Floodplain modification	Major clearing and development of floodplain, mostly impervious surfaces (>60%) with few natural features remaining.	0
	Moderate clearing and floodplain development, some impervious surfaces (25-60%) but some natural features and vegetation remain.	1
	Minor clearing, with some light development (housing, lawns etc), with few impervious surfaces (<25%).	2
	No visible evidence of floodplain clearing.	3
Catchment condition (land use etc)	Heavily impacted: heavy industry and/or sewage treatment plant discharging treated or untreated effluent into waterways.	0
	Moderate impacts: medium density industrial or commercial, heavy agricultural (e.g., cropping, fertilisers) land uses, with high probability of significant pollutants entering waterways via stormwater runoff or wet weather overflow, etc.	1
	Minor impacts: light residential, commercial or agricultural (e.g., grazing) land uses, with likelihood of minor pollutants entering waterways via stormwater runoff, etc.	2
	Catchment in near pristine condition with little or no land uses or anthropogenic activities likely to impact on waterways.	3
Maximum Score		**17**

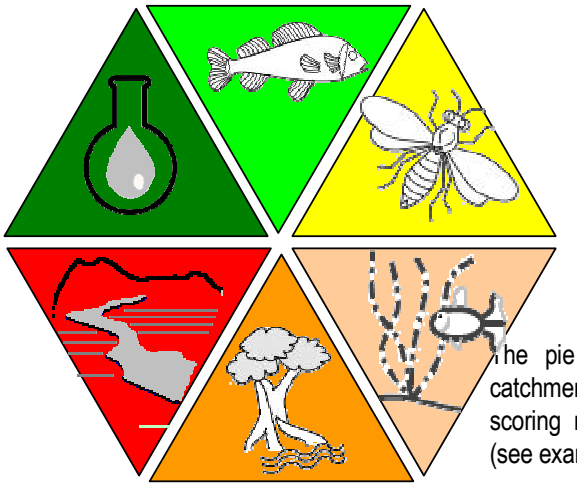
(Connell Wagner 2009, p.16)

Pictorial Representation

The Report Card generates an annual A (excellent) to F (fail) for the 6 categories before quantifying a final grade for individual catchments. To visually represent the individual categories and final catchment scores of the Black/Ross Basins as a whole, it is proposed that this information is graphically represented on layers of the Black and Ross Basins, which have previously been divided into catchments. This graphical representation will allow the end audience to easily identify the catchments within the Black or Ross Basins and their corresponding indicator and catchment scores.

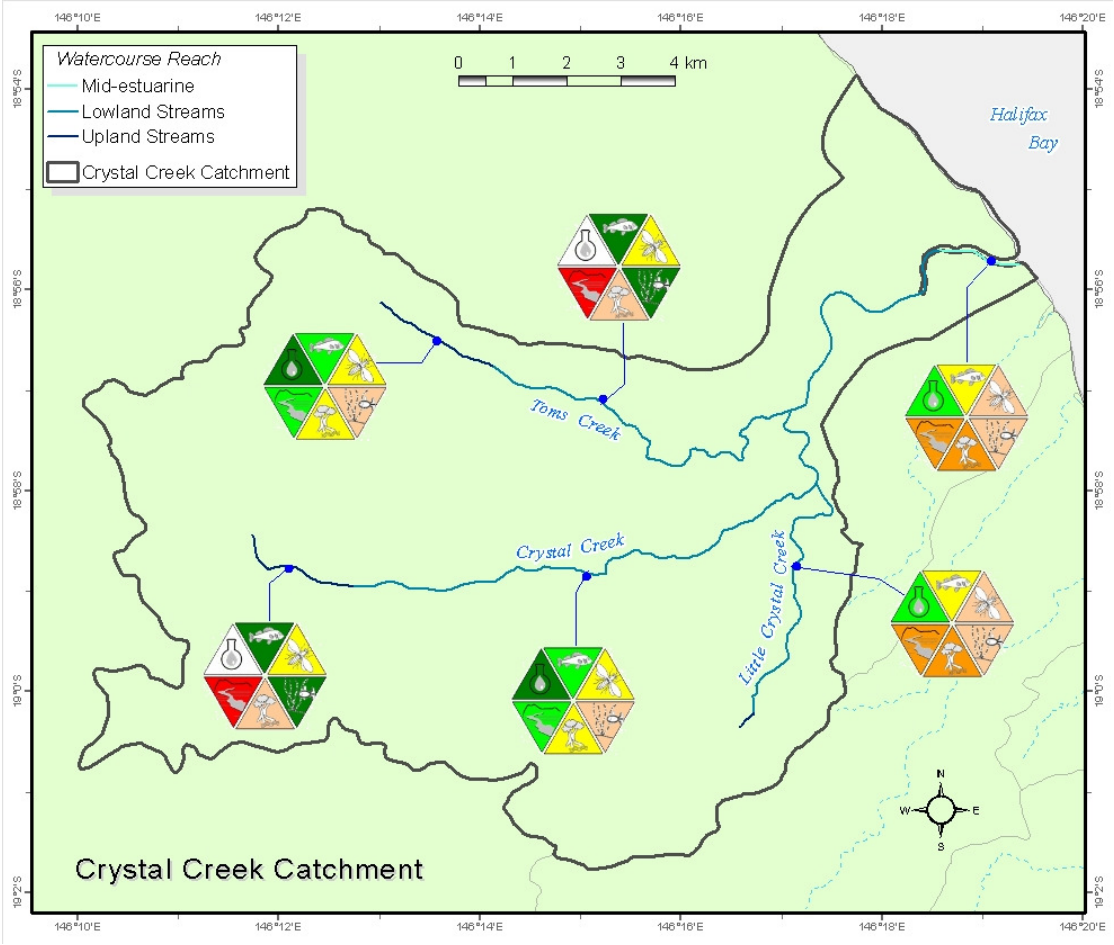
Grade	Description
A	**Excellent.** Conditions meet all set ecosystem health values; all key processes are functional and all critical habitats are in near pristine condition.
B	**Very Good.** Conditions meet all set ecosystem health values in most of the reporting region; most key processes are functional and most critical habitats are intact.
C	**Good.** Most conditions just meet set ecosystem health values. Most key processes are functional, but some critical habitats may be under threat.
D	**Fair.** Conditions meet some of the set ecosystem health values in most of the reporting region; some key processes are functional but some critical habitats are impacted.
E	**Poor.** Conditions are unlikely to meet set ecosystem health values in most of the reporting region; many key processes are not functional and many critical habitats are impacted.
F	**Very Poor.** Conditions do not meet set ecosystem health values; most key processes are not functional and most critical habitats are severely impacted.

For each catchment, a pie divided into 6 equal segments will represent the 6 indicators. Each indicator will be represented by a figure symbolic of each indicator. Following the determination of grades for each indicator, the section of the pie relating to its individual indicator will be shaded with the grades corresponding colour (see diagram below).



The pie diagram can then be displayed as part of a catchment condition overlay with the condition assessment scoring related to the reach, waterway or sub catchment (see example below).

[It should be noted that the scoring system needs to be tested for local relevance and that there are significant gaps in the data available for many of the indicator groupings. Where there is insufficient information to provide a score for any indicator grouping the section of the pie is left white i.e. no score colour is attributed.]



(Connell Wagner 2009, pp.17-18)

Appendix B

USQMP Atlas TCC

Geographic locations

Basin	Sub basin	Waterway	Latitude (South)	Longitude (East)
		Lake Paluma	18° 57'	146° 10'
Black River	Crystal Creek	Crystal Creek (397)	18° 55' (18.928)	146° 18' (146.324)
Black River	Crystal Creek	Lorna Creek	18° 56'	146° 19'
Black River	Crystal Creek	Ollera Creek (398)	19° 00' (18.965)	146° 18' (146.361)
Black River	Crystal Creek	Hencamp Creek	19° 00'	146° 23'
Black River	Crystal Creek	Scrubby Creek	19° 17'	146° 36'
Black River	Crystal Creek	Banana Creek	19° 28'	146° 37'
Black River	Rollingstone Creek	Rollingstone Creek (399)	19° 00' (19.008)	146° 23' (146.402)
Black River	Rollingstone Creek	Surveyors Creek	19° 02'	146° 26'
Black River	Rollingstone Creek	Station Creek	19° 04'	146° 26'
Black River	Rollingstone Creek	Camp Oven Creek	19° 06'	146° 29'
Black River	Rollingstone Creek	Leichhardt Creek (400)	(19.099)	(146.51)
Black River	Bluewater Creek	Christmas Creek	19° 07'	146° 30'
Black River	Bluewater Creek	Sleeper Log Creek (401)	(19.114)	(146.533)
Black River	Bluewater Creek	Two Mile Creek	19° 07'	146° 32'
Black River	Bluewater Creek	Bluewater Creek (402)	19° 08' (19.147)	146° 36' (146.593)
Black River	Bluewater Creek	Althaus Creek (403)	19° 08' (19.152)	146° 36' (146.601)
Black River	Bluewater Creek	Deep Creek	19° 12'	146° 33'
Black River	Bluewater Creek	Healy Creek	19° 09'	146° 36'
Black River	Black River	Black River (404)	19° 10' (19.178)	146° 38' (146.651)
Black River	Black River	Alick Creek	19° 10'	146° 38'
Black River	Black River	Alice River	19° 15'	146° 37'
Black River	Black River	Canal Creek	19° 16'	146° 37'
Black River	Black River	Log Creek	19° 16'	146° 36'
Black River	Black River	Acacia Creek	19° 35'	146° 33'
Black River	Black River	Keelbottom Creek	19° 47'	146° 06'
Ross River	Bohle River	Saunders Creek	19° 14'	146° 41'
Ross River	Bohle River	Bohle River (405)	19° 12'	146° 41'
Ross River	Bohle River	Little Bohle River	19° 19'	146° 41'
Ross River	Bohle River	Shelley Beach	19° 10'	146° 45'
Ross River	Bohle River	Town Common	WHP	
Ross River	Bohle River	Mt Louisa Creek	WHP	
Ross River	Bohle River	Mt St John Blakeys Crossing	WHP	
Ross River	Bohle River	Louisa Creek	19° 15'	146° 45'
Ross River	Ross River (Lower)	Ross River (406)	19° 15'	146° 49'
Ross River	Ross River (Lower)	Ross Creek	19° 15'	146° 49'
Ross River	Ross River (Lower)	Annandale Wetlands	19°25'	146°77'
Ross River	Ross River (Lower)	The Lakes	WHP	
Ross River	Ross River (Lower)	Rowes Bay channel	WHP	
Ross River	Ross River (Lower)	Mundy Creek		
Ross River	Ross River (Upper)	Blacksoil Creek	19° 21'	147° 03'
Ross River	Ross River (Upper)	Antill Plains Creek	19° 27'	146° 51'
Ross River	Ross River (Upper)	Antill Creek	19° 28'	146° 48'
Ross River	Ross River (Upper)	Bullock Creek	19° 30'	146° 38'
Ross River	Ross River (Upper)	Cattle Creek	19° 36'	146° 42'
Ross River	Ross River (Upper)	Central Creek	19° 29'	146° 42'

Ross River	Ross River (Upper)	Fern Creek	19° 30'	146° 37'
Ross River	Ross River (Upper)	Flagstone Creek	19° 32'	146° 47'
Ross River	Ross River (Upper)	Four Mile Creek	19° 31'	146° 48'
Ross River	Ross River (Upper)	Jimmys Lagoon	19° 30'	146° 48'
Ross River	Ross River (Upper)	Lagoon Creek	19° 29'	146° 42'
Ross River	Ross River (Upper)	Landsdowne Creek	19° 31'	146° 48'
Ross River	Ross River (Upper)	Ross Creek	19° 16'	146° 48'
Ross River	Ross River (Upper)	Round Mountain Creek	19° 29'	146° 42'
Ross River	Ross River (Upper)	Sachs Creek	19° 28'	146° 48'
Ross River	Ross River (Upper)	Sandy Creek	19° 29'	146° 42'
Ross River	Ross River (Upper)	Settlement Creek	19° 37'	146° 37'
Ross River	Ross River (Upper)	Six Mile Creek	19° 27'	146° 47'
Ross River	Ross River (Upper)	Toonpan Lagoon	19° 30'	146° 49'
Ross River	Ross River (Upper)	Spring Creek	19° 32'	146° 48'
Ross River	Stuart Creek	Gordon Creek	19° 16'	146° 49'
Ross River	Stuart Creek	Sandfly Creek (407)	19° 17'	146° 51'
Ross River	Stuart Creek	Stoney Creek	WHP	
Ross River	Stuart Creek	Stuart Creek	19° 16'	146° 49'
Haughton R	Alligator Creek	Alligator Creek (408)	19° 18'	146° 55'
Haughton R	Alligator Creek	Slippery Rocks Creek	19° 25'	146° 56'
Haughton R	Alligator Creek	Killymoon Creek	WHP	
Haughton R	Alligator Creek	Whites Creek	19° 22'	146° 57'
Haughton R	Alligator Creek	Cockatoo Creek	19° 27'	146° 56'
Haughton R	Crocodile Creek	Crocodile Creek (409)	19° 17'	146° 56'
Haughton R	Crocodile Creek	Cocoa Creek	19° 16'	146° 59'
Haughton R	Cape Cleveland	Long Beach	19° 13'	147° 01'
Haughton R	Cape Cleveland	Paradise Bay	19° 13'	147° 02'
	Magnetic Island	Gustav Creek	19° 09'	146° 51'
	Magnetic Island	Petersen Creek	19° 08'	146° 52'
	Magnetic Island	Alma Creek	19° 08'	146° 52'
	Magnetic Island	Endeavour Creek	19° 06'	146° 50'
	Magnetic Island	Gorge Creek	19° 07'	146° 50'

Datum GDA94
Notes: From \CCI\Z for research\Catchment units_info\Catchment and Rivers Info.
Lat/Long readings in (brackets) are from OzEstuary results.

(from catchment units information - Anne and Ben)
Crystal Creek
Crystal Ck
Birthday Ck
Ollera Ck
Scrubby Ck
Hencamp Ck
Fig tree Ck
Paluma Dam
Bluegum Ck (part1)
Bluegum Ck (part 2)
Lorna Ck
Unnamed Ck
Smith Ck

Banana Ck (part 1)
Banana Ck (part 2)

Bohle River
Bohle River to Cape Pallarenda Foreshore
Mt Saint John Area
Pee Wee Ck
Townsville Town Common

Ross River
Ross River (below dam) (6 sheets)
Mt Louisa ck (high flow)

Ross Creek
Anderson Park Lakes- Mundingburra
Belgian Gardens drainage
Blakey's crossing
Cape Pallarenda to Kissing Point Foreshore
Goondi Ck- South Townsville\
Gordon Ck-Idalia
Idalia Lagoons
Kissing point to Ross River (The Strand)
Inlet Drains to Lakes
The Lakes
Lavarack Ck-Annandale
Mindham Ck Drain
One Mile Creek (Pallarenda)
Three Mile Creek (Pallarenda)

Stuart Creek
- Freshwater swamps
- Rocky Springs (1) (slippery rocks creek-1)
- Vantassel Ck Lagoon

Magnetic Island
Gustav Ck
Petersen Ck
Alma Ck
Gorge Ck
Endeavour Ck
Western Ck

	Sub basin unit	Catchments	Existing Community Processes
1	**Crystal Creek**	Crystal, Birthday, Ollera, Scrubby & Hencamp Cks	• Crystal Creek Community Association • Mt Fox Community Working Group • Wet Tropics Forest Planning Group
2	**Rollingstone Creek (Northern Coast)**	Rollingstone, Saltwater, Cassowary, Camp Oven, Lillypond, Leichardt Cks	• Rollingstone and District Community Association • Mystic Sands and Balgal Coastal Group • Balgal Beach Boating and Leisure Club

			• Tomulla Progress Association • Toolakea Progress Association
3	**Bluewater Creek**	Sleeper Log, Two Mile & Christmas, Bluewater, Deep, Healy & Althaus Cks	• Bluewater Landcare
4	**Black River**	Black & Alice Rivers, Log, Canal and Alick Cks	• Saunders Beach Action Group • Saunders Beach Community Association
5	**Bohle River**	Little Bohle & Bohle Rivers, Stoney, Saunders, Middle Bohle, Mt Louisa Cks	• RIVER - Ross Island Volunteers for Estuarine Research • Seagrass Watch – Shelly Beach • Seagrass Watch – Bushland Beach
6	**Ross River**	Ross River (below dam), Mt Louisa Creek (high flow)	• Louisa Creek Watch • Town Common CVA • Cleveland Bay Consortium
7	**Ross River Dam**	Ross River (above Dam) & tributaries, Sachs, Antill Plains, Four Miles & Six Miles Cks	• Oak Valley Landcare • JCU Environmental Collective • Cleveland Bay Consortium
8	**Stuart Creek**	Stuart, Stoney & Sandfly Cks	• Stuart Creek Revegetation
9	**Alligator Creek**	Alligator, Slippery Rock, Whites, Killymoon, Crocodile & Cocoa Cks	• Seagrass Watch – Sandfly Creek
10	**Magnetic Island**	Gustav, Petersen, Alma, Gorge, Endeavour & Western Cks	• Magnetic Island Nature Care Association Inc • Gustav Creek Catchment Group • Cleveland Bay Consortium • MI Residents and Ratepayers Assoc. • MI Community Development Assoc.
	Cape Cleveland east	Bowling Green Bay/Cape Cleveland catchments	• Cungulla Progress Association • Cungulla Beach Care Group

Whole of Townsville WQIP area community groups and NGOs (environmental affiliation):

Birds Australia Nth Qld Group	Nth Qld Conservation Council Inc.
Burdekin Dry Tropics NRM	Nth Qld Wildlife Care Inc.
Coastal Dry tropics Landcare Inc. (CDTLI)	Reef Check
Conservation Volunteers Australia	Reef Guardian Schools
Dry Tropics Biodiveristy Group Inc.	Reef HQ
Greening Australia Queensland	Society for Growing Australian Plants, Townsville Branch Inc
Independent Wildlife Carers Association Inc.	Townsville Region Bird Observers Club of Australia
Indo- Pacific Sea Turtle Conservation Group	Water Watch
Marine and Coastal Community Network	Wildlife Preservation Society of Queensland Townsville Branch
NQ Reptile and Frog Club	Wildseeds

TCC USQMP Atlas site descriptions (Atlas/alphabetical order)

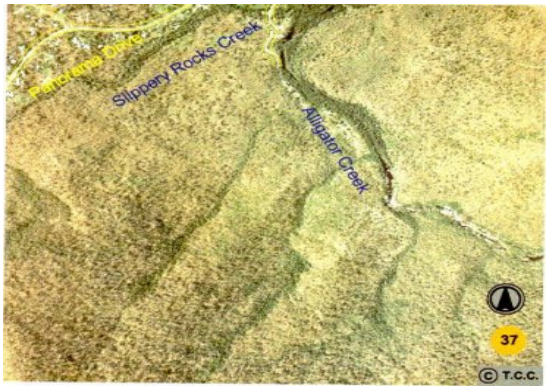
Alligator Creek - above Bruce Highway [37] (Alligator Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat, Transformed and/or Degraded Habitat
- Conservation value: High
- Important wildlife habitat
- Perennial freshwater habitats
- Closest flowing freshwater creek to Townsville
- Best example of rainforest element riparian vegetation and flood plain paperbark

Uses and Issues

- Freshwater fishery.
- A catchment care group is currently being formed in Alligator Creek
- National Park camping grounds
- High-level of use for nature-based recreation (upper catchment)
- Floating aquatic weeds (including Pistia, Salvinia & Hyacinth) require a catchment based integrated management approach
- Exotic grass and fire regime management is required for riparian areas, which are currently disturbed in much of the lowland areas
- Altered hydrology from levees, roads etc



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Alligator Creek - below Bruce Highway [38] (Alligator Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - Major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat, Transformed and/or Degraded Habitat
- Important Wildlife habitat
- Perennial freshwater habitats Closest flowing freshwater creek to Townsville
- Best example of rainforest element riparian vegetation and flood plain paperbark forest on Townsville area lowland
- Conservation value: High

Uses and Issues

- Floating aquatic weeds (including Pistia, Salvinia & Hyacinth) require a catchment based integrated management approach
- Exotic grass and fire regime management is required for riparian areas which are currently disturbed in much of the lowland areas
- Sewage disposal

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Anderson Park Lakes – Mundingburra [1] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined
- Fish habitat
- Waterbird habitat

Uses and Issues

- Recreational use in urban area - aesthetic value
- Stormwater contamination
- Stormwater drainage and retention area

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Antill Plains Creek - Lower Catchment [54] (Ross River [upper] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat, Transformed and/or Degraded Habitat
- Conservation value: Very High
- Semi-perennial inland freshwater lagoons within creek channel
- Habitat connectivity linking Anthill Plains with Mt Elliott National Park

Uses and Issues

- Maintenance of high water quality to supply Ross Reservoir
- Nature based recreation
- Grazing and exotic vegetation impacts especially on riparian zone

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Antill Plains Creek - Upper Catchment [55] (Ross River [upper] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat, Transformed and/or Degraded Habitat
- Conservation value: Medium - High
- Habitat connectivity linking Anthill Plains to Mt Elliott National Park

Uses and Issues

- Catchment and Creek are one of the major sources of potable water to the Ross River Reservoir
- Wilderness Recreation
- Grazing and exotic vegetation impacts on riparian zone
- Fire Management

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

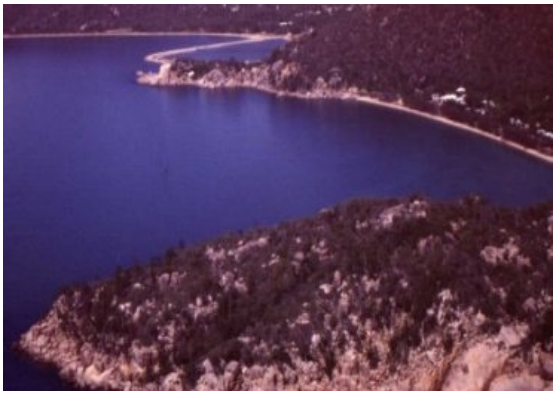
Arcadia [36] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridors - major drainage line
- Heritage Listing and Zoning: Some GBRMP Marine National Park 'B' Natural
- Habitat Quality: Transformed and/or degraded habitat
- Conservation value: Currently unassigned but High in some areas
- Offshore seagrasses and coastal mudflats
- Fringing reefs

Uses and Issues

- Tourism Outdoor recreation
- Popular area for reef walking and snorkelling in Geoffrey Bay
- Impacts on reefs by anchor damage and trampling
- Potential for heavy metal and/or oil spill pollution from vessel operations
- Urbanisation



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Belgian Gardens Drainage [2] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Currently undefined
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined

Uses and Issues

- Urban stormwater drainage
- Litter
- Flood mitigation purposes

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Blakey's Crossing [3] (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Part of National Estate registered as Townsville Town Common and Environs by AHC
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Medium
- Contiguous habitat corridor with Town Common
- Scenic amenity
- Waterfowl habitat and associated flora and fauna
- Fish habitat including juvenile barramundi
- Once a rich wetland site, but now degraded in places

Uses and Issues

- Retention Basin
- Exotic vegetation
- Litter and pollution
- Fire Management
- May require upstream retention basins to improve water quality
- Appropriate control of weeds required
- Potential for grazing

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Bohle River to Cape Pallarenda Foreshore [40] (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Contiguous Habitat Corridor
- Heritage Listing and Zoning: GBRMP National Park "A" area near Pallarenda
- Natural Habitat Quality: Natural Habitat and some Disturbed Habitat
- Conservation value: Currently undefined
- Natural Habitat buffer adjoining high value fishery wetlands area
- Contains endangered and vulnerable regional ecosystems
- Last remaining example of Mt Low beach vine thicket
- Connectivity between habitat types including regional connectivity and proximity to Bohle Plains leasehold areas to the south
- Fish, waterbird and estuarine crocodile habitat

Uses and Issues

- Supports commercial and recreational fisheries
- Freehold tenure of beach vine thicket remnant requires agency extension and conservation agreement to ensure retention of representative habitat area
- Fishing pressure

1. RIKES (1990) p10, 35-36. 2. Wetlands of Townsville (1996) Report 96/28 p6-7. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p62 Appendix 2, Figure 1,2 & 5, p11 Section 2. 4. GBRMPA Zoning Information

Bohle River – north of Bruce Highway [4] (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Contiguous Habitat Corridor
- Heritage Listing and Zoning: part of National Estate registered as Townsville Common and Environs by AHC
- Declared Fish Habitat Area - Management 'B' under Queensland Fisheries Act
- Natural Habitat Quality: Disturbed Habitat
- Conservation value: Currently undefined
- Wetland complex composed of mangrove estuaries, saltpans, brackish sedgelands and freshwater swamps
- Fish habitat & waterbird habitat
- Estuarine crocodile habitat
- Representation of old plains land system Habitat connectivity south to Hervey's Range

Uses and Issues

- Drainage development and land reclamation
- Loam extraction from riparian zone
- Previous sand extraction
- Commercial and recreational fishing
- Stream bank erosion
- Exotic vegetation

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Bohle River – south of Bruce Highway [5] (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Contiguous Habitat Corridors
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat
- Conservation value: Low, some areas High
- Public open space and nature based recreation
- Upper catchment has high value wetland or riparian zone

Uses and Issues

- Licensed discharge of sewage effluent
- Urban stormwater drains lack retention basins
- Erosion from catchment activities
- Sand extraction from riparian zone
- Floating aquatic weeds
- Fire Management
- Littering
- Riparian vegetation removal
- Urban and industrial development in catchment

Campus Creek – James Cook University [41] (Ross River [lower]sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Low - Medium

Uses and Issues

- Urban open space
- Nature based recreation
- Site of Townsville City Council habitat rehabilitation by the community

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

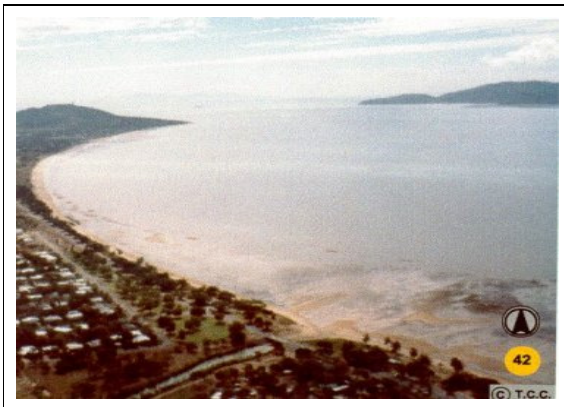
Cape Pallarenda to Kissing Point Foreshore [42] (Pallarenda sub basin)

Site Description

- Heritage Listing and Zoning: Contains GBRMP National Park 'A' area
- Natural Habitat Quality: Currently undefined
- Conservation value: Currently undefined
- Remarkable diversity of marine and terrestrial habitats
- Significant archaeological record
- Extensive intertidal area for wading birds
- Seagrass beds (dugong, fish habitat)
- Remnant native vegetation at Quarantine Station
- Overwintering site for the Danaid butterfly

Uses and Issues

- Extensive recreational use - eg. BBQ's, dog walking
- Recreational fishing
- Environmental buffer against storm surge
- Nursery for marine fish
- Maintain beachfront integrity as buffer for cyclone disturbances
- Up-drift coastal developments impeding sediment supply
- Impacts from recreational use eg. yachts, foot access
- Erosion adjacent to Jezzine Barracks by road activity



1. RIKES (1990) p13, 35-36.Appendic C4. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP. Figures 1,2 and 5 4. GBRMPA Zoning Information

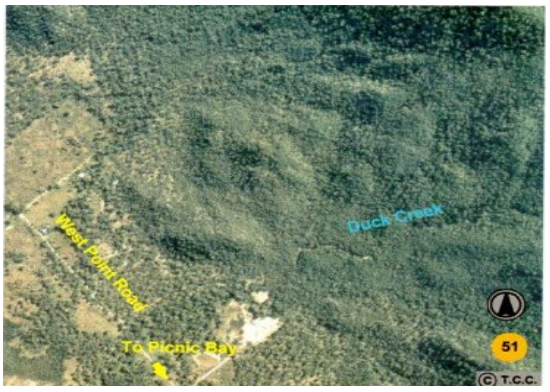
Duck Creek – Magnetic Island [51] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat
- Conservation value: High

Uses and Issues

- Potential future urban development area



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Endeavour/Gorge Creek – Horseshoe Bay [31] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Contiguous Habitat Corridors
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat
- Conservation value: Currently undefined

Uses and Issues

- None listed

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Freshwater Swamps – Cape Cleveland [9] (Alligator Creek sub basin) or Haughton

Site Description

- Wildlife habitat corridor
- Heritage Listing and Zoning: Ross River to Alligator Creek Coastal area is under assessment for inclusion to the National Estate register
- Natural Habitat Quality: Natural Habitat
- Conservation value: High Large flying fox, ibis and egret colonies
- Habitat for migratory waterbirds subject to international treaties
- Vulnerable plant and bird species
- Semi-permanent water with vegetation relatively intact
- Regionally largest example of woodland developed an old beach ridge soils
- Part of Townsville - Burdekin wetland aggregation listed in directory of important wetlands in Australia
- Barramundi nursery swamps

Uses and Issues

- Undamaged fire regime
- High density grazing and irrigation
- Exotic vines
- Supports recreational and commercial fisheries
- Urban and industrial expansion

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p8-9, 37. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p251-52 Appendix 52, Section 2

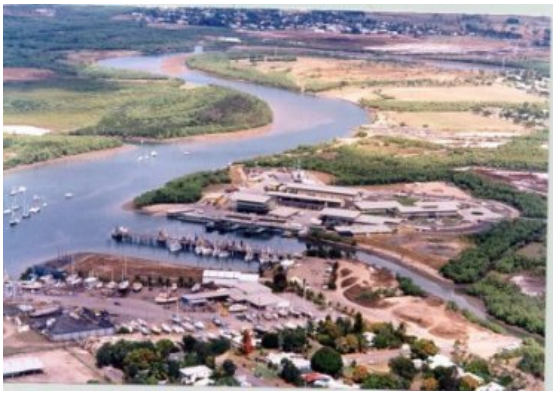
Goondi Creek – South Townsville [10] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Currently undefined
- Conservation value: Currently undefined
- Mangroves - fish habitat
- Waterbird habitat

Uses and Issues

- Recreational use
- Scenic feature adjacent to urban zone
- 10th Field Supply Battalion development by Australian Defence Force



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

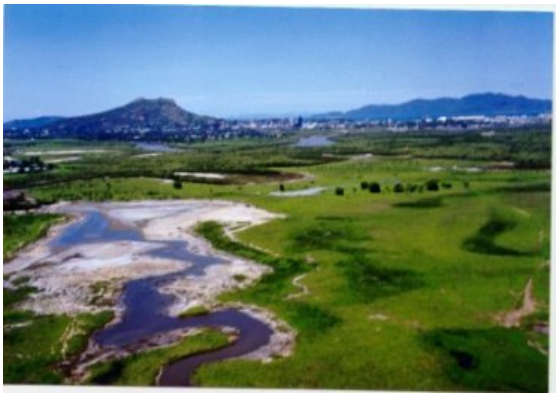
Gordon Creek – Idalia/South Townsville [11] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridors - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed habitat
- Conservation value: High

Uses and Issues

- Adjacent to development site
- Refinery industry - copper, zinc



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Gustav Creek – Nelly Bay [32] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined
- Typical of a creek that produces habitat diversity

Uses and Issues

- Important conduit during storm flow
- Subject to septic tank releases
- Urbanisation
- Weeds
- Stormwater

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Horseshoe Bay Foreshore [33] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridors - major drainage lines
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Some natural habitat, some transformed and/or degraded habitat
- Conservation value: Currently unassigned
- Buffer to National Park
- Representation of vegetation types not protected within Magnetic Island Park
- Scenic amenity

Uses and Issues

- Tourism
- Outdoor and water-based recreation
- Boat mooring
- Urban development
- Area is part of long standing National Park proposal

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-1

Horseshoe Bay Swamp [34] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Currently undefined
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Natural Habitat, Disturbed Habitat
- Conservation value: High
- Waterfowl and waterbird habitat including rare species
- High densities of swamp hen
- Fish habitat including barramundi nursery
- Largest freshwater habitat on Magnetic Island

Uses and Issues

- Nature based recreation and eco-tourism
- Sewerage effluent (upstream catchment adjoining sewage treatment plant)
- Urban encroachment
- Exotic grass invasion
- Fire regime management
- Paperbark die-back
- Hydrological changes

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

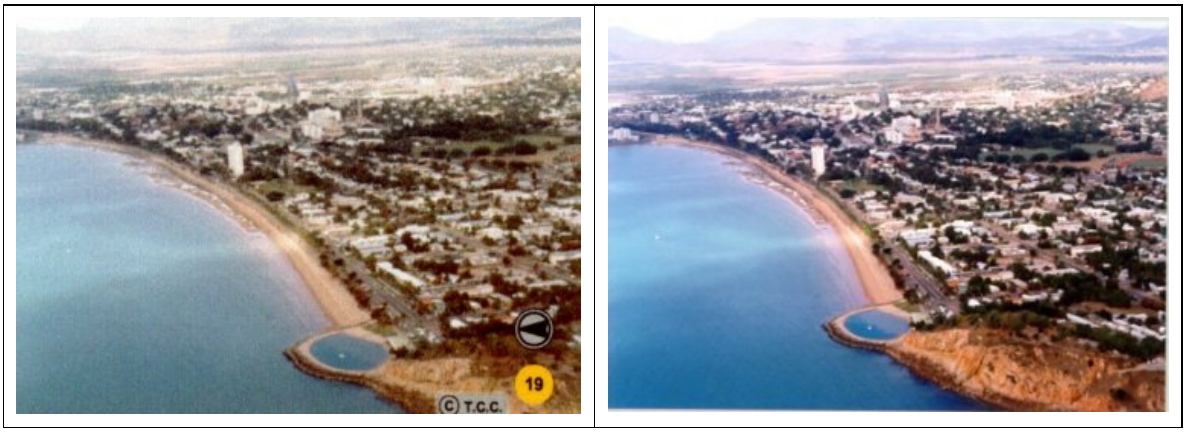
Kissing Point to Ross River – The Strand [19] (Ross River [lower] sub basin)

Site Description

- Heritage Listing and Zoning: World Heritage below tide
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined
- Dugong protection area
- Seagrass - Small to medium sized beds
- Low diversity, high cover reef offshore (Middle Reef)
- Feeding grounds for dugongs and marine turtles

Uses and Issues

- Very high recreational aesthetic value
- Adjoining tourist and residential development
- Subject to cyclone damage
- Site of future development



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Idalia Lagoons [12] (Stuart Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Medium - High
- Permanent freshwater habitat
- Habitat connectivity with Ross River estuary
- Fish habitat including suitability as barramundi nursery swamp
- Waterfowl and waterbird habitat
- Valuable ephemeral habitat in an urban area

Uses and Issues

- Area proposed for major urban development
- Buffers to be retained between residential "Fairfield" and adjacent wetland and riparian areas
- Hydrological connectivity with lower estuary (via channel adjacent Bowen Rd and Bruce Highway) needs to be maintained to retain fish habitat
- Exotic pasture grasses dominate riparian zone
- Cattle grazing and clearing has degraded riparian vegetation
- Pollution

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Inlet Drains to Lakes [23] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Currently undefined
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined
- Potential fish habitat
- Potential waterbird habitat

Uses and Issues

- Urban Stormwater drain
- Important in Townsville's flood mitigation scheme
- Litter issues
- Fish nursery / connectivity for migration

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

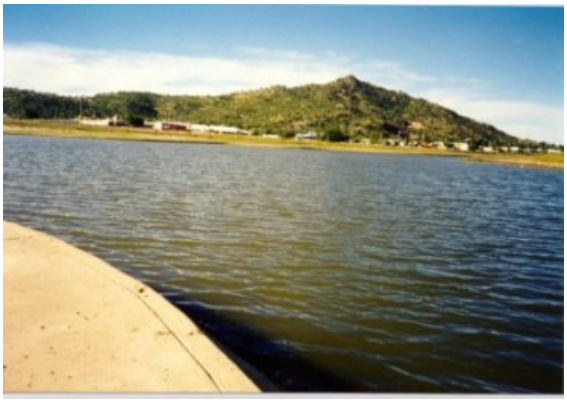
Lakes Development Stage I [21] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Currently undefined
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined

Uses and Issues

- Important in flood mitigation
- Potential to be important for recreation
- Active management requirements
- Potential to be an important wildlife habitat (permanent water)
- Weeds
- Water quality (in general) and blue-green algae issues
- Recreational fishing



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Lakes Development Stage II [22] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Currently undefined
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined

Uses and Issues

- Important in flood mitigation
- Potential to be important for recreation
- Potential to be an important wildlife habitat (permanent water)
- Flat Grade
- Weeds
- Water quality (in general) and bluegreen algae issues

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Lavarack Creek - Annandale [43] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined

Uses and Issues

- Increasing urbanisation

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Louisa Creek - Bohle [14] (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation Value: Low - Medium
- Fish and waterfowl habitat and associated flora and fauna
- Diverse indigenous aquatic fauna
- Locally rare vegetation eg. Dog's balls (Grewia sp.)
- Good stands of lowland woods including stands of blue gum (Eucalyptus tereticornis)

Uses and Issues

- Urban open space
- Site of Townsville City Council supported community riparian rehabilitation projects
- Exotic vegetation invasion
- Urban and industrial development in catchment
- Site is contiguous with Blakey's Crossing and the Town Common
- Upper catchment for conservation park

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Magnetic Island – Beaches and Rocky Foreshores [52] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Contiguous Habitat Corridors
- Heritage Listing and Zoning: GBRMP Marine National Park 'B' and General use 'B'
- Natural Habitat Quality: Currently undefined
- Conservation value: Very High
- Baitfish nursery - food for marlin
- Extensive coral growth
- Conservation area in Horseshoe Bay conserving a weeping tea-tree (Melaleuca leucadendra) wetland
- Seagrass beds. Large beds of low to high density adjoins mangrove and reef habitats
- Feeding ground for dugongs and marine turtles

Uses and Issues

- General recreation
- Tourism
- Aquaculture (Oyster Farm)
- Subject to cyclone damage
- Weed invasion
- Grazing
- Fire

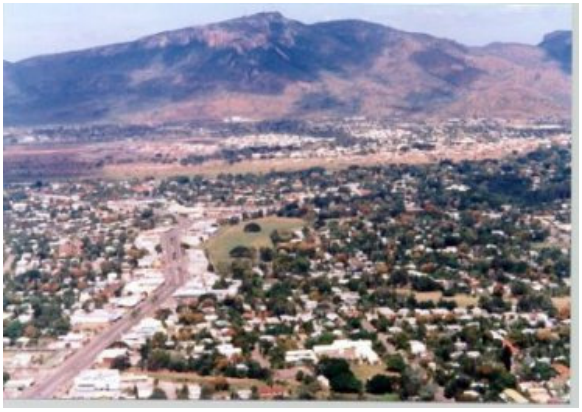
Mindham Creek Drain – Mindham Park [41] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined

Uses and Issues

- Major drainage system
- Flat grade
- Designed to detain stormwater in heavy rain
- Urbanisation
- Weeds



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Mt St John Area – Bohle River [15] (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High
- Key area for maintenance of Town Common Environmental Park waterfowl and waterbird populations

Uses and Issues

- Ecotourism/education
- Nutrient retention basin
- Grazing
- Weeds
- Artificial wetland for sewage treatment
- Sewage treatment plant

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

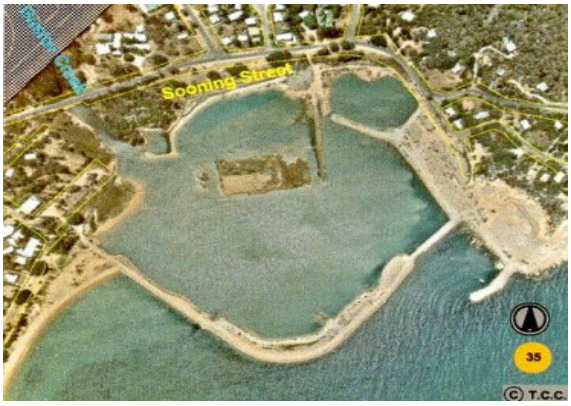
Nelly Bay Foreshore [35] (Magnetic Island)

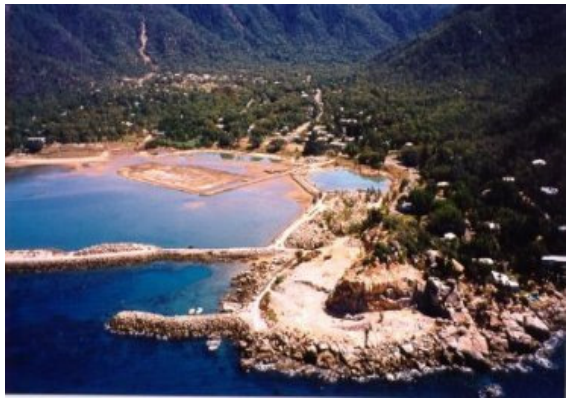
Site Description

- Wildlife habitat corridor: Riparian Corridors - major drainage line
- Heritage Listing and Zoning: currently unassigned
- Natural Habitat Quality: Transformed and/or degraded habitat
- Conservation value: Currently unassigned
- Offshore seagrasses and coastal mudflats
- Fringing reefs

Uses and Issues

- Tourism
- Outdoor recreation
- Sewage treatment plant location
- Buffer to National Park
- Impacts on reefs by anchor damage, trampling and marina development
- Adjacent to shipping channel
- Urbanisation





1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

One Mile Creek [6] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined

Uses and Issues

- Exotic vegetation invasion
- Abutting low lying residential development
- Eutrophication
- Fire
- Litter
- Periodic closure of mouth

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Pee Wee Creek [16] (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Contiguous Habitat Corridors
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined
- Corridor from Mt Louisa to Town Common Environmental Park

Uses and Issues

- Major drainage input into Town Common Environmental Park
- Buffers noise from growing industrial area
- Important tributary to Bohle River
- Upstream urban catchment (adjoining industrial catchment)
- Weeds

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

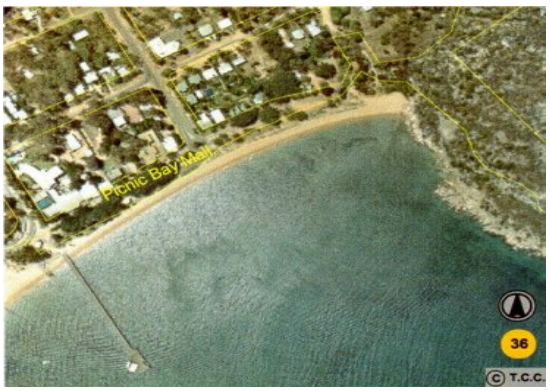
Picnic Bay Foreshore [36] (Magnetic Island sub basin)

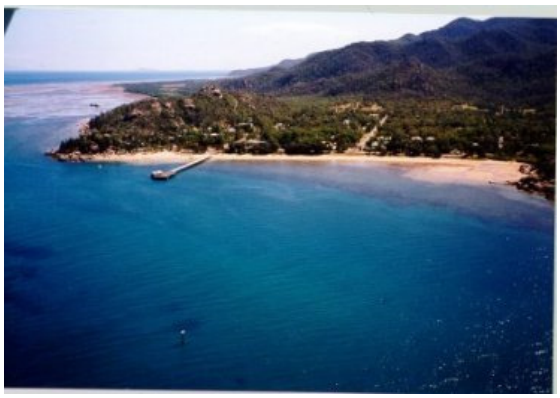
Site Description

- Wildlife habitat corridor: Riparian Corridors - major drainage line
- Heritage Listing and Zoning: National Park in area
- Natural Habitat Quality: Transformed and/or degraded habitat
- Conservation value: Currently unassigned
- Seagrass beds offshore (dugong and marine turtle feeding, fish habitat)
- Reefs offshore

Uses and Issues

- Tourism
- Outdoor recreation e.g. swimming and snorkelling
- Ferry terminal
- Urban development





1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Rocky Springs [45] (Stuart Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridors - major drainage lines
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Some disturbed habitat, some transformed and/or degraded habitat
- Conservation value: Low

Uses and Issues

- Site of potential future urban development

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

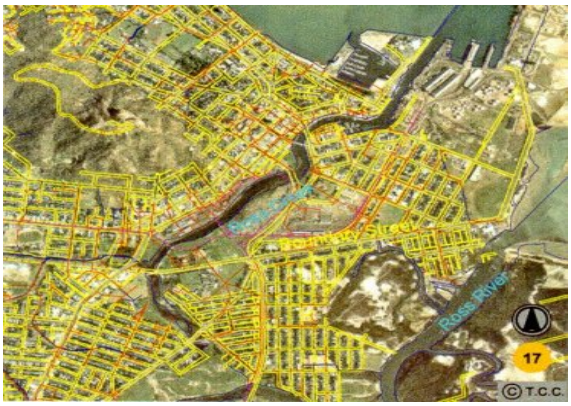
Ross Creek [17] (Ross River [lower] sub basin)

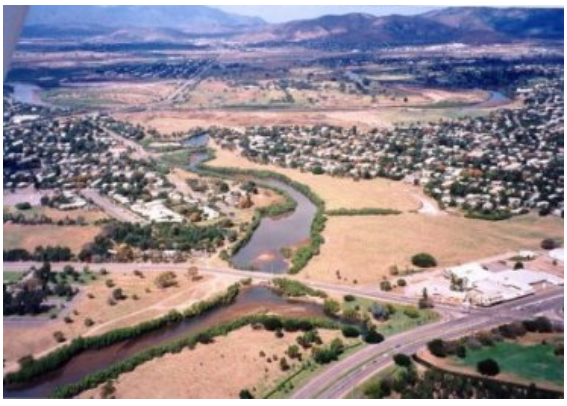
Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High
- Wetland complex composed of commercial port, rock breakwaters, mangrove estuaries, saltpans and marine grasslands
- Fish habitat supporting important recreational fishery
- Estuarine crocodile habitat

Uses and Issues

- Public open space with high level of recreational use
- Recreational fishing and boating
- Commercial port
- Boat mooring
- Heavy industry in catchment
- Fuel spills
- Stormwater management - High Priority
- TPA are managing various aspects
- Urban catchment Numerous inflow points
- Flat grade
- Weeds





1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Ross River – Aplin's Weir to Rooney's Bridge [28] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High Wildlife habitat
- Waterfowl habitat including rare species

Uses and Issues

- Nature-based recreation
- Recreational fishing
- Horse-swimming (below Aplin's Weir)
- Urban runoff
- Urbanisation
- Riverbank stabilisation
- Noxious weed control

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Ross River – Black's Weir to Gleeson's Weir [26] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High
- Waterfowl habitat - including rare species

Uses and Issues

- Urban catchment
- Stormwater management required to maintain or improve water quality
- Riparian vegetation heavily infested with exotic grass
- Floating aquatic weeds
- Maintenance of riparian zone buffer required
- Previously cleared riparian areas now landscaped parkland
- Encroaching urban areas require native revegetation to maintain habitat integrity

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

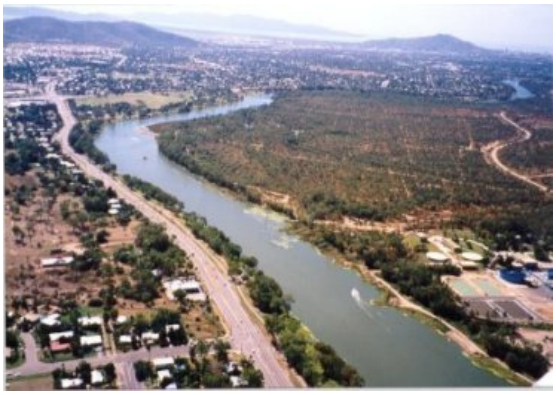
Ross River – Gleeson's Weir to Aplin's Weir [27] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridors - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or degraded habitat
- Conservation value: High
- Feral freshwater crocodile population
- Waterbird habitat
- Fish habitat

Uses and Issues

- Local residents have developed managed areas of the riparian zone
- Urbanisation of southern bank
- Riparian vegetation heavily infested with exotic grass
- Urban catchment
- Stormwater
- Floating aquatic weeds



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

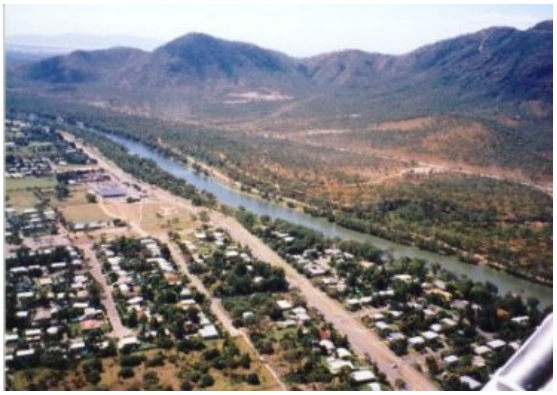
Ross River – Reservoir to Black's Weir [25] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High
- Waterfowl habitat (including rare species)

Uses and Issues

- Nature and water based recreation (e.g. water skiing)
- Commercial eel fishery
- Recreational Barramundi fishery
- Riparian vegetation heavily infested with exotic grass
- Floating aquatic weeds require integrated approach for control
- Potential conflict exists between use for water skiing and sand extraction
- Urban catchment stormwater management required to maintain water quality
- Fishing pressure



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Ross River – Rooney's Bridge to Mouth [29] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - Major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High
- Wildlife Habitat
- Largest Sacred Ibis colony in northern Queensland
- Flying fox habitat

Uses and Issues

- Boat Mooring
- Recreational fishing
- Aquaculture
- Urban and industrial encroachment, stormwater inputs and other contaminants

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

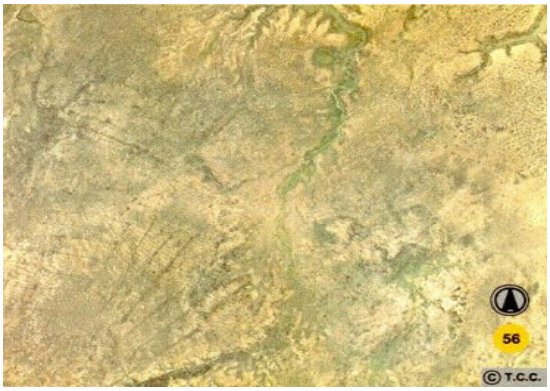
Ross River - catchment above Dam [56] (Ross River [upper] sub basin

Site Description

- Wildlife habitat corridor: Riparian corridor
- Heritage Listing and zoning: Currently unassigned
- Conservation value: High

Uses and Issues

- Grazing
- Bank erosion
- Clearing within the catchment
- Water quality for portable supply
- Sand and gravel extraction



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Ross River Reservoir [57] (Ross River [upper] sub basin)

Site Description

- Wildlife habitat corridor: Currently undefined
- Heritage Listing and Zoning: Artificial wetland of national significance listed in ANCA (1996)
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High
- Supports major populations of waterfowl and waterbirds and acts as a drought refuge
- The principal habitat of the rare cotton pygmy goose
- Fish habitat
- Riparian vegetation

Uses and Issues

- Potable water supply
- Potential for public open space and outdoor recreation
- Commercial eel fishery
- Development of recreation potential
- Control of aquatic weeds
- Cattle grazing
- Extraction of gravel

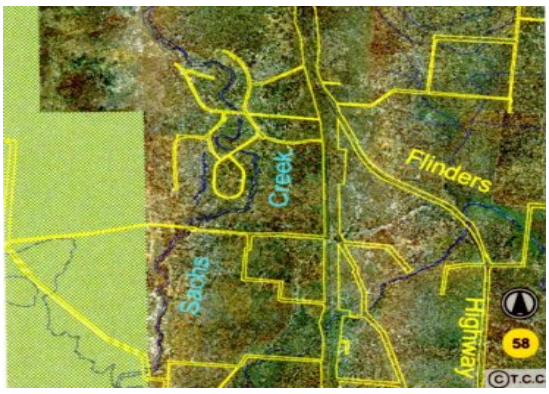
Sach's Creek – Oak Valley [58] (Ross River [upper] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High
- Permanent lagoons
- Fish and other wildlife habitat

Uses and Issues

- Upper catchment for Ross River Dam
- Agricultural runoff
- Public open space and nature based recreation within an expanding rural residential area



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

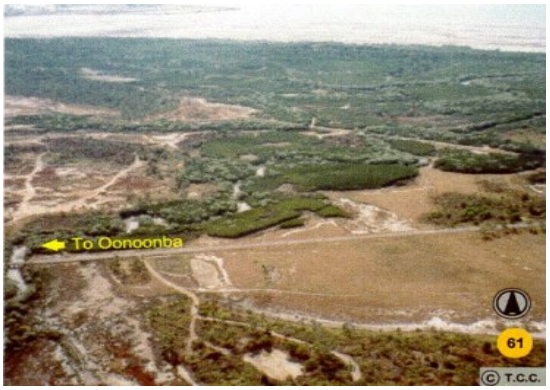
Sandfly Creek [61] (Stuart Creek sub basin)

Site Description

- Wildlife habitat corridor: Currently unassigned
- Heritage Listing and Zoning
- Natural Habitat Quality: Some natural habitat
- Conservation value: High

Uses and Issues

- Sewage disposal
- Productive coastal area
- Industrial activities
- Landfill
- Recreational fishing



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

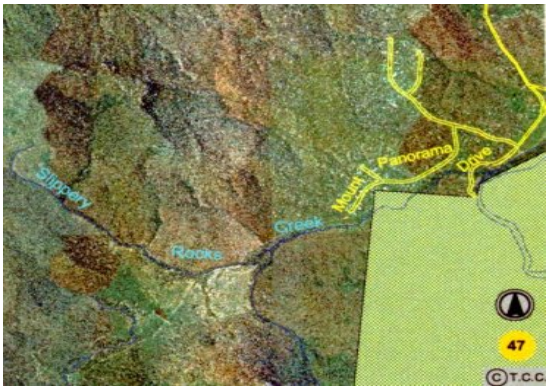
Slippery Rocks Creek – Rocky Springs [47] (Stuart Creek sub basin)

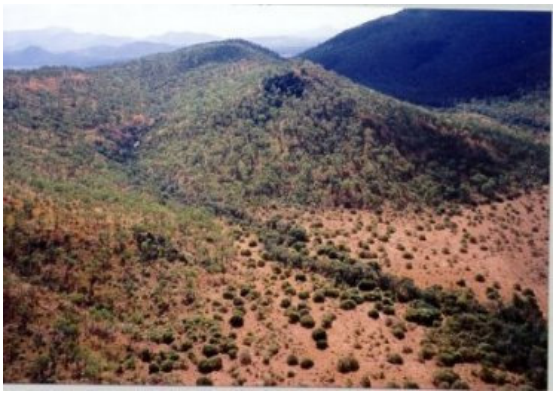
Site Description

- Wildlife habitat corridor: Riparian Corridor - Contiguous Habitat Corridors
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat, Transformed and/or Degraded Habitat
- Conservation value: High
- Diverse riparian vegetation
- Wildlife habitat
- Habitat linkage between Mt Elliott National Park and the Three Sisters Mountains

Uses and Issues

- Nature-based recreation
- Weed invasion
- Excessive fire regime
- Grazing
- Urban Development





1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Stoney Creek – Roseneath [48] (Stuart Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat, Transformed and/or Degraded Habitat
- Conservation value: Medium - High

Uses and Issues

- Weed infestation
- Quarry
- Ephemeral stream
- Stability of channel and banks

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

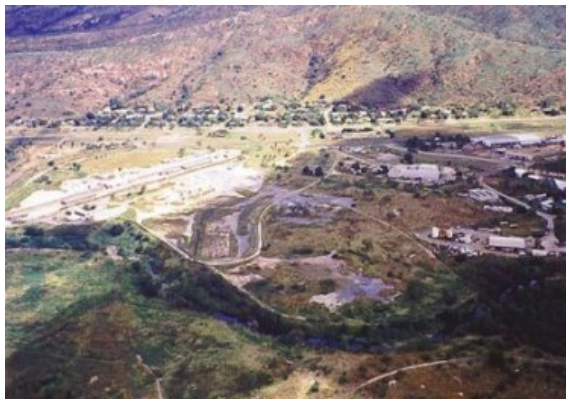
Stuart Creek - Stuart [18] (Stuart Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - major drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat, Transformed and/or Degraded Habitat
- Conservation value: Low but Medium to High for lower catchment
- Diverse riparian vegetation
- Permanent freshwater lagoons
- Fish habitat (including barramundi)
- Best example of riparian gallery forest in Townsville area
- Major drainage area into South Bank
- Aesthetic value high

Uses and Issues

- Public open space/nature based recreation/education
- Exotic vegetation invasion including introduced pasture grasses
- Loss of riparian vegetation
- Riparian vegetation rehabilitation
- Mixture of urban light industrial open space development
- Water quality issues
- Industrial activity in catchment
- Urban and domestic activity



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Three Mile Creek - Pallarenda [49] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Disturbed Habitat
- Conservation value: Currently undefined
- Fish and waterbird habitat

Uses and Issues

- Popular recreational fishing area
- Fish nursery
- Connectivity with Town Common

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

Townsville Town Common (Bohle River sub basin)

Site Description

- Wildlife habitat corridor: Contigous habitat corridors
- Heritage Listing and Zoning: Part of National Estate registered as Townsville Town Common and Environs by AHC
- Natural Habitat Quality: Natural Habitat
- Conservation value: Conservation reserve
- Conservation Park
- Important bird feeding and breeding habitat (subject to Japan Australia and China Australia Migratory Bird Agreements)
- Fish nursery (including Barramundi)
- Diversity of habitat type

Uses and Issues

- Nature-based recreation
- Eco-tourism
- Requires control of exotic weed (rubber vine, noogoora burr, chiney apple, guinea grass, lantana, stinking passionfruit, snake weed, para grass, martinia)
- Introduced fish (Tilapia, Gambusia)
- Industrial catchment, requires water quality control
- Recreational vehicle disturbance
- Feral animals
- Fire

1. RIKES (1990) p35-36, 39 Appendix A11. 2. Wetlands of Townsville (1996) Report 96/28 p21 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p46 Appendix 2, Figure 1,2 & 5.

Vantassel Creek - Pallarenda [20] (Stuart Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: High

Uses and Issues

- Downstream industrial development
- Ephemeral wetland

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

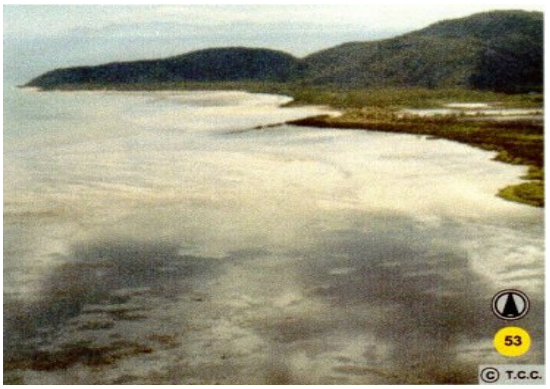
West Point to Cockle Bay Foreshore [53] (Magnetic Island sub basin)

Site Description

- Wildlife habitat corridor: Contiguous Habitat Corridors
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Natural Habitat, Transformed and/or Degraded Habitat
- Conservation value: Very High
- Important seagrass beds (dugong, fish habitats)
- Complex mangrove, fringing reefs, sand dunes and salt pans
- Contains aboriginal sites
- Productive fish habitat

Uses and Issues

- Education: Aboriginal sites
- Supports significant bait fishery and fish nursery
- Potential for development of infrastructure associated with ferry reserve within Cockle Bay
- Adequate buffers and waste water controls need to apply to any further rural residential development
- Grazing
- Weeds



1. RIKES (1990) p35-36, 39 Appendix C2. 2. Wetlands of Townsville (1996) Report 96/28 p8 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p63 Appendix 2, Figure 1,2 & 5. 4. ANCA (1996)

Whites Creek Catchment - Nome [50] (Alligator Creek sub basin)

Site Description

- Wildlife habitat corridor: Riparian Corridor - minor drainage line
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Low - Medium

Uses and Issues

- Public open space and nature based recreation within an expanding rural/residential and urban area
- Invasion of exotic vegetation, eg. chinee apple
- Rural residential encroachment into riparian zone

1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2

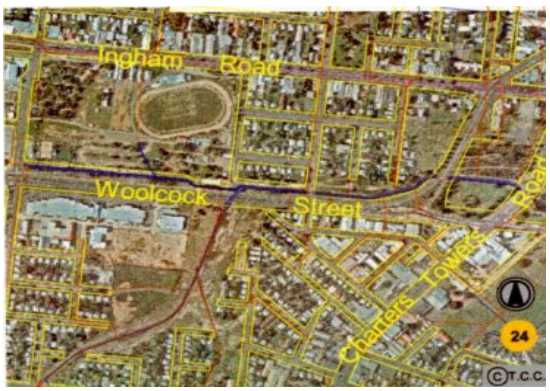
Woolcock Street Channel [24] (Ross River [lower] sub basin)

Site Description

- Wildlife habitat corridor: Currently undefined
- Heritage Listing and Zoning: Currently unassigned
- Natural Habitat Quality: Transformed and/or Degraded Habitat
- Conservation value: Currently undefined

Uses and Issues

- Urban stormwater drainage
- Secures Lakes base flows & flushing
- Balance flow for Lakes
- Urban catchment
- Weed invasion
- Water quality issues



1. RIKES (1990) p35,36. 2. Wetlands of Townsville (1996) Report 96/28 p9-10, 39. 3. Townsville - Thuringowa Strategy Plan (1996) - NCDP p14 Appendix 2.

Appendix C

OzEstuary

OzEstuaries Profiles

OzEstuary ID 397 Crystal Creek
OzEstuary ID 398 Ollera Creek
OzEstuary ID 399 Rollingstone Creek
OzEstuary ID 400 Leichhardt Creek
OzEstuary ID 401 Sleeper Log Creek
OzEstuary ID 402 Bluewater Creek
OzEstuary ID 403 Althaus Creek
OzEstuary ID 404 Black River
OzEstuary ID 405 Bohle River
OzEstuary ID 406 Ross River
OzEstuary ID 407 Sandfly Creek
OzEstuary ID 408 Alligator Creek
OzEstuary ID 409 Crocodile Creek

OzEstuary ID 397 Crystal Creek

Condition assessment
This estuary is in largely unmodified condition.
This initial classification was based on the changes to land use: agriculture.

Process based classification
The way Crystal Creek functions is primarily a result of river energy. It is a wave-dominated delta. This means that the estuary would have low sediment trapping efficiency; naturally low turbidity, salt wedge/ partially mixed circulation and there is a low risk of habitat loss due to sedimentation.

Habitat Condition Index
Crystal Creek was mapped in 2000 and the following facies areas were calculated:
Flood and ebb tidal delta 0.1 sq.km; Mangroves 0.1 sq.km; Saltmarsh/Saltflats 0.1 sq.km.
Total facies area 0.3 sq.km.
The following habitat deviations from expected were identified -1; no fluvial-bayhead delta (Ref 2).
Mangrove coverage 0.378 sq km
Saltmarsh coverage 0.174 sq km

Pressure Component (Overall)
Utilisation Index
1995 BRS data: Crop/pasture & Plantations comprise 36.9579% of the catchment. Native woody vegetation comprises 59.8583% of the catchment (Ref 3).

Commercial fishing
A maximum of 5 boats fished Crystal Creek + Ollera Creek in 1999, for a total catch of 9.04 tonnes. Commercial fishing effort (days fished) by method comprised line (6), net (68), pot (18), trawl (9), not stated (44) (Ref 1).

1. QLD state data, 2. AGSO, 3. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 398 Ollera Creek

Condition assessment

This estuary is in largely unmodified condition.

This initial classification was based on the changes to land use: agriculture.

Could be upgraded to near pristine. Has some agriculture and clearing in the catchment and a road. Unmodified coastal plain.

Process based classification

The way Crystal Creek functions is primarily a result of river energy. It is a wave-dominated delta. This means that the estuary would have low sediment trapping efficiency; naturally low turbidity, salt wedge/ partially mixed circulation and there is a low risk of habitat loss due to sedimentation.

Habitat Condition Index

Ollera Creek was mapped in 2000 and the following facies areas were calculated: Intertidal flats 0.1 sq.km; Mangroves 0.4 sq.km; Saltmarsh/Saltflats 0.1 sq.km; Total facies area 0.6 sq.km. The following habitat deviations from expected were identified -2; no fluvial-bayhead delta/no intertidal flats (Ref 2).

Mangrove coverage 0.564 sq km

Saltmarsh coverage 0.182 sq km

Pressure Component (Overall)

Utilisation Index

1995 BRS data: Crop/pasture & Plantations comprise 36.9579% of the catchment. Native woody vegetation comprises 59.8583% of the catchment (Ref 4).

Commercial fishing

A maximum of 5 boats fished Crystal Creek + Ollera Creek in 1999, for a total catch of 9.04 tonnes. Commercial fishing effort (days fished) by method comprised line (6), net (68), pot (18), trawl (9), not stated (44) (Ref 1).

1. QLD state data, 2. AGSO, 3. Expert opinion through state workshop, 4. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 399 Rollingstone Creek

Condition assessment

This estuary is in largely unmodified condition.
This initial classification was based on the changes to land use: aquaculture

Habitat Condition Index

Rollingstone Creek was mapped in 2000 and the following facies areas were calculated: Intertidal flats 0.1 sq.km; Mangroves 0.1 sq.km; Total facies area 0.3 sq.km. The following habitat deviations from expected were identified -4; no barrier or back barrier/no fluvial-bayhead delta/no flood and ebb tidal delta/no saltmarsh or saltflats (Ref 2).

Mangrove coverage: 0.549 sq km

Fish Condition Index

In the 1997 RFISH diary program (not a comprehensive geographical survey), ranked recreational catch for Rollingstone Creek included Bream, Grunter, Fingermark, Mangrove Jack (4 species total) (Ref 1).

Pressure Component (Overall)

Utilisation Index

1995 BRS data: Crop/pasture & Plantations comprise 36.9579 % of the catchment. Native woody vegetation comprises 59.8583 % of the catchment (Ref 3).

Recreational Fishing

Total estimated recreational catch (harvest & released) for Rollingstone Creek in 1997 was 8,115 fish (0.01% of Qld total) from 541 trips (0.005% of Qld total). Estimated catch (no.) Bream 3,246, Grunter 2,705, Fingermark 1,623, Mangrove Jack 541 (Ref 1).

Commercial fishing

A maximum of <5 boats fished Rollingstone Creek in 1999.
Commercial fishing effort (days fished) by method comprised
line (0), net (71), pot (7), trawl (4), not stated (15) (Ref 1).

1. QLD state data, 2. AGSO, 3. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 400 Leichhardt Creek

Condition assessment

This estuary is in largely unmodified condition.
This initial classification was based on the changes to land use: aquaculture.
Upgraded to near pristine. Original classification based on aquaculture - intact habitat 95% up to Rollingstone.

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 401 Sleeper Log Creek

Condition assessment

This estuary is in largely unmodified condition.
This initial classification was based on the changes to land use: urban.

Process based classification

The way Sleeper Log Creek function is primarily a result of river energy. It is a wave- dominated delta. This means that the estuary would have low sediment trapping efficiency; naturally low turbidity, salt wedge/ partially mixed circulation and there is a low risk of habitat loss due to sedimentation.

Habitat Condition Index

Sleeper Log Creek was mapped in 2000 and the following facies areas were calculated: Flood and ebb tidal delta 0.1 sq. km; Intertidal flats 0. 1 sq. km; Mangroves 0.5 sq. km; Saltmarsh/ Saltflats 0.4 sq. km; Total facies area 1.1 sq. km. The following habitat deviations from expected were identified -2; no barrier or back barrier/ no fluvial- bayhead delta (Ref 2).

Mangrove coverage 0.463 sq km
Saltmarsh coverage 0.395sq km

Fish Condition Index

In the 1997 RFISH diary program (not a comprehensive geographical survey), ranked recreational catch for Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek included Mullet, Whiting, Sardine, Herring (Bait), Mud Crab, Garfish, Flathead, Grunter, Stripey, Coral Cod (14 species total) (Ref 1).

Pressure Component (Overall)

Utilisation Index

1995 BRS data: Crop/ pasture & Plantations comprise 14. 3256 % of the catchment. Native woody vegetation comprises 81. 7408 % of the catchment (Ref 4).

Recreational fishing

Total estimated recreational catch (harvest & released) for Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek in 1997 was 32, 550 fish (0. 06% of Qld total) from 2,697 trips (0. 03% of Qld total). Estimated catch (top 5 species by no.) Mullet 15, 876, Whiting 6,357, Sardine 6,027, Herring (Bait) 1,470, Mud Crab 735 (Ref 1).

Commercial fishing

A maximum of 8 boats fished Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek in 1999, for a total catch of 17. 56 tonnes. Commercial fishing effort (days fished) by method comprised line (4), net (130), pot (1), trawl (65), not stated (52) (Ref 1).

Details of References 1. QLD state data, 2. AGSO, 3. Expert opinion through state workshop, 4. Derived from BRS landcover data.

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 402 Bluewater Creek

Condition assessment

This estuary is in largely unmodified condition.

This initial classification was based on the changes to land use: urban.

Process based classification

The way Bluewater Creek function is primarily a result of river energy. It is a wave- dominated delta. This means that the estuary would have low sediment trapping efficiency; naturally low turbidity, salt wedge/ partially mixed circulation and there is a low risk of habitat loss due to sedimentation.

Habitat Condition Index

Bluewater Creek was mapped in 2000 and the following facies areas were calculated: Flood and ebb tidal delta 0.7 sq. km; Intertidal flats 0. 1 sq. km; Mangroves 0.2 sq. km; Saltmarsh/ Saltflats 0.1 sq. km; Total facies area 1.0 sq. km. The following habitat deviations from expected were identified -2 / +1; no fluvial- bayhead delta/ contains tidal sand banks (Ref 2).

Mangrove coverage 0.207 sq km

Saltmarsh coverage 0.095 sq km

Fish Condition Index

In the 1997 RFISH diary program (not a comprehensive geographical survey), ranked recreational catch for Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek included Mullet, Whiting, Sardine, Herring (Bait), Mud Crab, Garfish, Flathead, Grunter, Stripey, Coral Cod (14 species total) (Ref 1).

Pressure Component (Overall)

Utilisation Index

1995 BRS data: Crop/ pasture & Plantations comprise 14. 3256 % of the catchment. Native woody vegetation comprises 81. 7408 % of the catchment (Ref 3).

Recreational fishing

Total estimated recreational catch (harvest & released) for Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek in 1997 was 32, 550 fish (0. 06% of Qld total) from 2,697 trips (0. 03% of Qld total). Estimated catch (top 5 species by no.) Mullet 15, 876, Whiting 6,357, Sardine 6,027, Herring (Bait) 1,470, Mud Crab 735 1 (Ref 1).

Commercial fishing

A maximum of 8 boats fished Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek in 1999, for a total catch of 17. 56 tonnes. Commercial fishing effort (days fished) by method comprised line (4), net (130), pot (1), trawl (65), not stated (52). (Ref 1).

Details of References 1. QLD state data, 2. AGSO, 3. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 404 Black River

Condition assessment

This estuary is in modified condition.
This initial classification was based on the changes to land use: urban.

Process based classification

The way Black River function is primarily a result of river energy. It is a wave- dominated delta. This means that the estuary would have low sediment trapping efficiency; naturally low turbidity, salt wedge/ partially mixed circulation and there is a low risk of habitat loss due to sedimentation.

Habitat Condition Index

Black River was mapped in 2000 and the following facies areas were calculated: Flood and ebb tidal delta 1. 8 sq. km; Intertidal flats 0.7 sq. km; Mangroves 0. 4 sq. km; Saltmarsh/ Saltflats 0.1 sq. km; Total facies area 3.1 sq. km. The following habitat deviations from expected were identified -2 / +1; no fluvial- bayhead delta/ contains tidal sand banks (Ref 2).

Mangrove coverage 0.144 sq km
Saltmarsh coverage 0.043 sq km

Fish Condition Index

In the 1997 RFISH diary program (not a comprehensive geographical survey), ranked recreational catch for Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek included Mullet, Whiting, Sardine, Herring (Bait), Mud Crab, Garfish, Flathead, Grunter, Stripey, Coral Cod (14 species total) (Ref 1).

Pressure Component (Overall)

Utilisation Index

1995 BRS data: Crop/ pasture & Plantations comprise 14. 3256 % of the catchment. Native woody vegetation comprises 81. 7408 % of the catchment (Ref 3).

Recreational fishing

Total estimated recreational catch (harvest & released) for Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek in 1997 was 32, 550 fish (0. 06% of Qld total) from 2,697 trips (0. 03% of Qld total). Estimated catch (top 5 species by no.) Mullet 15, 876, Whiting 6,357, Sardine 6,027, Herring (Bait) 1,470, Mud Crab 735 (Ref 1).

Commercial fishing

A maximum of 8 boats fished Leichardt Creek + Althaus Creek + Black River + Sleeper Log Creek + Bluewater Creek in 1999, for a total catch of 17. 56 tonnes. Commercial fishing effort (days fished) by method comprised line (4), net (130), pot (1), trawl (65), not stated (52) (Ref 1).

Details of References 1. QLD state data, 2. AGSO, 3. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 405 Bohle River

Condition assessment

This estuary is in modified condition.
This initial classification was based on the changes to land use: urban.

Process based classification

The way Bohle River function is primarily a result of river energy. It is a tide- dominated delta. This means that the estuary would have low sediment trapping efficiency; naturally high turbidity, well mixed circulation and there is a low risk of habitat loss due to sedimentation.

Habitat Condition Index

Bohle River was mapped in 2000 and the following facies areas were calculated: Flood and ebb tidal delta 2. 2 sq. km; Intertidal flats 1.5 sq. km; Mangroves 3. 8 sq. km; Saltmarsh/ Saltflats 12.9 sq. km; Total facies area 20.4 sq. km. No habitat deviation was identified (Ref 2).

Mangrove coverage 18.6% - Extensive stands of mangroves present
Saltmarsh coverage 63.1% - Extensive areas of saltmarsh and unvegetated claypans present
(Ref 2,3).

Fish Condition Index

In the 1997 RFISH diary program (not a comprehensive geographical survey), ranked recreational catch for Bohle River included Poppy Mullet, Whiting, Longtom, Bream, Box Fish, Mud Crab, Shark (7 species total); Fisheries values: barramundi, blue salmon, bream, estuary cod, flathead, grey mackerel, grunter, mangrove jack, queenfish, recreational fishing, sea mullet, school mackerel tiger prawns, banana prawns, blue legged king prawns (Ref 1,3).

Pressure Component (Overall)

Utilisation Index

1995 BRS data: Crop/ pasture & Plantations comprise 37. 9235 % of the catchment. Native woody vegetation comprises 43. 6138 % of the catchment (Ref 4).

Recreational fishing

Total estimated recreational catch (harvest & released) for Bohle River in 1997 was 20, 467 fish (0.04% of Qld total) from 2,095 trips (0. 02% of Qld total). Estimated catch (top 5 species by no.) Poppy Mullet 16,771, Whiting 1,416, Longtom 1, 082, Bream 541, Box Fish 287 (Ref 1).

Commercial fishing

A maximum of 5 boats fished Bohle River in 1999, for a total catch of 4. 29 tonnes. Commercial fishing effort (days fished) by method comprised line (0), net (60), pot (2), trawl (15), not stated (54) (Ref 1).

Details of References 1. QLD state data, 2. AGSO, 3. Beumer J et al. 1997. Declared Fish Habitat Areas in Queensland, 4. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 406 Ross River

Condition assessment

This estuary is in modified condition.
This initial classification was based on the changes to land use: urban.

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 407 Sandfly Creek

Condition assessment

This estuary is in modified condition.
This initial classification was based on the changes to catchment hydrology: STP.

Process based classification

The way Sandfly Creek functions is primarily a result of tide energy. It is classed as a tidal flat/ tidal creek. This means that the estuary would have low sediment trapping efficiency; naturally high turbidity, well mixed circulation and there is low risk of sedimentation.

Habitat Condition Index

Sandfly Creek was mapped in 2000 and the following facies areas were calculated: Intertidal flats 0. 1 sq. km; Mangroves 0.8 sq. km; Saltmarsh/ Saltflats 4.3 sq. km; Total facies area 5.2 sq. km. The following habitat deviations from expected were identified -2; no flood and ebb tidal delta/ no tidal sand banks (Ref 2).

Mangrove coverage 0.153 sq km
Saltmarsh coverage 0.824 sq km

Fish Condition Index

In the 1997 RFISH diary program (not a comprehensive geographical survey), ranked recreational catch for Ross River + Sandfly Creek included Grunter, Mud Crab, Silver Bream, Barramundi, Trevally, Bream, Whiting, Red Bream, Butter Bream, Cod (75 species total) (Ref 1).

Pressure Component (Overall)

Utilisation Index

1995 BRS data: Crop/ pasture & Plantations comprise 42. 2428 % of the catchment. Native woody vegetation comprises 36. 0567 % of the catchment (Ref 3).

Recreational fishing

Total estimated recreational catch (harvest & released) for Ross River + Sandfly Creek in 1997 was 494,831 fish (0.89% of Qld total) from 74,161 trips (0.69% of Qld total). Estimated catch (top 5 species by no.) Grunter 79,997, Mud Crab 58, 072, Silver Bream 52, 512, Barramundi 33,744, Trevally 27,306 (Ref 1).

Commercial fishing

A maximum of 6 boats fished Ross River + Sandfly Creek in 1999, for a total catch of 3. 91 tonnes. Commercial fishing effort (days fished) by method comprised line (3), net (76), pot (74), trawl (17), not stated (6) (Ref 1).

Details of References 1. QLD state data, 2. AGSO, 3. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 408 Alligator Creek

Condition assessment
This estuary is in largely unmodified condition.
This initial classification was based on the changes to land use: agriculture.

Process based classification
The way Alligator Creek functions is primarily a result of river energy. It is a tide- dominated delta. This means that the estuary would have low sediment trapping efficiency; naturally high turbidity, well mixed circulation and there is a low risk of habitat loss due to sedimentation.

Habitat Condition Index
Alligator Creek was mapped in 2000 and the following facies areas were calculated: Flood and ebb tidal delta 2.3 sq. km; Intertidal flats 0. 4 sq. km; Mangroves 4.9 sq. km; Saltmarsh/ Saltflats 5.0 sq. km; Total facies area 12. 6 sq. km. The following habitat deviations from expected were identified -1; no tidal sand banks (Ref 2).
Mangrove coverage 0.39 sq km
Saltmarsh coverage 0.399 sq km

Pressure Component (Overall)
Utilisation Index
1995 BRS data: Crop/ pasture & Plantations comprise 12. 8728 % of the catchment. Native woody vegetation comprises 65. 4939 % of the catchment (Ref 5).

Recreational fishing
Medium pressure - adjacent fisherman's retreat (Ref 3).

Commercial fishing
Gill net fishery; A maximum of <5 boats fished Alligator Creek + Crocodile Creek in 1999. Commercial fishing effort (days fished) by method comprised line (0), net (41), pot (11), trawl (0), not stated (2) (Ref 3).

Urbanisation and urban runoff
Rural residential adjacent.

Industry
Industrial meat works (historical).

Ports & Port Works
Absent - used to be a port

Details of References 1. QLD state data, 2. AGSO, 3. Expert opinion through state workshop, 4. Derived from BRS landcover data

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

OzEstuary ID 409 Crocodile Creek

Condition assessment
This estuary is in near pristine condition.

Source: ESTUARY ASSESSMENT FRAMEWORK FOR NON-PRISTINE ESTUARIES 2000 (ANRA)

Appendix C

Wetland Proforma

Wetland Habitat Pro-forma (Bohle River)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Estuarine/Intertidal
Class/subclass	Streambed/Mud
Dominance Type	*Avicennia marine*
Water Regime	Regularly flooded
Water Chemistry	Mixohaline
Soil	Organice
Associated Vegetation	*Bruguiera* spp., *Ceriops tagal*
Size	Channel <20m
Management Issues	Streambank erosion, fishing pressure, exotics, access track.
Conservation Value	Low-Medium.

Wetland Habitat Pro-forma (Ross Creek)

Wetland sample site No.	7.15 Ross Creek - Townsville
Grid Reference No.	DU805698
Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Land system	
Landform pattern/ element	
Ecological system/subsystem	Estuarine/Subtidal
Class/subclass	Consolidated Bottom/Mud
Dominance Type	*Avicennia marina*
Water Regime	Subtidal
Water Chemistry	Mixohaline
Soil	Organic
Special modifiers	Impounded
Associated Vegetation	*Sporobolus virginicus, Halosarcia indica*
Size	Channel ~30m
Management Issues	Stormwater, litter, recreational use
Conservation Value	Medium-High
Recommended action	1 Control access to the creek to prevent erosion of banks and deposition of litter 2 Revegetation 3 Clean up and water quality and sediment monitoring program

Wetland Habitat Pro-forma (Ross River)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Riverine/Intermittent
Class/subclass	Streambed/Sand
Dominance Type	*Urochloa mutica*
Water Regime	Seasonally flooded
Water Chemistry	Fresh
Soil	Mineral
Associated Vegetation	*Cyperus* spp.

Size	Channel ~20m
Management Issues	Potable water supply, grazing, weeds.
Conservation Value	Very high

Wetland Habitat Pro-forma (Toonpan Lagoon)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Palustrine
Class/subclass	Emergent/Persistent
Dominance Type	*Urochloa mutica*
Water Regime	Seasonally flooded
Water Chemistry	Fresh
Soil	Organic
Associated Vegetation	*Panicum maximum, Chloris spp.*
Management Issues	Grazing, weeds
Conservation Value	Low-Medium

Wetland Habitat Pro-forma (Antill Plains Creek)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Riverine/Intermittent
Class/subclass	Streambed/Rubble
Dominance Type	*Callistemon viminalis*
Water Regime	Temporarily flooded
Water Chemistry	Fresh
Soil	Mineral
Associated Vegetation	*Lophostemon grandiflorus, Melaleuca leucadendra.*
Size	Channel ~>10m
Management Issues	Potable water supply, land tenure.
Conservation Value	Very high

Wetland Habitat Pro-forma (Sachs Creek)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Riverine/Intermittent
Class/subclass	Aquatic bed/Floating leaved
Dominance Type	*Nymphaea gigantea*
Water Regime	Temporarily flooded
Water Chemistry	Fresh
Soil	Organic
Associated Vegetation	*Marsilea mutica, Ludwigia peploides, Vallisneria spiralis, Aponogeton queenslandica.*
Size	Channel ~10m
Management Issues	Potable water supply, semi rural subdivision, recreational use.
Conservation Value	High

Wetland Habitat Pro-forma (Stuart Creek)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Riverine/Lower Perennial
Class/subclass	Emergent/Persistent
Dominance Type	*Urochloa mutica*
Water Regime	Permanently flooded
Water Chemistry	Fresh
Soil	Organic
Associated Vegetation	*Communis riccinus, Panictum maximum*
Size	Channel ~<20m
Management Issues	Exotics, stormwater contamination
Conservation Value	Low

Wetland Habitat Pro-forma (Sandfly Creek)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Riverine/Tidal
Class/subclass	Streambed/Mud
Dominance Type	*Avicennia marina*
Water Regime	Regularly flooded
Water Chemistry	Mixohaline
Soil	Organic
Associated Vegetation	*Brugueira spp. Rhizophera spp.*
Size	Channel ~15m
Management Issues	Sewerage disposal
Conservation Value	High

Wetland Habitat Pro-forma (Alligator Creek)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)
Ecological system/subsystem	Riverine/Lower Perennial
Class/subclass	Unconsolidated bottom/sand
Dominance Type	*Urochloa mutica*
Water Regime	Intermittently exposed
Water Chemistry	Fresh
Soil	Mineral
Associated Vegetation	*Cyperus spp. Potamogeton crispus, Vallisneria spiralis.*
Size	Channel <5m
Management Issues	Agricultural runoff, recreational use, weeds
Conservation Value	High

Wetland Habitat Pro-forma (Horseshoe Bay)

Wetland Type Classification (after Blackman *et al* 1992)	Simple wetland aggregation
Biogeographic Region	Brigalow Belt (North)

Ecological system/subsystem	Palustrine
Class/subclass	1. Forested/Evergreen 2. Emergent/ Non Persistent
Dominance Type	1. *Melaleuca leucadendra* 2. *Eleocharis dulcis*
Water Regime	Seasonally flooded
Water Chemistry	Fresh
Soil	Organic
Associated Vegetation	*Urochloa mutica, Passiflora foetida.*
Size	800x100m
Management Issues	Sewerage disposal, urban encroachment, exotics, fire.
Conservation Value	High

Appendix E

Wetland Reports Extracts

Leichhardt Creek

Location
Leichhardt Creek drains a small coastal catchment north of Townsville. The site is immediately upstream of the Bruce Highway crossing approximately 35 kilometres north of Townsville, 3.5 kilometres upstream of the creek mouth. The creek catchment drains the Paluma Range, which includes State and National Park forest, comprised rain forest vegetation.
Land Use
The lower coastal plains are leasehold with grazing the predominant landuse. The current property has run cattle and horses since 1975.
Local Creek Geomorphology
The creek appeared to flow for most of the year. The catchment is comparatively small and the creek course is relatively 'straight to sea', which means that it has a quick response to any rainfall occurring on the coastal side of Paluma Range. The creek bed in the vicinity of the monitoring site consists of inter-connected small pools running through distinct rocky channels comprised of an unusual type of bedrock.
Vegetation
The riparian vegetation is overhanging *Melaleuca* sp., with some *Casuarina* sp., which adds a considerable amount of leaf litter to the pools that persist during the baseflow conditions. The riparian zone was generally intact with only minimal visible disturbances by stock or pigs. There was a lack of appreciable aquatic macrophyte growth throughout the survey period, presumably as a result of the high degree of shading by the overhanging riparian vegetation.

Source: Water Quality in the Townsville/Burdekin Dry Tropics Region (ACTFR Report 2002).

Bohle River

Vegetation
In the freshwater sections, weed invasion, particularly rubber vine and chinee apple, but also aquatic weeds such as *Pistia stratiodes* (pistia) and *Eichhornia crassipes* (water hyacinth), has degraded the aquatic habitat.
Wetlands
The size and nature of the wetland complex insulates it from many of the incremental impacts, which can significantly degrade urban wetlands; however, the encroachment of land subdivision along Rowes Bay, together with the continued degradation of its ecological values, should be of some concern. The most significant problem is *Urochloa mutica* (paragrass), which is widespread, and few pockets of native emergent macrophytes occur in the freshwater parts of the wetland. Without such intervention, the long-term accumulation of paragrass is likely to exhaust native macrophyte seedbanks, making the possibility of rehabilitation more unlikely.
Issues for Management
Rubbish is extensive, soil erosion is prevalent, riparian vegetation has been cleared, and pollutants from upstream (e.g. a sewerage treatment plant) is resulting in the eutrophication of the river. A large wet season flush will improve the waterway, but ongoing pollution and degradation by weeds and erosion (riverbank, sheet and rill) will continue. In the tidal reaches, stormwater from industrial developments, the clearing of riparian zones, illegal boat access points, fishing pressures, weed invasion and soil erosion have similarly resulted in the degradation of the river.

Source: Wetlands of the Townsville Area (ACTFR Report 1996)

Ross Creek

Location
Ross Creek is situated in the city of Townsville and stretches for a length of about 5km from Ross River through the central business district to Cleveland Bay.
Land Use
The major land use influences on the character of the Ross Creek from Lowths Bridge upstream are the

series of land fill dumps from Dean Street Park to Bicentennial Park, the construction of the Queens Road levee which cut off tidal flow from the Ross River, and the building of the Boundary Street and Queens Road causeways. Areas that were formally used as dump sites are now well grassed and several parkland areas have been planted out, although the majority of these areas remain as open spaces with little or no aesthetic value. Apart from the Civic Theatre, and the small Model Engineers Fun Park, there have been no constructions built in close proximity to the creek since the early 1960s.

The Ross Creek area is dominated by four major land uses, namely the Townsville Port and associated industries, the Central Business District, the north and south Bank Rail Yards, and the Residential Areas.

Local River Geomorphology

Today, the creek is a tidal estuary which receives freshwater flow only during the wet season (generally November to March). However, the monsoon may fail, so a "good" wet season is expected only intermittently. During such wet seasons the high volume of stormwater runoff may result in Ross Creek exhibiting a "salt-wedge" type of estuary, in which the freshwater output rides over the saltwater.

Vegetation:

A survey of all the vegetation of the Ross Creek environment was undertaken [and] eight species of mangrove, four salt-marsh species, three main exotic grasses, and three dominant woody weeds were identified. No species of macro-algae were noted although undescribed micro algae are evident along most of the creek margins and the Lakes Development. Fouling algae such as *Ceramium spp.* and *Padina spp.* have been observed on the waterline of floating pontoons in the harbour.

Non-estuarine vegetation:
As Ross Creek was originally in the middle of a large mangrove tidal flat there was very little non-estuarine vegetation. However, with the extensive land reclamation around the creek, many exotic species of vegetation have been introduced.

Grasses are predominant, especially Guinea Grass (*Panicum maximum*), Rhodes Grass (*Chloris gayana*) and Red Natal Grass (*Melinis repens*). Most of the grassed areas are on old landfill sites which are largely kept mown.

Woody weeds are found scattered around the creek margins and have established strongly in unkempt grass areas and along the mangrove perimeters. Of particular concern are the legumes *Leucaena leucocephala*, *Parkinsonia aculata* and *Macroptilium lathyroides* (Phasey Bean).

Other trees that are found around the creek are principally a result of deliberate planting such as in established parks, streets and large open grass areas. These include a variety of exotic species such as *Terminalia* spp., Rain Tree, *Albizia* spp., mango and native eucalypts, melaleucas, she-oaks and fig trees.

Estuarine Vegetation:
Mangroves are by far the dominant type of vegetation found around Ross Creek. Salt marsh vegetation has colonised the tidal flats behind mangrove stands or in areas where the mangroves have not established. The dominant species is the Saltwater Couch (*Sporobolus virginicus*) with *Sued australis* (Seablight), *Halosarcia* spp. (Samphire), *Sarcocornia australis* (Chicken Claws) and *Sesuvium portulacastrum* (Sea Purslane).

Pollution:

The present character, form and constitution and constitution of Ross Creek are greatly affected by land reclamation, waste disposal and pollution. The intense industrial activity around the middle and outer reaches of the creek, discharges from the central business district and wider suburbia, continuous boating use around the inner city, and the filling of estuarine inlets, tidal flats and mangrove stands with industrial and domestic waste, make Ross Creek a sad example of neglect and indifferent exploitation of is ecological, aesthetic and recreational function and potential.

Ross Creek is heavily influenced by climatic, tidal and urban inputs (including industrial and harbour activity – dredging and vessel movement) which affect the water quality and ecology of the system. Stormwater runoff often carries contaminants such as sewerage, animal wastes, oils, household litter, chemical residues, vegetative matter and soils. These pollutants are mainly carried through the stormwater pipes but some may flow directly overland into the creek during heavy storms. As Townsville experiences significant rains only during the summer months, pollutants which have collected in gully traps or drains over the dry months are mostly flushed into the creek in major single events. There is direct discharge into the creek via stormwater or special purpose pipes on a continuous basis from the major industries such as the rail yards and the harbour.

Ross Creek is greatly affected by pollution, which can be linked to a number of urban and commercial factors. Its catchment drains residential and commercial land and the original morphology of the creek has been altered by land reclamation to satisfy town planning needs.

Source: Ross Creek Scoping Study (Browne, Broome and Faithful 1994)

Stuart Creek

Location:
Stuart Creek lies within cleared grazing land with the upper parts of the catchment draining Mt Stuart (Stoney Creek) and the Sisters Mountains. The sampling site was positioned approximately 7 kilometres from the creek mouth, within the Heleena Downs cattle property 8 kilometres SSE of Townsville off the Bruce Highway.
Land Use:
Despite the surrounding land being cleared, riparian vegetation is reasonably good in several areas upstream of the Bruce Highway Bridge. The upper parts of the Stuart Creek and Stoney Creek catchments comprise dry open woodlands, but after their confluence, flow through urban and industrial estates before reaching Heleena Downs.
Vegetation:
Despite the potential for water quality disturbance, the creek supports a significant aquatic macrophyte assemblage, which gives rise to its aesthetic appeal and environmental value. The macrophytic diversity supports *Azolla* sp., *Nymphaea* spp., *Otellia* sp., *Potamogeton* sp., *Egeria* sp., *Salvinia* sp., *Aponogeton* sp., *Ceratophylum* sp., *Nymphoides* sp. and *Hydrilla* sp., and over the course of the study numerous fish species ranging up to 60cm were observed.

Source: Water Quality in the Townsville/Burdekin Dry Tropics Region (ACTFR Report 2002).

Stuart Creek

Fish habitat:
High quality fish habitats were distributed throughout the stream. Other features of note often associated with the lagoons were well vegetated margins with overhanging riparian canopy, bank undercuts formed by dense stream bank root masses, rocky substrates and undercuts, diverse macrophyte beds, and shallow riffles, the latter unlikely to be persistent in all but the wettest years. Migratory or catadromous fish species were conspicuous by their absence re-enforcing the assessment that the defunct road crossing D/S of the Q-Rail crossing is in fact an effective fish passage barrier.
Vegetation:
Where present riparian vegetation had a diverse representation of rainforest species, structural complexity and maturity of individual trees in some stands. Several areas also retained good representative examples of native riparian grasses including kangaroo and black spear grass. The observed diversity of submerged macrophytes was high (>8 species). No exotic floating or submerged macrophyte species were observed although the exotic emergent umbrella sedge was recorded. The

diversity of macrophytes reflects the generally high water clarity and natural hydrology retained by these sections of Stuart Creek. Infestation of the elevated levees by Guinea grass and the lower stream bank by Para Grass is a major impediment to the recovery of the riparian ecosystem in degraded areas of the stream. In some areas light grazing by horses appears to be limiting the hot fire hazard associated with exotic grass fuel loads. An apparently low frequency of burning also appears responsible for successful recruitment of riparian species through the exotic grass dominated understorey in some stream margins which is subsequently serving to reduce grass dominance by shading. However for more open riparian areas the exotic grass infestation appears intractable without intervention and the risk of hot fire impacts to the remnant riparian vegetation is high. Several species of woody weed were noted. Chinee Apple, Elbizia and Mango were most prevalent. Other species noted included Tamarind, Parkinsonia, Prickly Acacia, Lantana, Castor Oil Bush, Grewia and Rubber vine
Riparian and Levee Clearing:
Past vegetation clearing practices in most of the surveyed stream reaches has resulted in the loss of adjoining woodland assemblages and in many instances has also involved some limited clearing of bank side trees within the riparian forest assemblages. This clearing is historical and subject to exotic grass and woody weed infestation levels recovery of the riparian vegetation was observed to have at least partially occurred at many sites. Away from the immediate riparian zone a combination of exotic grass infestation and past hot fire regimes appears to have prevented the re-establishment of ecotonal woodland assemblages.
Water quality:
By and large the water quality observed appeared to be good in terms of low turbidity, temperature regime and dissolved oxygen status as indicated by riparian shading, abundant fish life and good water clarity. However, the high availability of nutrient appeared to be an issue in the uppermost sections of the *Upstream Reaches* where abundant algal scums occurred within several pools downstream of the Roseneath rural residential area. The causes of this apparent abundance of instream nutrient could not be ascertained but possible sources include unsewered residential development, adjoining agricultural run off or possibly mineral nutrient inputs sourced from upstream quarrying operations. Affected smaller pools appeared highly eutrophic.

Source: Assessment of Values, Condition and Strategic Management Options for lower Stuart Creek Reaches (Stuart Prison – Bruce Highway) (2006)

Alligator Creek

Land Use
Burgeoning rural-residential development on the seaward side of the Muntalunga Range, exotic species (chinee apple, para grass, rubber vine), and agricultural development on the Alligator Creek floodplain are placing at risk this important area.
Water Quality
With a significant proportion of its headwaters contained within Bowling Green Bay National Park, the water quality of the stream generally appears good above the Alligator Creek subdivision. However, a significant proportion of the creek is also fed by a tributary which passes through grazing lands, and there is a need to monitor water quality in the stream throughout the year. This is particularly important as the creek is heavily utilised for recreation (e.g. swimming) both within the National Park and downstream. The riparian vegetation is generally intact above the subdivision, but it rapidly degrades downstream. This decrease in stream habitat quality is mostly the result of clearing riparian zones, farming the levees, and the invasion of weeds.

Vegetation
The coastal area between Muntalunga Range and Alligator Creek is not well documented and there is insufficient information about the habitat value of the wetland complex. The area is composed of mangrove, samphire and saltmarsh species and is much more developed than neighbouring areas. In general, there is a more intact continuum between the intertidal zone and the terrestrial lowlands, and through the Muntalunga Range, a link to upland areas also exists.
The slower movement of water in the lower reaches of Alligator Creek has caused the build up aquatic macrophytes in some areas during dry seasons, and this has probably been enhanced by nutrient rich runoff from adjacent fertilised croplands. This level of macrophyte growth is likely to cause oxygen depletion in the stream and the seasonal loss of fish habitat. Large lagoons impounded by a weir on the creek downstream of the highway are generally in good condition, with remnant riparian forest for much of the stream length. However, the (current) minor occurrence of water hyacinth, salvinia (*Salvinia molesta*) and pistia in the deepwater lagoons above the weir, should be of some concern.

Source: Wetlands of the Townsville Area (ACTFR Report 1996)

Cocoa Creek

Land Use
A mosaic of mangrove, saltmarsh and lowland habitat stretches from the Ross River past Cocoa Creek and is the most significant in the greater Townsville region, outside of conservation reserves. Historically, it has been the subject of considerable development pressure (e.g. shipping port, clearing and grazing, abattoir, aquaculture, dredge spoil dump, sand mine, rubbish tip, sewerage treatment and disposal, and more recently, land subdivision). It is also the designated area for the proposed zinc refinery and, possibly, a power generation plant.
Geomorphological Significance
The importance of this northern section of the southbank coast (i.e. Ross River to Muntalunga Range) for commercial and recreational fisheries, habitat for migratory birds, and local ibis, egrets and flying foxes, has been documented in many previous reports. However, the geomorphological significance of this relatively narrow and stunted strip of mangrove and saltmarsh has seldom been mentioned. It is regarded as crucial to stabilising the coast and preventing saltwater intrusion (G.Blackman, pers.comm.), and impacts which may reduce its capacity to buffer tidal movements place at risk infrastructure and valuable grazing lands. The nature of these impacts may be as subtle as progressive mangrove defoliation from airborne pollutants or the increased erosive force of sea currents due to breakwater construction. It is recommended that the TCC further investigate the geomorphological significance of this coastline.

Source: Wetlands of the Townsville Area (ACTFR Report 1996)

Cape Cleveland

Land Use
The western side of Cape Cleveland contains few freshwater wetlands. There are several intermittent streams, which flow toward Cleveland Bay and one small palustrine wetland behind dune ridges at the far end of Long Beach. The small swamp was dry at the time of sampling and there was extensive damage to the aquatic vegetation by both fire and feral pigs; however, some stands of *Phragmites australis* did remain and it appeared that groundwater was close to the surface. Given the long period of drought, this wetland would appear to be at least semi-permanent, and its relative isolation has meant that the surrounding vegetation has mostly remained intact.
Flora and Fauna
This region contains a variety of wetland types, including large estuarine systems, expansive saltmarsh

and samphire communities, freshwater swamps and several intermittent riverine streams.
The estuarine wetlands which fringe the northern and southern coasts of the cape, and extend up the Haughton River and its tributaries (e.g. Burrumbush Ck, Doughboy Ck) support commercial and recreational fisheries and provide habitat for a variety of migratory birds, regionally significant populations of egrets, ibis, spoonbills and other waterfowl, and also saltwater crocodiles. The extensive saltmarsh and samphire communities which are associated with these waterways form part of a coastal complex which is largely intact and there are few immediate pressures on the integrity of these landforms. However, the freshwater wetlands which occur leeward to the intertidal zones, and are possibly of greater regional importance, are likely to come under considerably more pressure over time (particularly from land subdivision).
The principal land holding in the area ("Eden" of the Chapman family) is a large grazing property which extends from the Cape Cleveland road to almost the township of Cungulla. However, the natural values of the holding have become progressively more degraded through grazing, pasture establishment and repeated fires. This has affected many of the freshwater wetlands on the property, as exotic species dominate and there is little recruitment of native riparian species. However, two of the important functions of these swamps are that they provide valuable habitat for waterfowl and fish (e.g. barramundi). Experience of many degraded Burdekin wetlands suggests that (under the correct management) these functions can still be supported by the wetlands.

Source: Wetlands of the Townsville Area (ACTFR Report 1996)

Magnetic Island

Flora and Fauna
The Picnic Bay-West Point intertidal and lowland mosaic contains valuable mangroves and saltmarsh, which provide the connectivity from the coast to the upland areas, and in turn support important migratory bird and fishery habitats. However, the construction of the coast road has caused changes to tidal hydrodynamics, and resulted in the death of some *Melaleuca* stands. This extent of tree death does not warrant rehabilitation in itself, but any proposal to seal and upgrade this road should ensure that no further damage to these habitats occurs, and if possible areas, which have previously been affected, are restored. It is also recommended that the TCC consult the Department of Natural Resources and seek the reservation of this coastal zone as a Wetland Reserve.
Hydrology
Magnetic Island also contains a significant number of intermittent streams, which can often be disregarded by development proposals or planning controls. These seasonal creeks (e.g. Gustav Creek) and drainage lines not only produce more heterogenous vegetation assemblages and hence greater habitat diversity, but they are also important conduits of stormflows. Seasonal rainfall often forms ephemeral off-stream wetlands through overbank streamflow, and alterations to creek hydrology (e.g. for flood mitigation) can significantly reduce their viability.

Source: Wetlands of the Townsville Area (ACTFR Report 1996)