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

November 2009

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Contents

Tables

Page

Figures

Page

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1. Introduction

1.1 Background

Creek to Coral managed the Townsville Coastal Catchments Initiative (CCI) project and along with its many partners prepared a Water Quality Improvement Plan (WQIP) for the Black and Ross River Basins. One of the first tasks was to delineate the extent of the receiving water bodies to 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 were also delineated.

This document provides the rationale for the delineation of the receiving waters including the estuarine reaches of the waterways within the Black Ross 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 2,900 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 2,000 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).

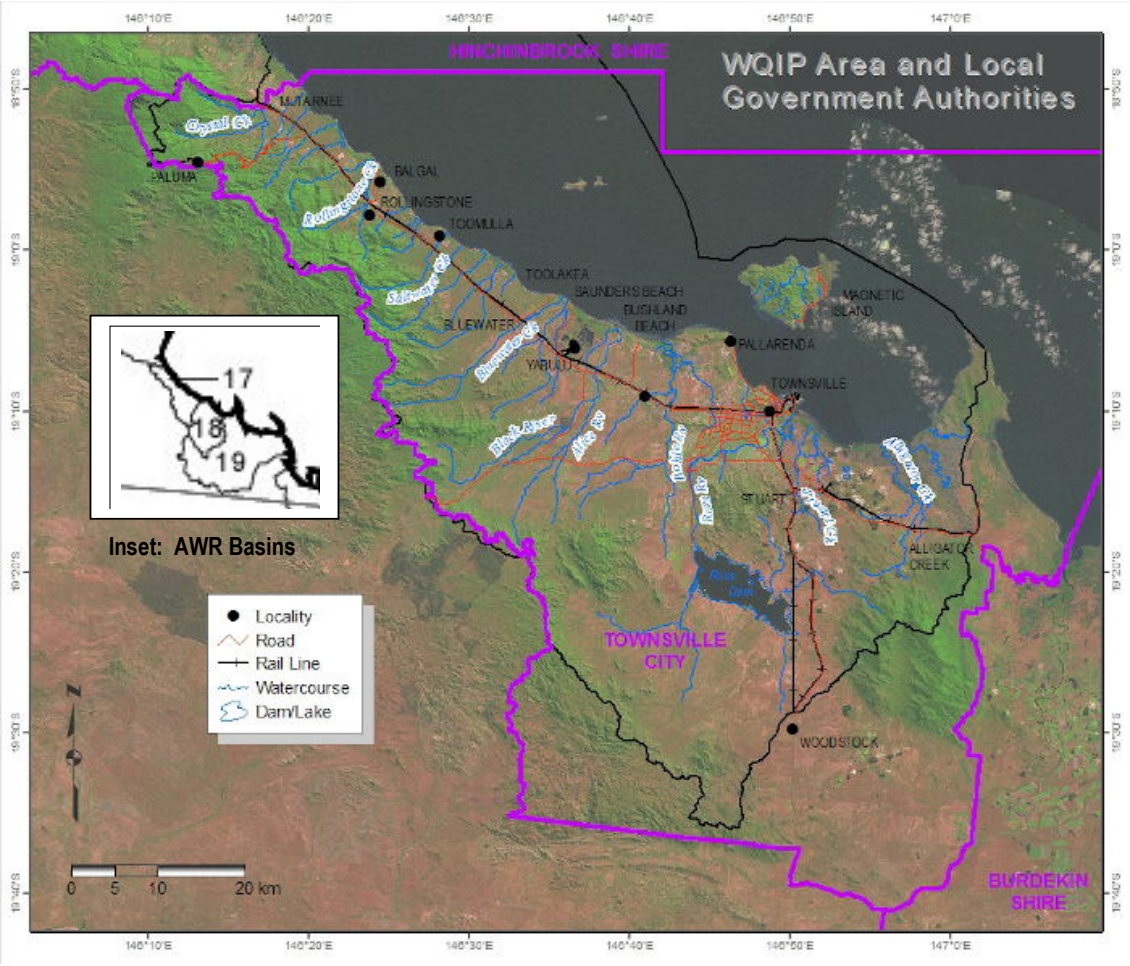
The quality of water in the GBR lagoon is important to the maintenance of the habitats and amazing biodiversity of the GBRMP, and especially of the near shore areas. The water quality of the GBR is impacted by the quality of water entering the GBRMP from the catchments stretching the 14 degrees of latitude 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 River and Ross River Basins are part of the GBR catchment and Townsville is home to the largest urban population in the coastal zone adjacent to the GBR. 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 (Townsville) WQIP area covers most waterways within the Townsville City local government area (LGA) 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 (see Figure 2.1).

Figure 2.1 Black/Ross WQIP Area

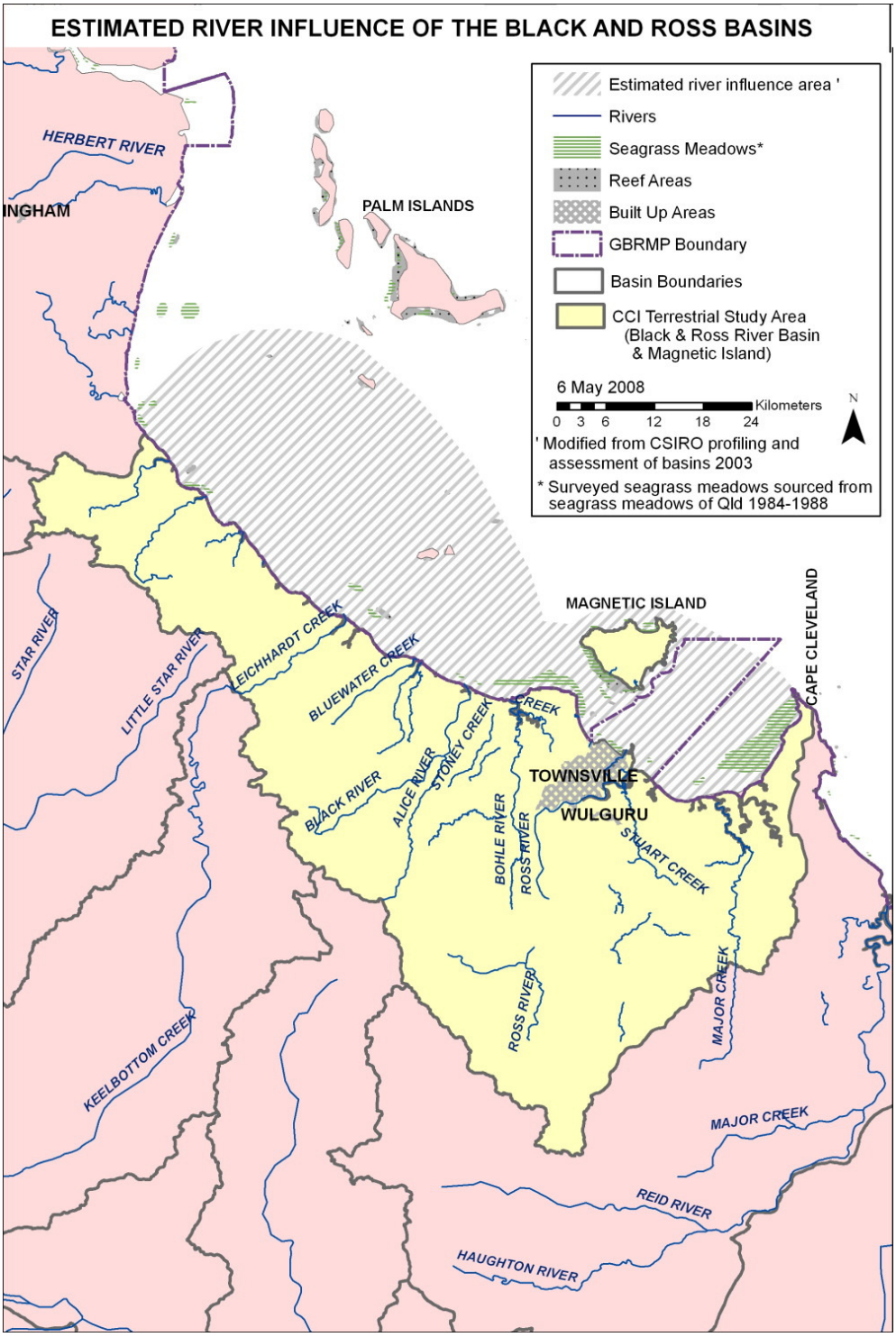


2.2 Black Ross WQIP Receiving Waters

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

As Magnetic Island is also a part of the Black Ross (Townsville) 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 marine waters influenced by mainland terrestrial run-off. The result is the extent of marine receiving waters of the Black Ross (Townsville) WQIP area (see Figure 2.2).

Figure 2.2 Black Ross WQIP Receiving Waters Based on River Influence

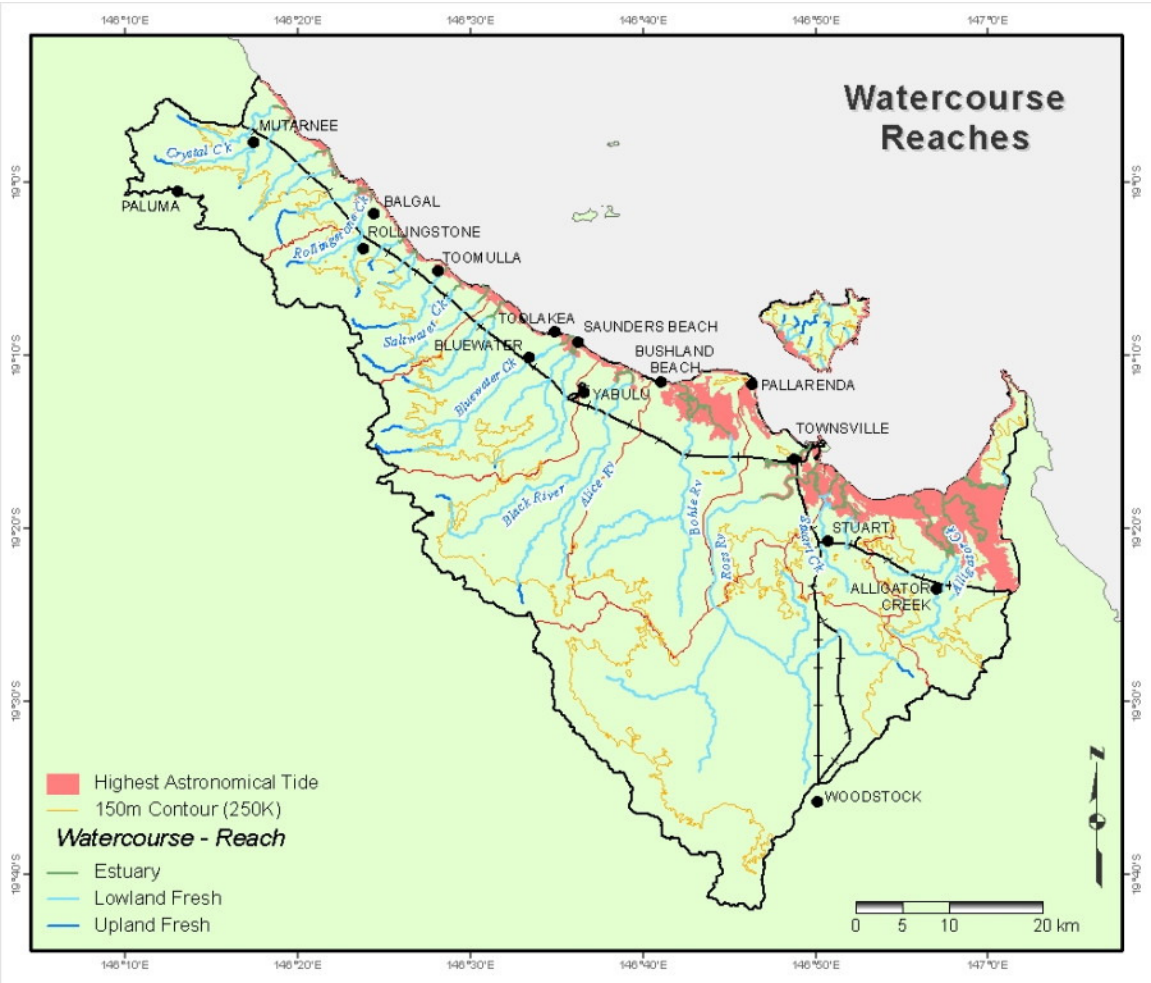


Source: Estimated river/waterway influence prepared by CSIRO based on mapping from a report titled *Profiling and assessment of basins with respect to the sediment, nutrient and other diffuse-source loads they export to the Great Barrier Reef WHA* (Greiner et al 2003).

The extent of estuarine receiving waters was determined primarily from the distribution of 'marine' plants as defined by Queensland's regional ecosystem mapping (Department of Environment and Resource Management). The landward extent of vegetation communities (regional ecosystems) known to be saltwater tolerant was delineated and this was assumed to be the extent of tidal influences and therefore the upstream limit of highest astronomical tides (HAT). Thus the extent of saltwater tolerant vegetation communities was used to define HAT and hence the inland extent of estuarine waters.

The waters upstream of the saltwater tolerant vegetation communities (HAT) line were considered to be freshwater. Lowland and upland freshwaters were also delineated with upland freshwaters being above the 150-metre contour and lowland freshwater between the 150-metre contour and the estuarine line. The delineated water types are shown in Figure 2.3.

Figure 2.3 Fresh and Estuarine Water Types

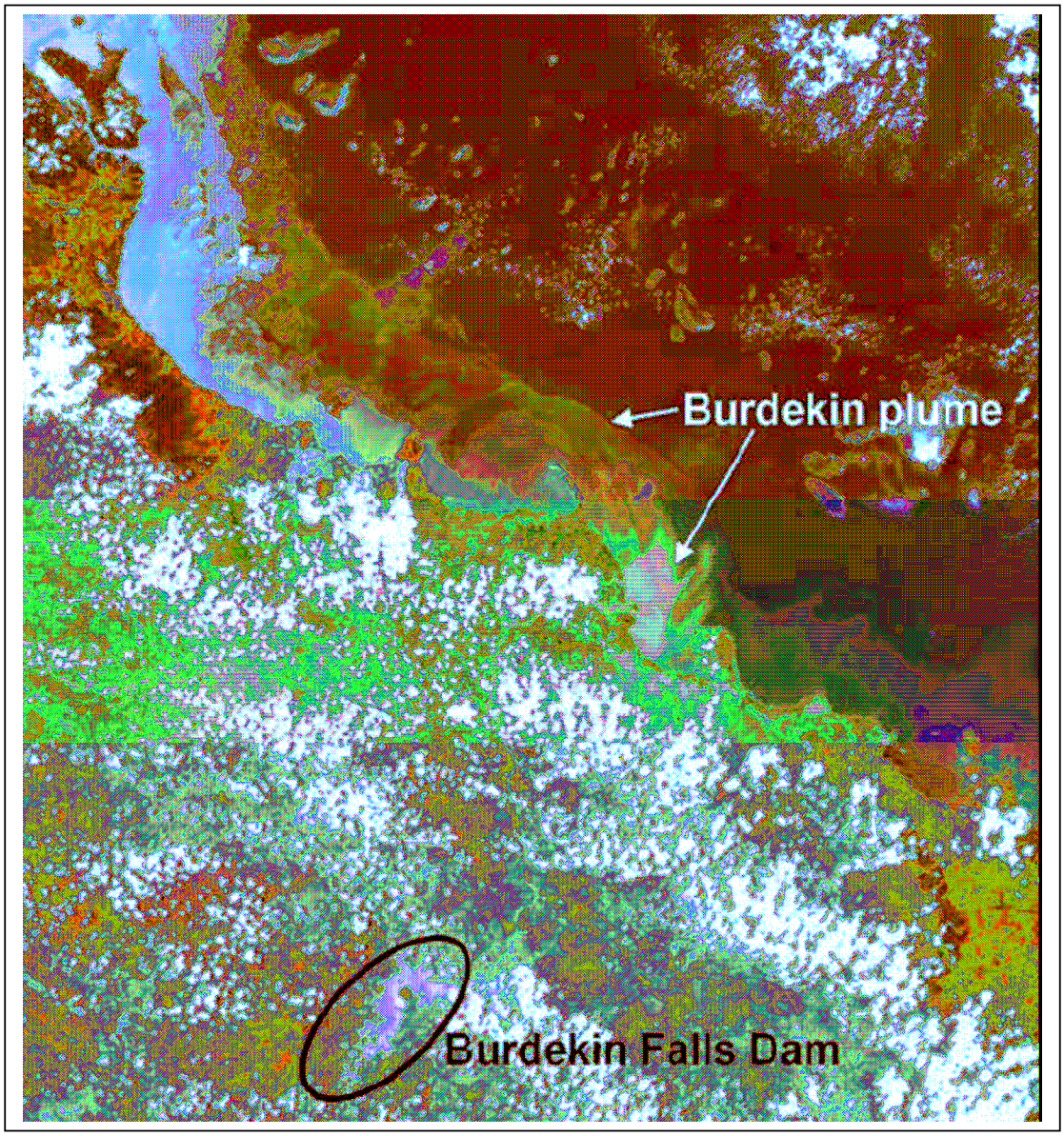


Most of the waterways in the north of the WQIP area have relatively short estuarine reaches and distinct upland freshwater reaches. Waterways in the Ross River Basin generally have short, or no upland freshwater reaches while the estuarine reaches are quite extensive. This is indicative of the topographic differences between the Black River Basin and the Ross River Basin (see section 3.3).

2.2.1 External influences

It is recognised that run-off from the Burdekin and Haughton River Basins (see Figure 2.4) also influences the marine receiving waters of the Black Ross WQIP area, and especially Cleveland Bay.

Figure 2.4 Burdekin River Influence on Black Ross WQIP Area



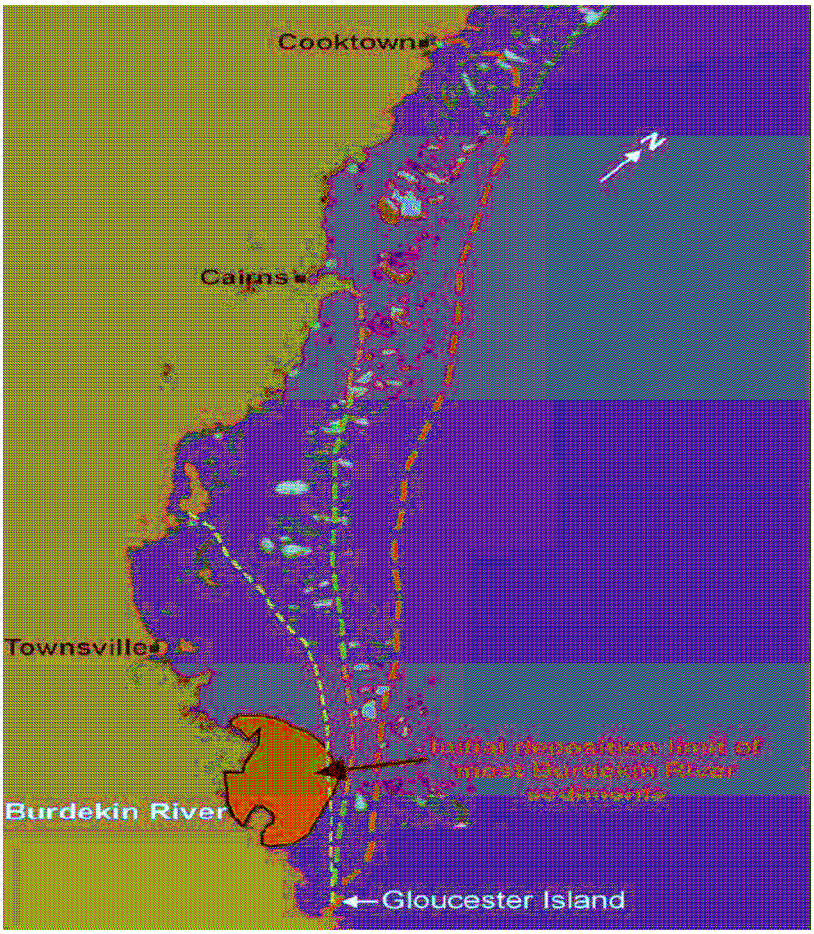
Source: Lewis et al 2006 ACTFR Report No. 06/02 (p.51)

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.

"*Most sediments in the Burdekin River plume flocculate and settle out within 10 km from the delta* (see Figure 2.5)*, 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).

Figure 2.5 Burdekin River Sediment Extent



Source: Lewis et al 2006 ACTFR Report No. 06/02 (p.42)

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.

While the percentage of fine sediment from the Burdekin River discharge reaching Cleveland Bay is relatively small due to the high sediment load discharged from the Burdekin River the amount of fine sediment can be significant (see Table 2.1). Nutrients are also discharged from the Burdekin River and add to the loads discharged from the Black Ross WQIP area direct to Cleveland Bay and Halifax Bay.

Table 2.1 Relative Basin Size and Pollutant Discharge

Parameter	Black	Ross	Haughton	Burdekin
Catchment size (km²)	907	1,296	3,983	130,035
Total land use (%)	57.06	71.94	81.45	95.84
Annual run-off volume (km³)	0.38	0.49	0.74	10.29
Annual sediment export (tonnes)	140,000	180,000	270,000	3,770,000
Average suspended sediment event (mg/L)	N/A	22	110	394
Range of suspended sediment event (mg/L)	N/A	3-69	41-200	74-3,559
TN export (tonnes)	319	411	621	8,633
TP export (tonnes)	63	81	122	1,695

Extracted from Lewis et al 2006, p.1 (Table 1)

2.3 Marine Receiving Waters 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 terrestrial runoff from various land use activities within the WQIP area. Land use is mostly urban and peri-urban in the Ross Basin and predominantly rural in the Black Basin. Flood plumes originating from the Burdekin and Haughton Basins also influence the marine waters of the Black Ross WQIP area, particularly during large flood events.

Recent water monitoring quality data (see Lewis et al 2008) and) and modelling (see BMT WBM 2009 and 2010) 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 around 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 runoff and the re-suspension of sediment associated with wind and wave action in 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 a range of ecosystem health parameters. Site description and sampling frequency is shown in Table 2.2 and results from this program are presented in Table 2.3. Marine sampling sites within and near the Black Ross WQIP area are displayed in Figure 2.6.

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. 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 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 lower rows and historic chlorophyll a sampling sites are listed in the upper rows. The [numbers] in the site description column indicate chlorophyll a sites that are in similar locations to MMP sites i.e. [1] Inside Cleveland Bay is in a similar position to [1] Cleveland Bay (middle). See Figure 2.6 for site locations.

Figure 2.6 Black Ross WQIP Marine Sampling Points

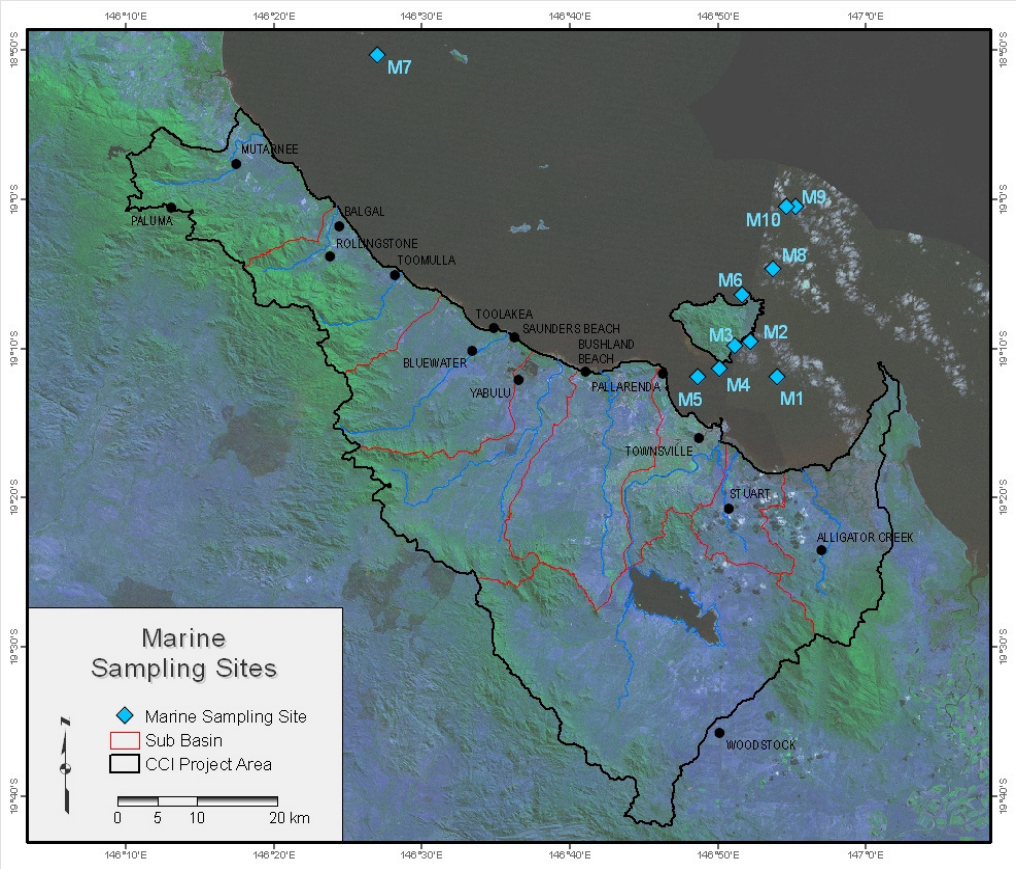


Table 2.3 MMP Sampling Results (Mean)

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]).

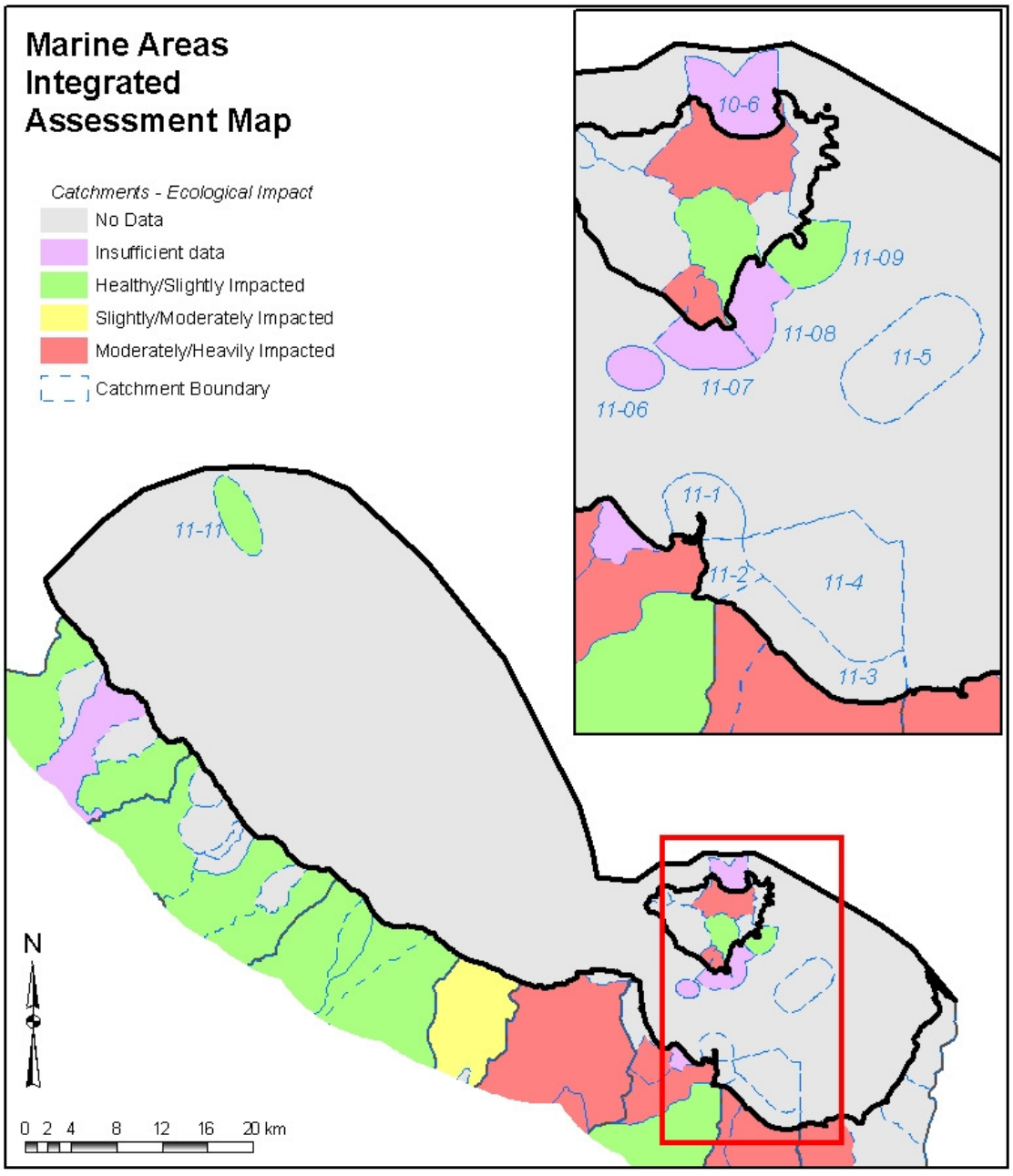
Studies suggest that generally the Burdekin average for hard coral cover is lower while macroalgae cover is higher when compared with other GBR regions. This may be attributed to the frequency and severity of disturbances to reefs in this region in recent times. Of the reefs monitored in the WQIP region 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.

A water quality condition analysis (Connell Wagner 2008) indicated that generally there is insufficient data to adequately assess the water quality for the marine areas of Cleveland Bay, Halifax Bay and the waters around Magnetic Island (see Figure 2.7). 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 2.7 Marine Areas Ecological Impact



Source: Connell Wagner 2008

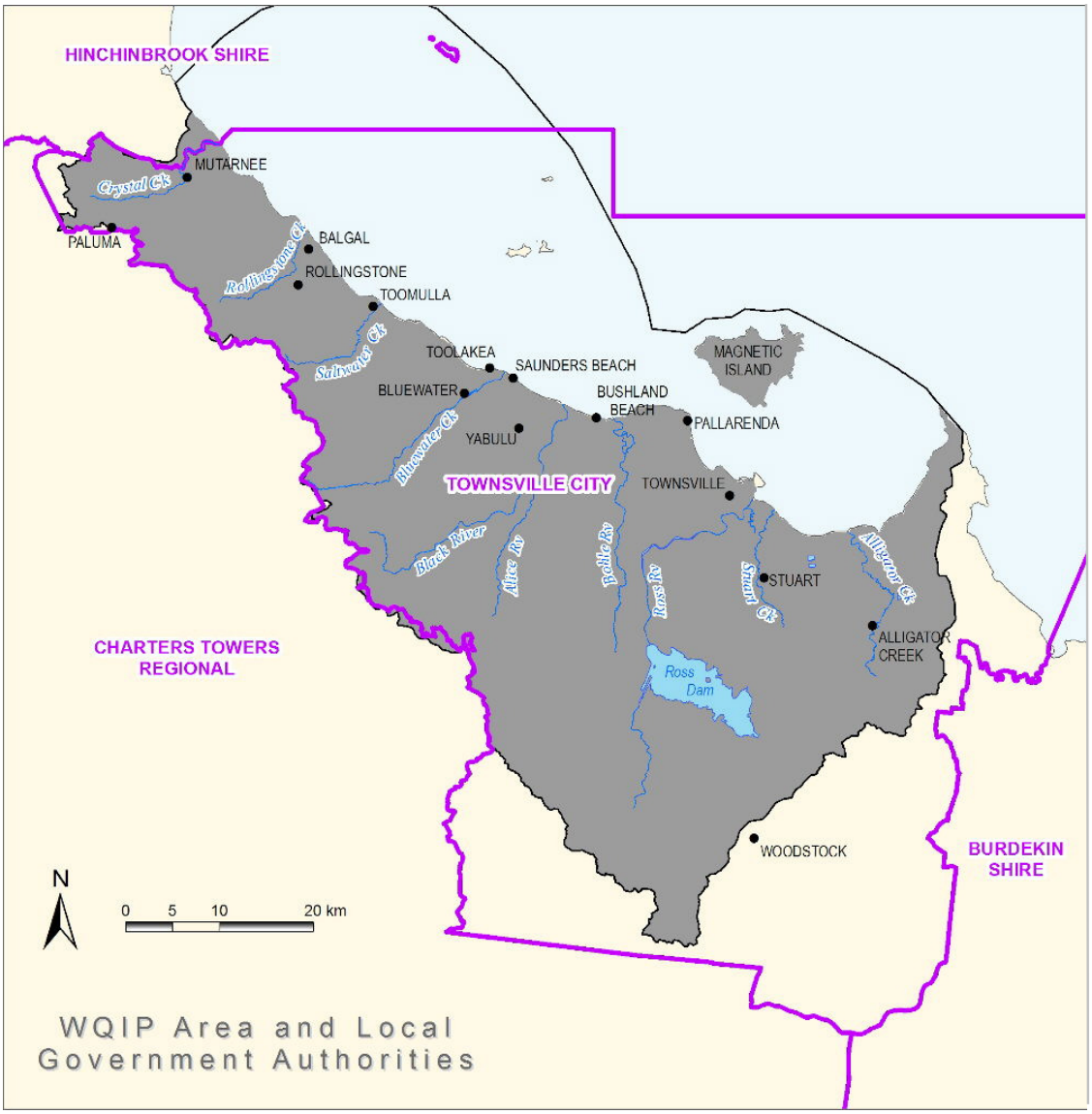
3. WQIP Area Overview

3.1 Introduction

Statistical and descriptive information is not readily available for the overall Black Ross WQIP area so a number of aggregations and disaggregations were required to provide a relevant overview (see *Black Ross Water Quality Improvement Plan – Socio-Demographic Profile* (Cardiff 2009) Townsville City Council). 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 some modifications to fit the WQIP area.

The Black Ross WQIP area is shown in relation to the Townsville City local government area in Figure 3.1.

Figure 3.1 Black Ross WQIP Area and Townsville LGA

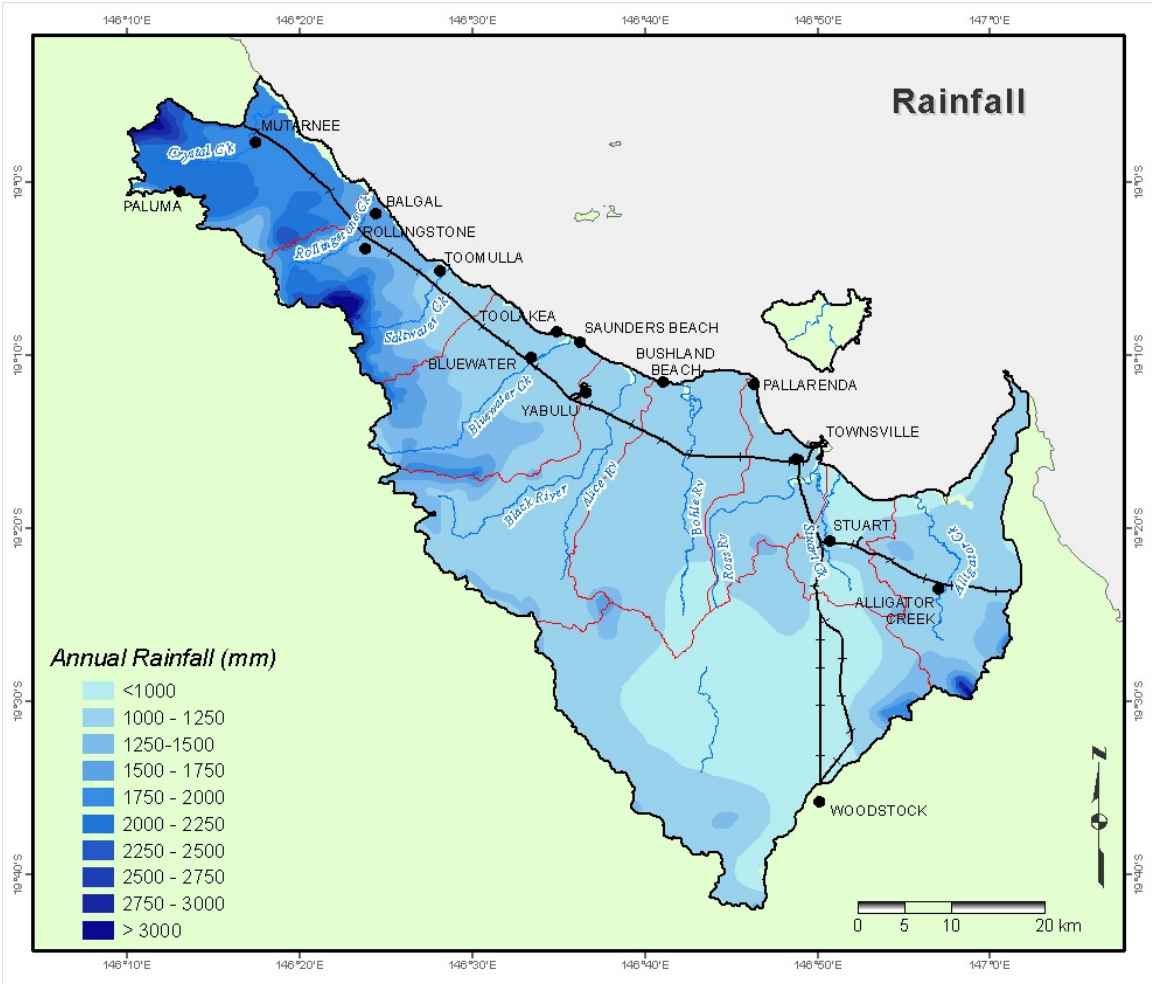


3.2 Climate

The region typically experiences a dry tropical climate, characterised by distinct wet and dry seasons. 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.

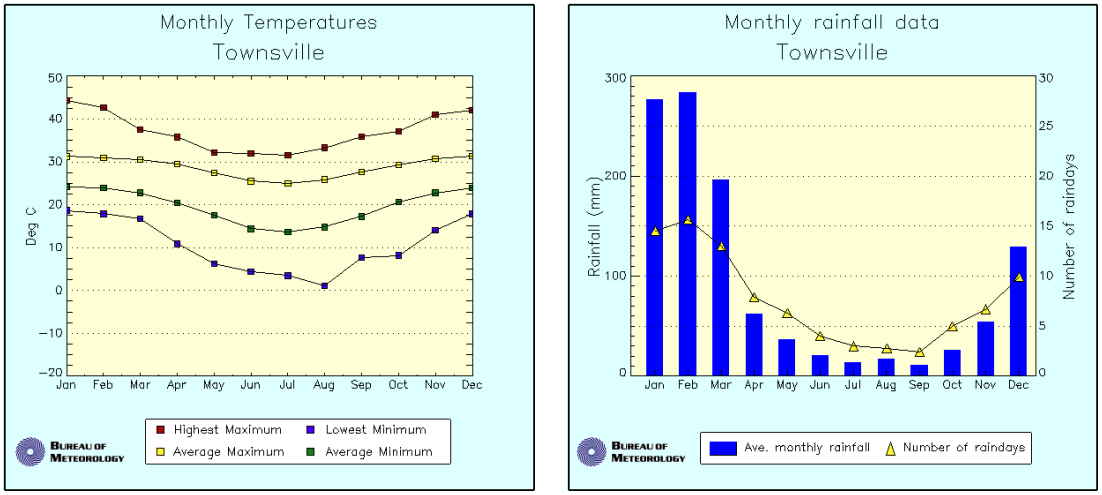
The average annual rainfall for Townsville is approximately 1,100 millimetres with substantial variation across the region from a high of 2,571 millimetres at Paluma (northern ranges) to a low of 853 millimetres at Woodstock on the western boundary of the WQIP area (see Figure 3.2). In comparison evaporation for Townsville is approximately 2,400mm per annum (BOM records 1969-1999).

Figure 3.2 Rainfall



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

Figure 3.3 Climatic graphs

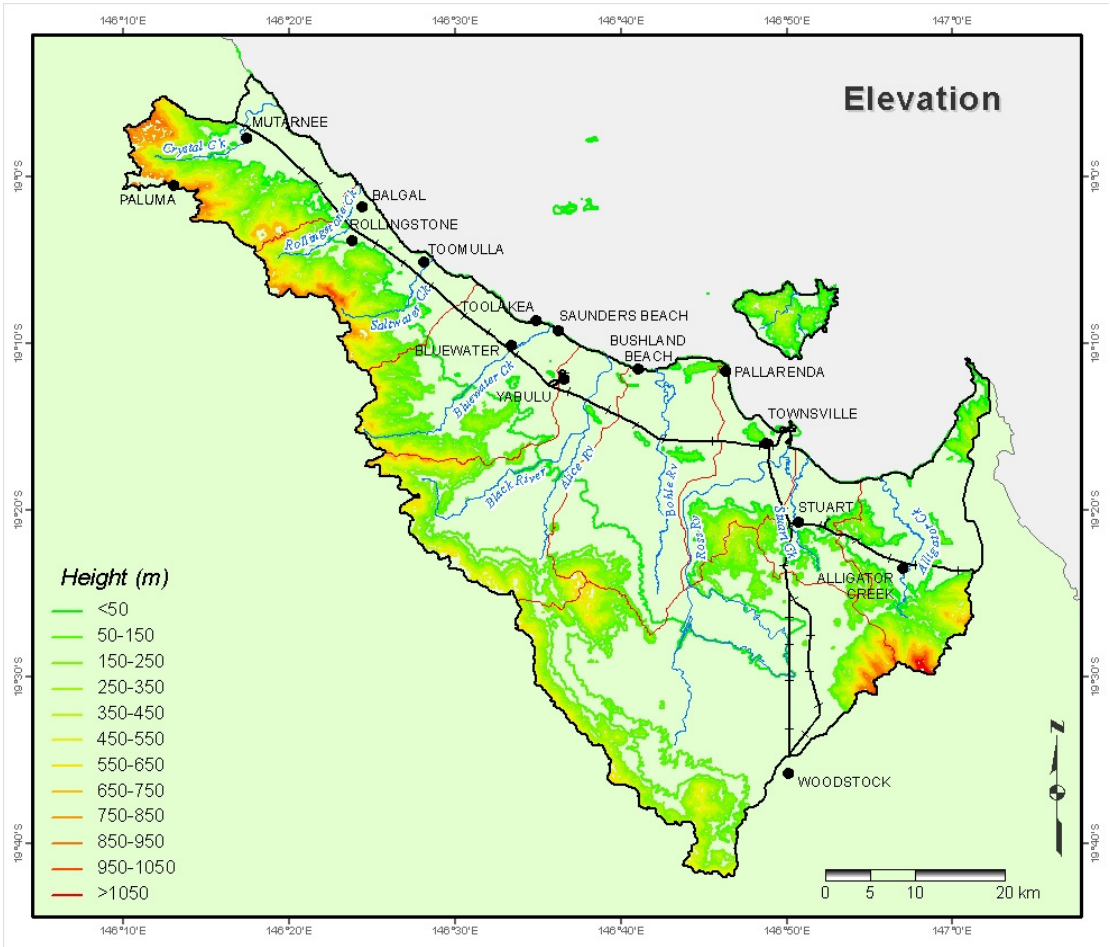


Source: Bureau of Meteorology (BOM)

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).

Figure 3.4 Elevation/Relief Map



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

The region can be roughly divided into four distinctive geographic sub-regions (see Figure 3.5):

- 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 on 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.

With the exception of some wet tropics vegetation on the Paluma Range and Mt Elliot (geographic sub-regions 1 and 3), the Black Ross (Townsville) WQIP area primarily consists of savanna landscapes generally described as the Dry Tropics. The Townsville dry tropics environment is primarily a function of the climatic regime, the underlying geology and the topographic features of the region. Sections of the ranges in geographic sub-region 1 are part of the Wet Tropics World Heritage Area (WHA).

Figure 3.5 Black Ross WQIP Geographic Sub-regions

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

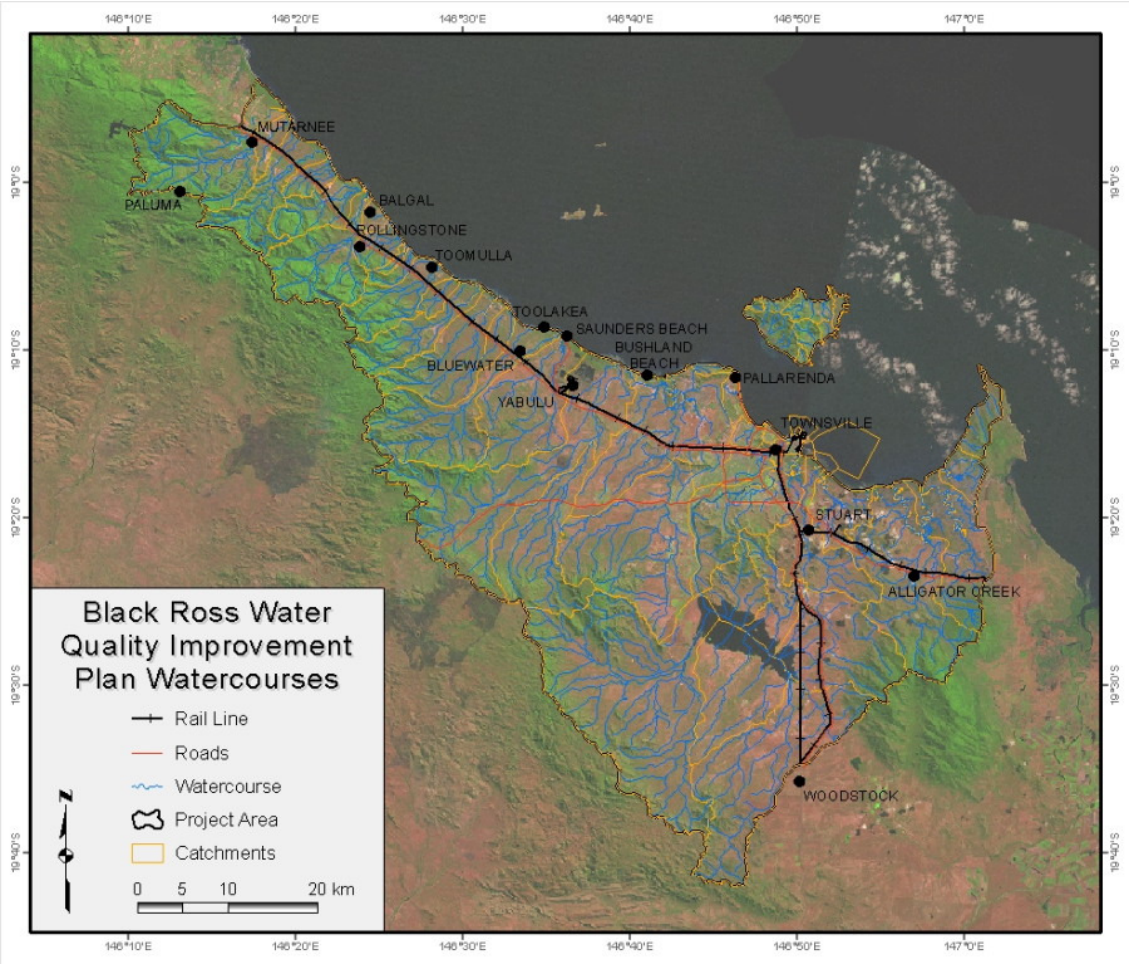
The main environmental features of the region are described briefly in the following sections.

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/south, at the headwaters, to northeast/north at the coast.

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 minor tributaries, of the study area are illustrated in Figure 3.6 with more detailed drainage patterns for each sub basin in Chapters 5 to 14.

Figure 3.6 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 Orogenic 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 the 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 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 the 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.

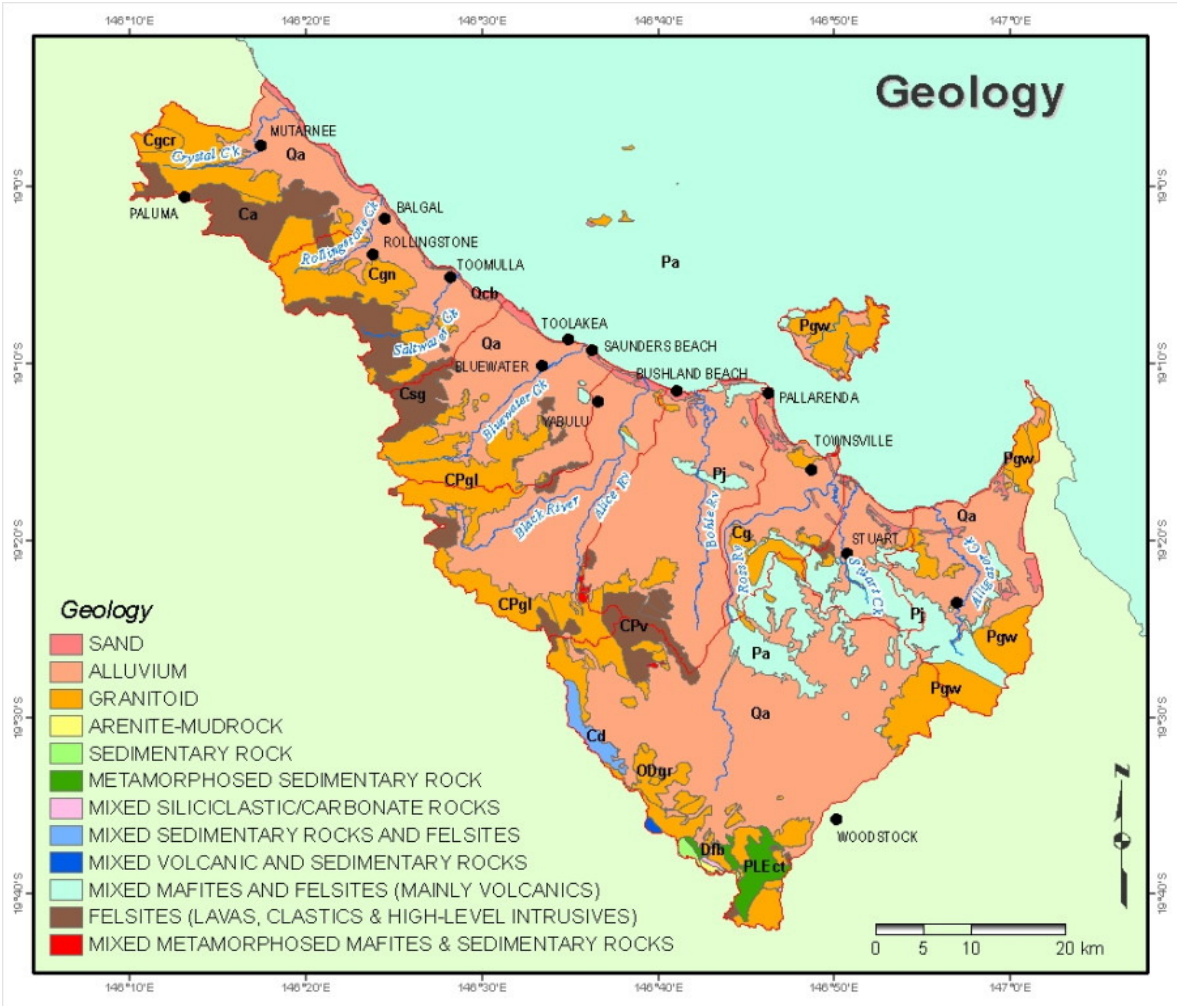
The coastal plain as we see it now is composed of relatively coarse recently weathered and eroded material at the base of the Hervey Range grading into the older (Pleistocene) alluvial plains towards the coast. The material of the alluvial plains was deposited mainly by braided stream systems with a 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.

The main geological features of the Black Ross (Townsville) WQIP areas are illustrated in Figure 3.7. A key to the geological features is provided in Table 3.1.

Figure 3.7 Main Geological Features



Source: Department of Natural Resources, Mines and Energy (now DERM). Extracted from the Mineral and Energy Resources Location and Information Netowrk (MERLIN) corporate database, July 2004. The data was captured at a scale of 1:25,000. Also applies to Table 3.1

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 soils). 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	105,600		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)

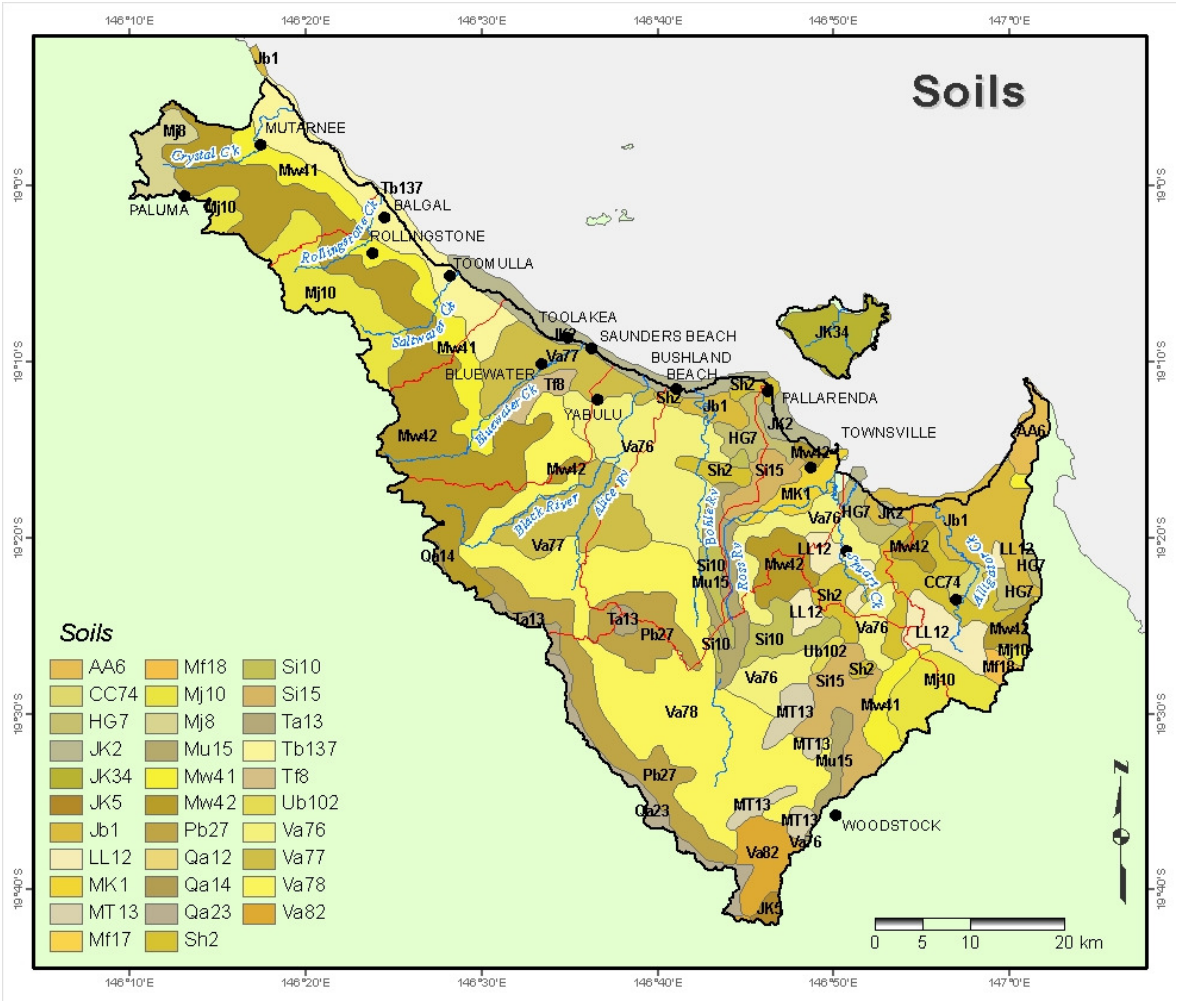
Table 3.3 Australian Great Soil Groups

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)

Soil type distribution across the Black Ross (Townsville) WQIP area is illustrated in Figure 3.8 with a key to the soil types listed in Table 3.4.

Figure 3.8 Soils



Source: Digital version of the Atlas of Australian Soils at 1:2,000,000 (Northcote et al. 1960-1968). Digital version created by NRIC in 1991 from scanned tracings of the published hardcopy maps. Original survey completed by CSIRO. Also applies to Table 3.4

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).

"*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 to 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)

3.3.4 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 occurring 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 southeast 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

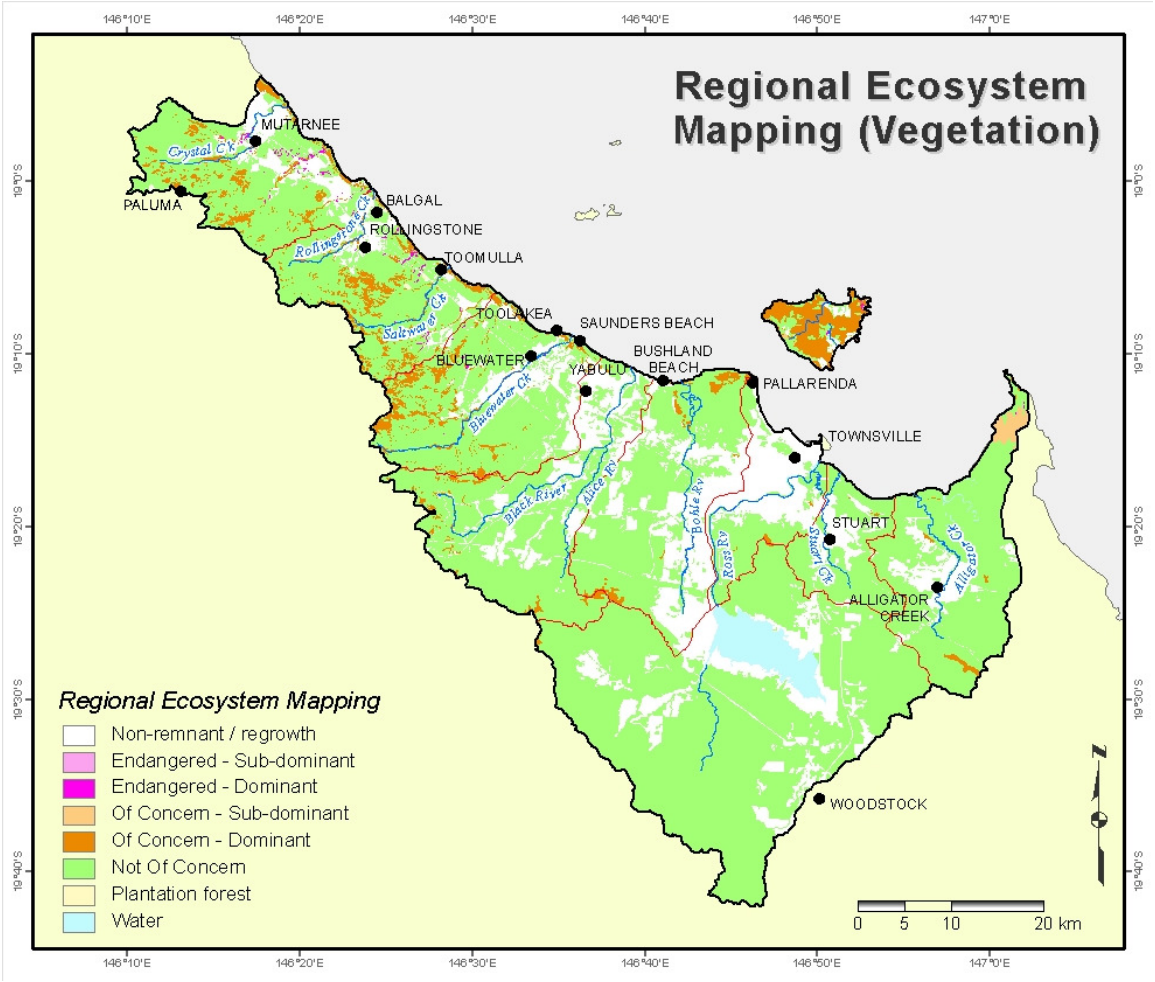
Element	Black River (117)	Ross River (118)	GBR Catchment
Basin area (km²)	1,057	1,707	423,070
Cleared (km²)	55 – 5.2% [16.2%] (17%)	336 – 19.7% [25%] (26.3%)	95,100 - 22% [37.6%] (38.3%)
Thinned (km²)	446	893	147,000 - 35%
Uncleared (km²)	539	442	169,000 - 40%
Intermediate (km²)			9,216 – 2.2%
Unclassified (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 regional ecosystem mapping (DERM/EPA) in Figure 3.9. 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 3.9 Remnant Vegetation (Regional Ecosystem) Status



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.

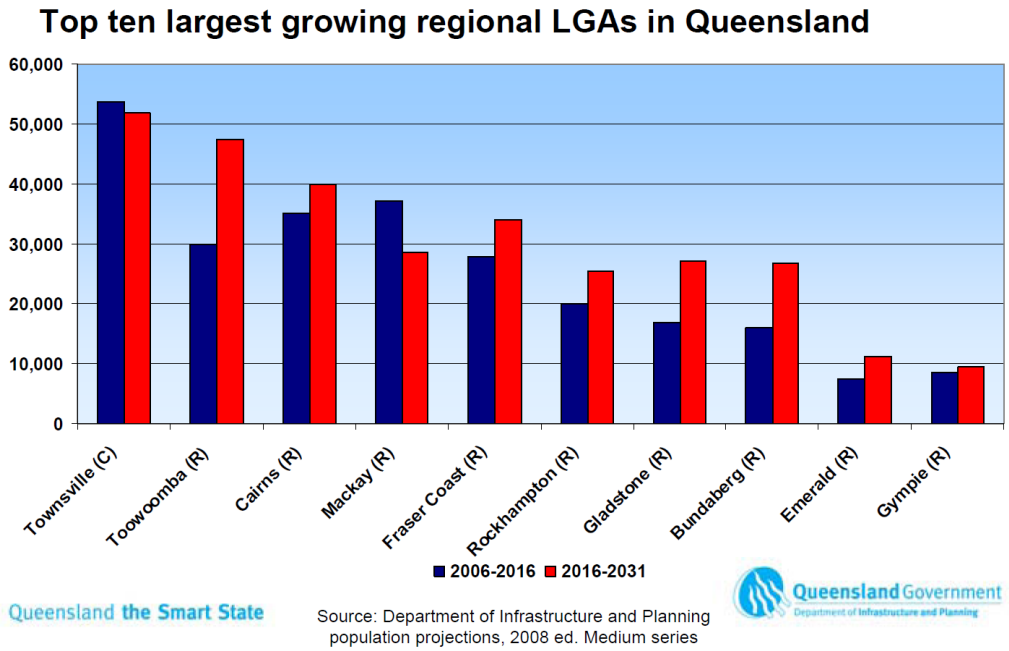
3.4 Socio Economic Summary

The following summary is indicative of the growth being experienced in Queensland and does not reflect a sustainable environmental situation.

3.4.1 People

The amalgamated City of Townsville covers an area of 3,736 square kilometres, encompassing the Black Ross (Townsville) 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 3.10).

Figure 3.10 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 3.11.

Table 3.7 Estimated Resident Population Growth Trends

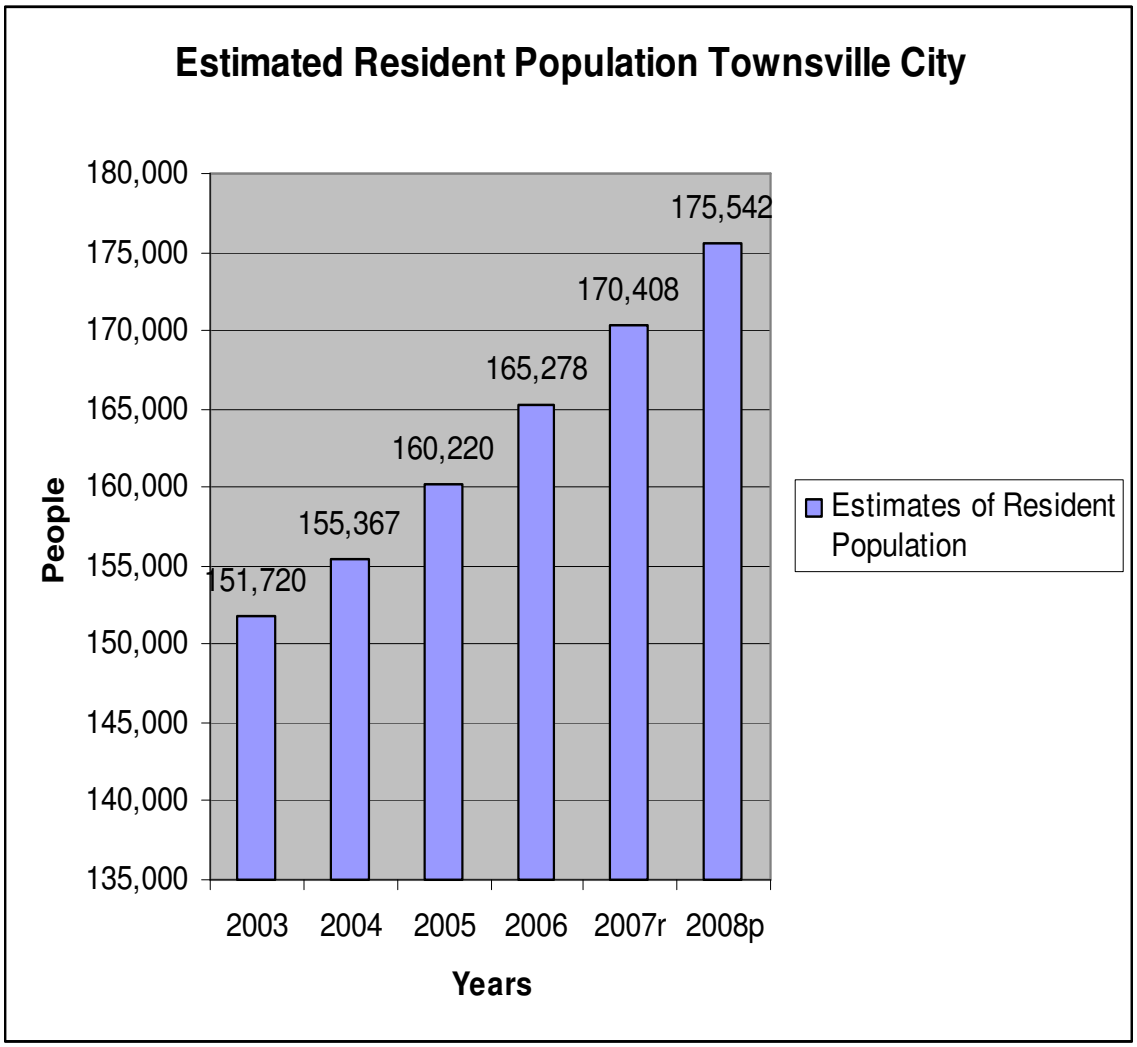
Year at 30 June	Number	Year to 30 June	Number	Percent
2003	151,720			
2004	155,367	2004	3647	2.40%
2005	160,220	2005	4853	3.10%
2006	165,278	2006	5058	3.20%
2007r	170,408	2007r	5130	3.10%
2008p	175,542	2008p	5134	3.00%
2003-2008p			Average	3.00%

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 3.11 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 and Australia (both 2.6 people). It is likely that the young population profile for Townsville, which includes significant numbers of families with children, is the main 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 1,743 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 has helped the City develop its diverse economy. The strength and diversity of the Townsville economy is reflected in the high employment levels (Table 3.9) and broad range of industries of employment (see Table 3.10).

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 the Townsville City local government area (LGA), 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 individual income for Townsville at the 2006 Census was $ 531.00, median weekly 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)

"*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 annually. 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.*

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)

Figure 3.12 Population Growth Impacts the GBR

3.4.5 Land Use

In conjunction with the physical environment it is land use and associated 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 3.13 and Figure 3.14.

Table 3.12 Black Ross WQIP Area Land Use 2005

Land use (Secondary/tertiary)	Hectares	%
Nature conservation	61,815	23.03
Other minimal use	35,467	13.21
Grazing natural vegetation	133,450	49.72
Forestry	73	0.03
Cropping	188	0.07
Perennial horticulture	16	0.01
Irrigated cropping	485	0.18
Irrigated sugar	1,748	0.65
Irrigated perennial horticulture	235	0.09
Irrigated tree fruits	913	0.34
Irrigated tree nuts	9	0.00
Irrigated fruits	375	0.14
Irrigated vegetables & herbs	51	0.02
Poultry	14	0.01
Aquaculture	266	0.10
Manufacturing and industrial	2,369	0.88
Urban residential	9,232	3.44
Rural residential	7,229	2.69
Services	2,817	1.05
Electricity generation/transmission	31	0.01
Airports/aerodromes	970	0.36
Railways	106	0.04
Mining	610	0.23
Waste treatment and disposal	112	0.04
Reservoir/dam	4,530	1.69
River	648	0.24
Channel/aqueduct	7	0.00
Marsh/wetland	4,634	1.73
Total hectares	268,400	

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)

Secondary and Tertiary Land Use	Adopted Land Use Groups	Hectares	%
Nature conservation, Other minimal use	Conservation and natural areas	98,527	36.7
Grazing natural areas, Production forestry	Grazing	132,209	49.3
Residential.	Rural residential	8,173	3.0
Cropping, Perennial horticulture, Plantation forestry, Irrigated cropping, Irrigated horticulture (perennial and seasonal), Intensive animal production.	Intensive agriculture	4,108	1.5
Residential, Manufacturing and industrial, Services, Utilities, Transport and communication, Waste treatment and disposal, Mining.	Urban	15,565	5.8
Channel/aqueduct, Marsh/wetland, Reservoir/dam, River.	Water and wetlands	9,819	3.7

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	%
Nature Conservation	11,786	49.2	15,865	72.1	1,645	5.7	1,962	6.5	3,197	9.9	944	7.0	8,218	10.9	1,366	13.2	14,194	53.6	2,639	52.9
Other minimal use	7,365	30.7	2,863	13.0	3,133	10.8	1,962	6.5	2,053	6.4	4,584	34.0	7,461	9.9	1,704	16.4	3,663	13.8	1,924	38.6
Grazing Natural Vegetation	2,287	9.5	2,382	10.8	21,893	75.4	23,063	75.9	19,018	59.0	316	2.3	54,082	71.7	5,054	48.7	4,111	15.5		
Production Forestry	1	0.0	2	0.0																
Plantation Forestry			70	0.3																
Cropping	10	0.0	28	0.1			103	0.3	4	0.0							43	0.2		
Irrigated Cropping	1,697	7.1	52	0.2			7	0.0	88	0.3			63	0.1	299	2.9	26	0.1		
Irrigated Perennial Horticulture	88	0.4	70	0.3	77	0.3	58	0.2	299	0.9			323	0.4	56	0.5	185	0.7		
Irrigated Seasonal Horticulture	178	0.7	215	1.0									35	0.0			15	0.1		
Perennial Horticulture	4	0.0							10	0.0							3	0.0		
Intensive Animal Production			40	0.2	117	0.4			101	0.3					23	0.2				
Residential	171	0.7	253	1.1	1,473	5.1	2,081	6.9	4,755	14.8	4,046	30.0	647	0.9	191	1.8	2,439	9.2	383	7.7
Manufacturing and industrial					48	0.2	564	1.9	1007	3.1	381	2.8	11	0.0	353	3.4			5	0.1
Services	25	0.1	34	0.2	45	0.2	58	0.2	532	1.7	2,004	14.9	75	0.1	32	0.3			27	0.5
Transport and Communication	85	0.4	15	0.1			7	0.0	485	1.5	416	3.1			68	0.7				
Utilities									21	0.1	9	0.1			2	0.0				
Waste treatment and disposal			5	0.0	4	0.0			17	0.1					62	0.6			13	0.3
Mining	4	0.0			177	0.6			110	0.3	21	0.2	173	0.2	116	1.1	11	0.0		
Channel/Aqueduct					7	0.0														
Reservoir/Dam	2	0.0	5	0.0	20	0.1	5	0.0	3	0.0	149	1.1	4,332	5.7	14	0.1				
River	61	0.3	10	0.0	58	0.2	343	1.1	16	0.0	91	0.7	27	0.0			43	0.2		
Marsh/Wetland	205	0.9	96	0.4	341	1.2	165	0.5	514	1.6	515	3.8	12	0.0	1,033	10.0	1,755	6.6		
Total (hectares)	23,969		22,003		29,037		30,377		32,229		13,475		75,460		10,371		26,489		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 3.13 Land Use 2005

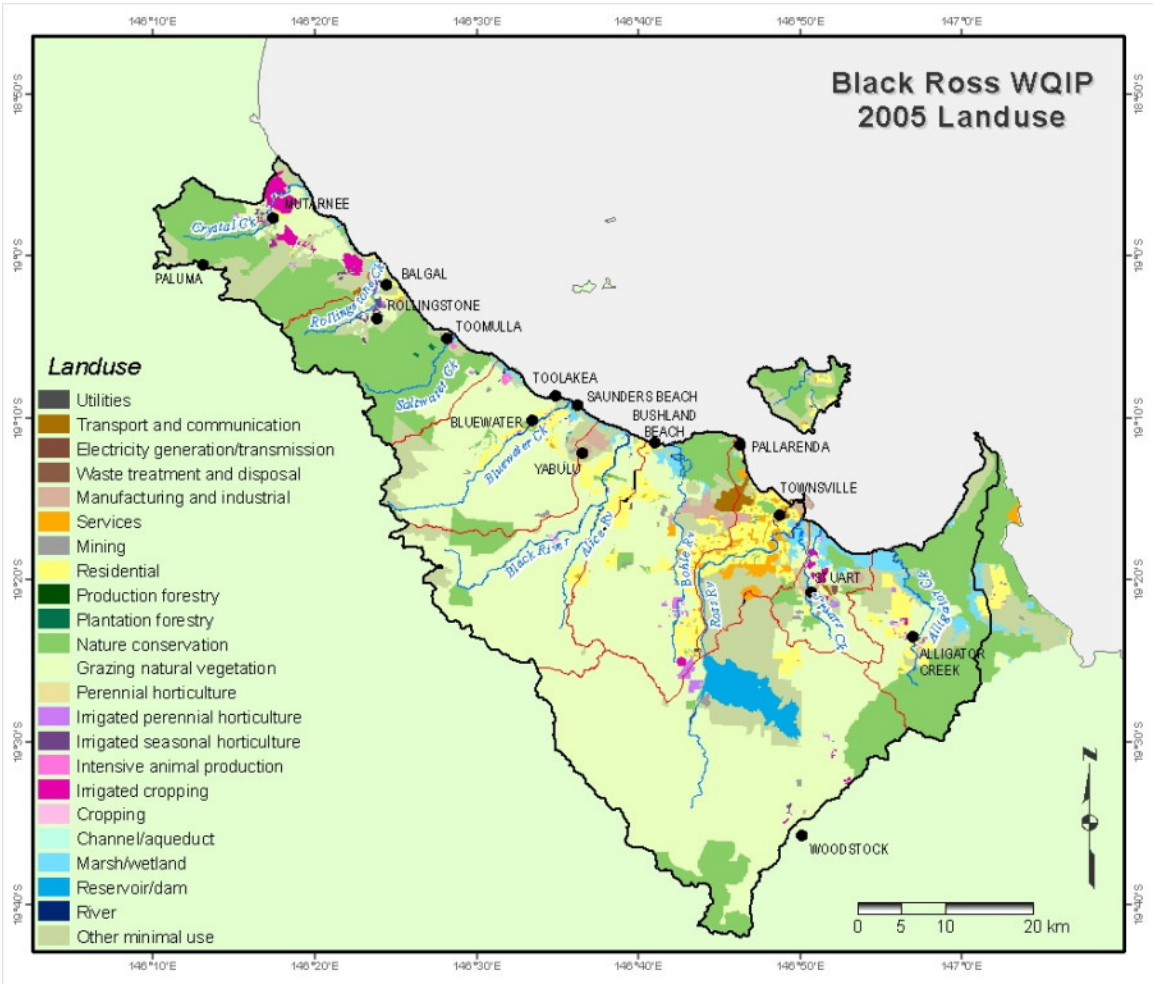
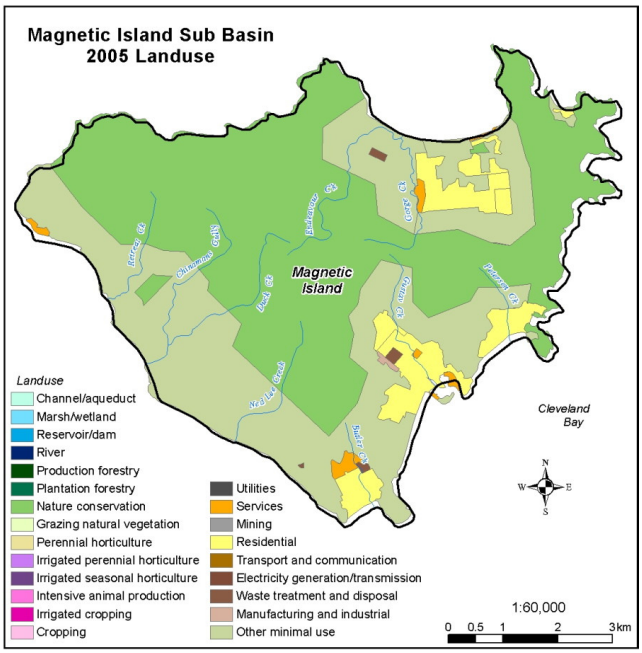


Figure 3.14 Magnetic Island Land Use 2005



Land use categories have been grouped and subdivided for different studies as part of the process of developing the Black Ross WQIP. This was seen as necessary as the urban component of the study area is a significant factor in determining water quality condition and pollutant loads. Various land use divisions adopted for elements of the Black Ross WQIP, and their relationship to each other, are shown in Table 3.15.

Table 3.15 Initial Land Use Divisions by Study

Pollutant source identification	WaterCAST Modelling	Bayesian Belief Network (BBN)
Rural		
Minimal Use/Natural Areas	Greenspace (includes forestry)	Natural areas/minimal use *
		Forestry
Intensive agriculture	Agriculture (intensive)	Intensive agriculture/Horticulture
Rural (with rural residential)	Grazing	Grazing
Urban		
Urban/residential	Traditional i.e. houses Dense i.e. units etc	Traditional residential * High density residential
Commercial	Commercial	Commercial/Light industrial *
Industry (includes ports and railways)	Industry (includes manufacturing, services, utilities, transport and waste treatment and disposal)	Heavy industry (includes manufacturing, some services, some utilities, ports, railways, airports and waste disposal)
	Other	**Low urban**
		Formal parkland
	Rural residential	Peri-urban/Rural residential *
	Mining	Mining
		Bare ground (developing urban) *
	Water	(Water to be separated from natural areas/minimal category)

Note: Separate rows are assigned to the landuse category adopted for each of the studies. The BBN project has adopted three primary land use categories i.e. rural, urban and low urban, and placed the sub categories within these. Low urban is conceptualised as the zone between urban and rural areas where the next 'wave' of development is likely to take place. *Primary land use categories used by ACTFR in event monitoring 2006-2008 – Established urban, developing urban, light industrial, urban industrial, rural residential, minimal use and conservation.

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 the 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

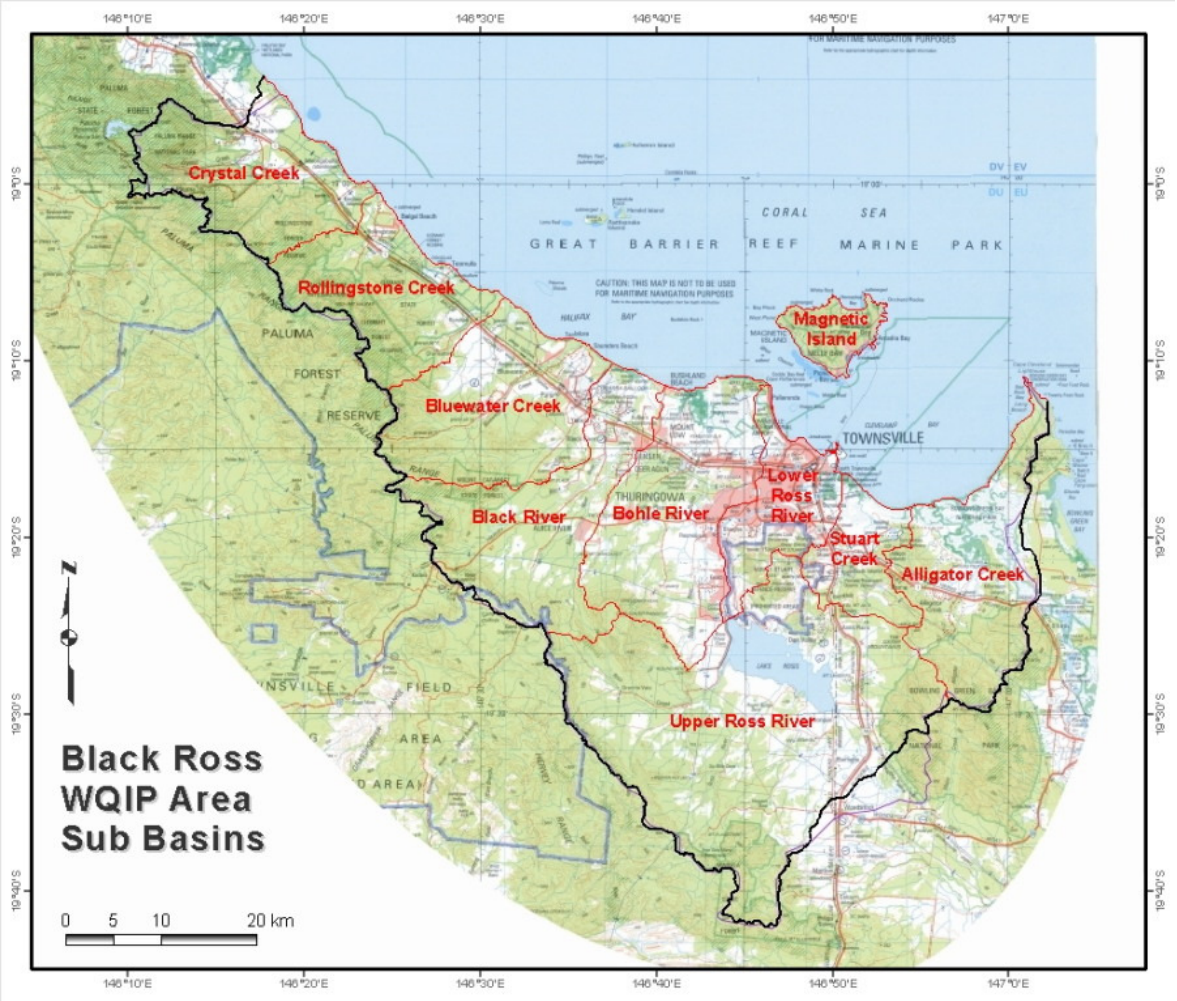
4.1 Components of the WQIP Area

The coastline of the Black Ross (Townsville) 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 268,400 hectares (~2,700 square kilometers). This represents approximately 0.6% of the total area of the GBR catchments. While not a large area in terms of the GBR catchment the Black Ross (Townsville) WQIP area is home to approximately 20% of the GBR catchment population.

As previously described the land area of the Black Ross (Townsville) 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 4.5). 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	23,969	240	8.9
Black River	2	Rollingstone Creek	22,003	220	8.2
Black River	3	Bluewater Creek	29,037	290	10.8
Black River	4	Black River	30,377	304	11.3
		Black River Basin sub total	105,386	1,054	
Ross River	5	Bohle River	32,229	322	12.0
Ross River	6	Lower Ross River	13,475	135	5.0
Ross River	7	Upper Ross River	75,460	755	28.1
Ross River	8	Stuart Creek	10,371	104	3.9
		Ross River Basin sub total	131,535	1,315	
Haughton River	9	Alligator Creek	26,489	265	9.9
	10	Magnetic Island	4,990	50	1.9
		Total	**268,400**	2,684	

Note: Total area of the Black Ross WQIP area equals the area of the Black and Ross Basins plus the area of part of the Haughton River Basin (Alligator Creek sub basin) and Magnetic Island sub basin.

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 km² compared to the AWR Ross Basin area of 1,315 km² (difference = 392 km²). Variation in figures associated with the Ross Basin is generally a result of this discrepancy, along with smaller standard errors associated with 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 4.4.

Table 4.2 General Statistics Black and Ross Basins

Element	Black River (117)	Ross River (118)
Area (km²)	1,057	1,707
% 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	1,530	1,027
Ave annual runoff mm	360	287
% runoff	23	28
Population	10,605 *	140,072 *
Clearing (km²)	501	1,229
% Cleared	47	72
Area under Grazing (km²)	802	1,481
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 1,057 km². Grazing is the dominant land use occupying 802 km². Other land uses are; sugarcane farming covering 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:*

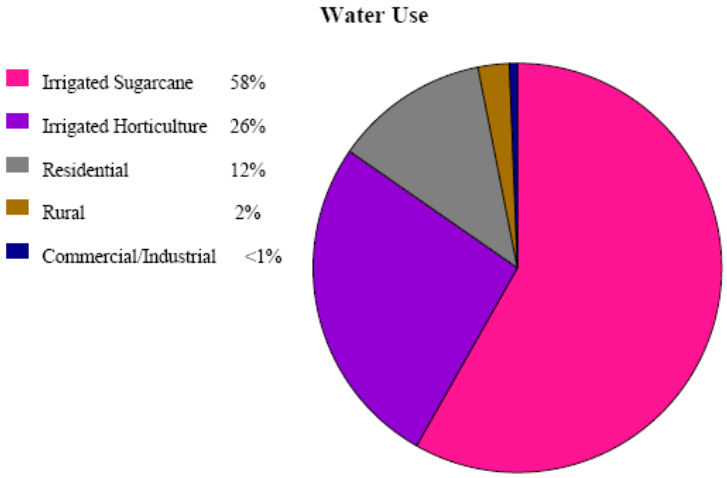
- *There are problems of ground water supplies in the Black River;*
- *Significant quantities of sand and gravel are extracted from the Black River for the Townsville market, creating an in-stream environmental impact;*
- *The riverbanks are severely eroded;*
- *Significant area of the Catchment has 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 1,707 km². Grazing is the dominant land use occupying 1,481 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:

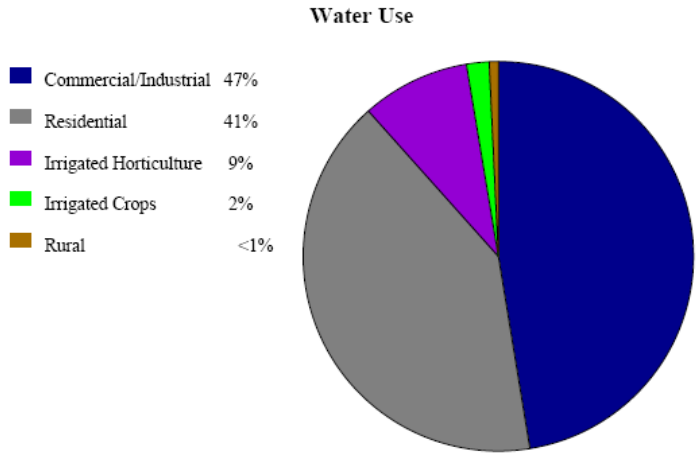
- *Grazing lands are in reasonably good condition with only minor gully and sheet erosion;*
- *Most native grasses are still present;*
- *The Ross River Dam is a major source of the Townsville water supply;*
- *The catchment contains the heavily urbanised City of Townsville and its small surrounds and 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 lowland 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.

Figure 4.4 Bohle River February 2010

4.5 Sub Basins and Catchments

Catchments are shown by sub basin in Figure 4.5 and Figure 4.6 with areas listed in Table 4.5. Catchment profiles are provided by sub basin in chapters 5 to 14, commencing from the northern end of the WQIP study area.

Figure 4.5 Black Ross Sub Basins and Catchments

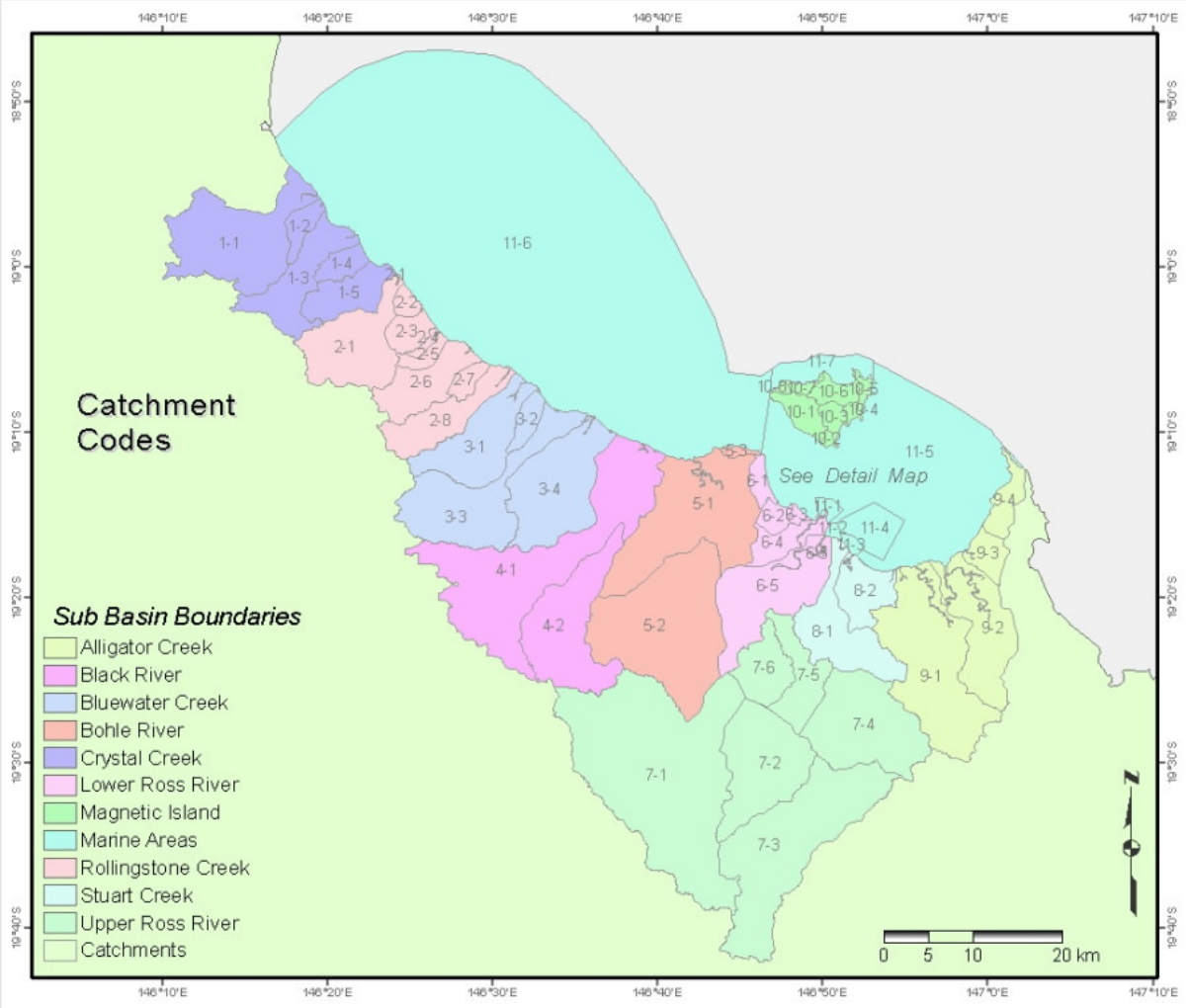


Table 4.5 Black/Ross WQIP catchment areas

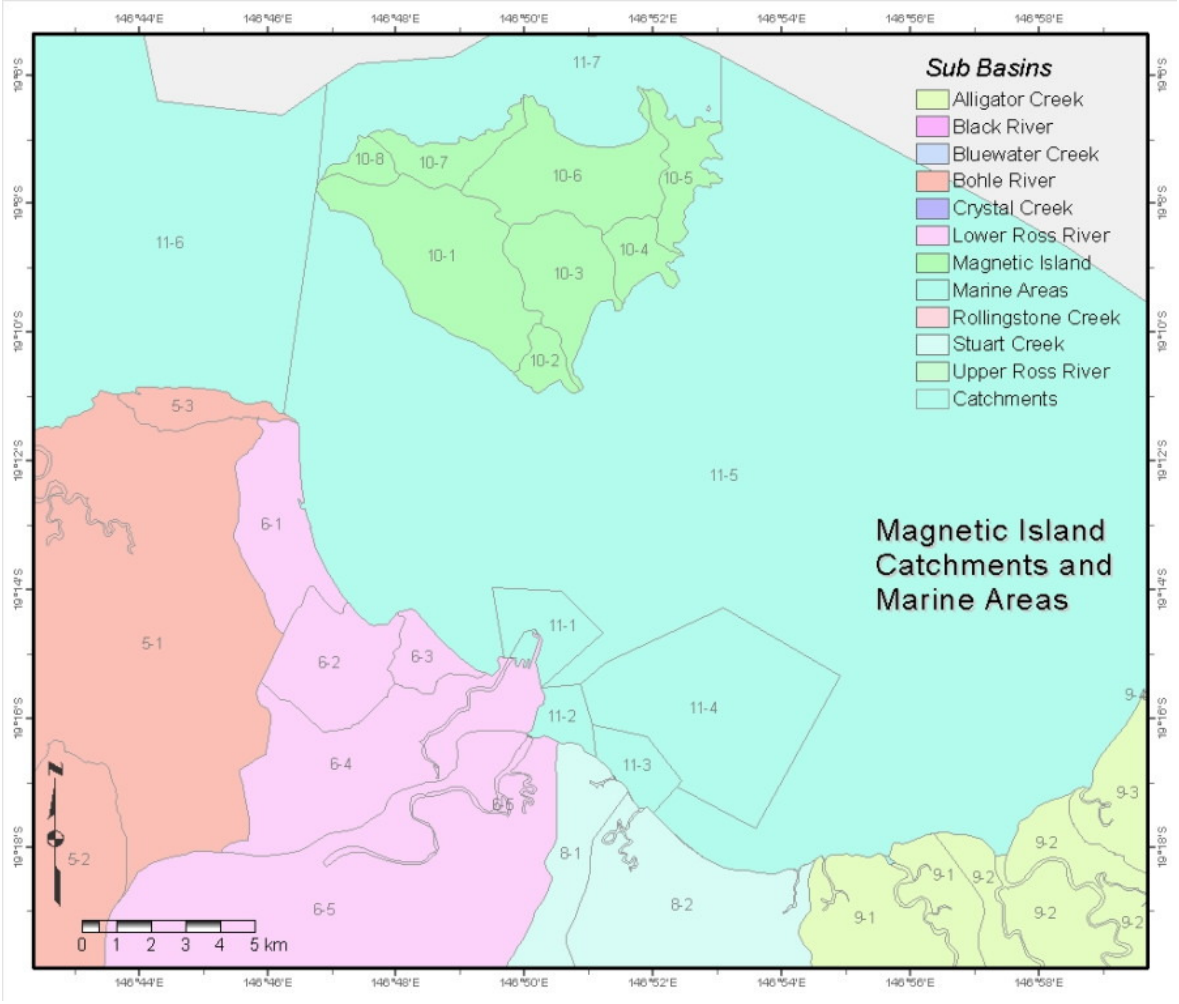
AWRC Basin	Sub Basin	No.	Catchment	Hectares	km²	% area
Black River	Crystal Creek	1-1	Crystal Creek	11,592	116	4.3
Black River	Crystal Creek	1-2	Lorna Creek	1,424	14	0.5
Black River	Crystal Creek	1-3	Ollera Creek	5,769	58	2.1
Black River	Crystal Creek	1-4	Scrubby Creek	1,467	15	0.5
Black River	Crystal Creek	1-5	Hencamp Creek	3,716	37	1.4
Black River	Rollingstone Creek	2-1	Rollingstone Creek	7,732	77	2.9
Black River	Rollingstone Creek	2-2	Unnamed	731	7	0.3
Black River	Rollingstone Creek	2-3	Surveyors Creek	1,674	17	0.6
Black River	Rollingstone Creek	2-4	Wild Boar Creek	344	3	0.1
Black River	Rollingstone Creek	2-5	Station Creek	882	9	0.3
Black River	Rollingstone Creek	2-6	Saltwater Creek	4,662	47	1.7
Black River	Rollingstone Creek	2-7	Cassowary Creek	997	10	0.4
Black River	Rollingstone Creek	2-8	Leichhardt Creek	4,981	50	1.9

Black River	Bluewater Creek	3-1	Sleeper Log Creek	7,169	72	2.7
Black River	Bluewater Creek	3-2	Two Mile Creek	1,338	13	0.5
Black River	Bluewater Creek	3-3	Bluewater Creek	10,492	105	3.9
Black River	Bluewater Creek	3-4	Deep Creek	10,057	101	3.7
Ross River	Black River	4-1	Black River	20,389	204	7.6
Black River	Black River	4-2	Alice River	9,988	100	3.7
Ross River	Bohle River	5-1	Bohle River	14,583	146	5.4
Ross River	Bohle River	5-2	Bohle River 2	17,289	173	6.4
Ross River	Bohle River	5-3	Shelly Beach	357	4	0.1
Ross River	Lower Ross River	6-1	Pallarenda	963	10	0.4
Ross River	Lower Ross River	6-2	Mundy Creek	971	10	0.4
Ross River	Lower Ross River	6-3	Esplanade	292	3	0.1
Ross River	Lower Ross River	6-4	Ross Creek	2,225	22	0.8
Ross River	Lower Ross River	6-5	Ross River (btd)	9,023	90	3.4
Ross River	Upper Ross River	7-1	Ross River (atd)	30,247	302	11.3
Ross River	Upper Ross River	7-2	Six Mile Creek	9,625	96	3.6
Ross River	Upper Ross River	7-3	Toonpan Lagoon	16,935	169	6.3
Ross River	Upper Ross River	7-4	Antill Plains Creek	10,726	107	4.0
Ross River	Upper Ross River	7-5	Sachs Creek	4,130	41	1.5
Ross River	Upper Ross River	7-6	Mt Stuart	3,798	38	1.4
Ross River	Stuart Creek	8-1	Stuart Creek	6,727	67	2.5
Ross River	Stuart Creek	8-2	Sandfly Creek	3,644	36	1.4
Haughton River	Alligator Creek	9-1	Alligator Creek	14,767	148	5.5
Haughton River	Alligator Creek	9-2	Crocodile Creek	7,995	80	3.0
Haughton River	Alligator Creek	9-3	Cocoa Creek	1,716	17	0.6
Haughton River	Alligator Creek	9-4	Cape Cleveland	2,011	20	0.7
	Magnetic Island	10-1	West Coast	1,632	16	0.6
	Magnetic Island	10-2	Picnic Bay	177	2	0.1
	Magnetic Island	10-3	Nelly Bay	777	8	0.3
	Magnetic Island	10-4	Arcadia	264	3	0.1
	Magnetic Island	10-5	Radical Bay	372	4	0.1
	Magnetic Island	10-6	Horseshoe Bay	1,223	12	0.5
	Magnetic Island	10-7	Five Beach Bay	386	4	0.1
	Magnetic Island	10-8	Rollingstone Bay	159	2	0.1
			Total	**268,419**	**2,684**	100.0
Marine Area	**Name**	**No.**		**Hectares**	**km²**	**% area**
Townsville Harbour		11-1		458		
Ross River Near Shore		11-2		233		
Sandfly Creek Near Shore		11-3		327		
Ross Offshore		11-4		2,448		
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		2,716	27	1.6

Source: Derived from catchments defined by Connell Wagner for Creek to Coral CCI WQIP using modified QLUMP 1999 data to reflect 2005 land use from aerial photography (TCC) and SPOT imagery (NQ Dry Tropics).

Notes: Cleveland Bay km² total is the sum of areas 11-1 to 11-5. btd is below the dam and atd is above the dam. % of area is the catchment area in relation to the total Black Ross (Townsville) WQIP area.

Figure 4.6 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 and Figure 5.2).

Figure 5.1 Crystal Creek Sub Basin and Drainage

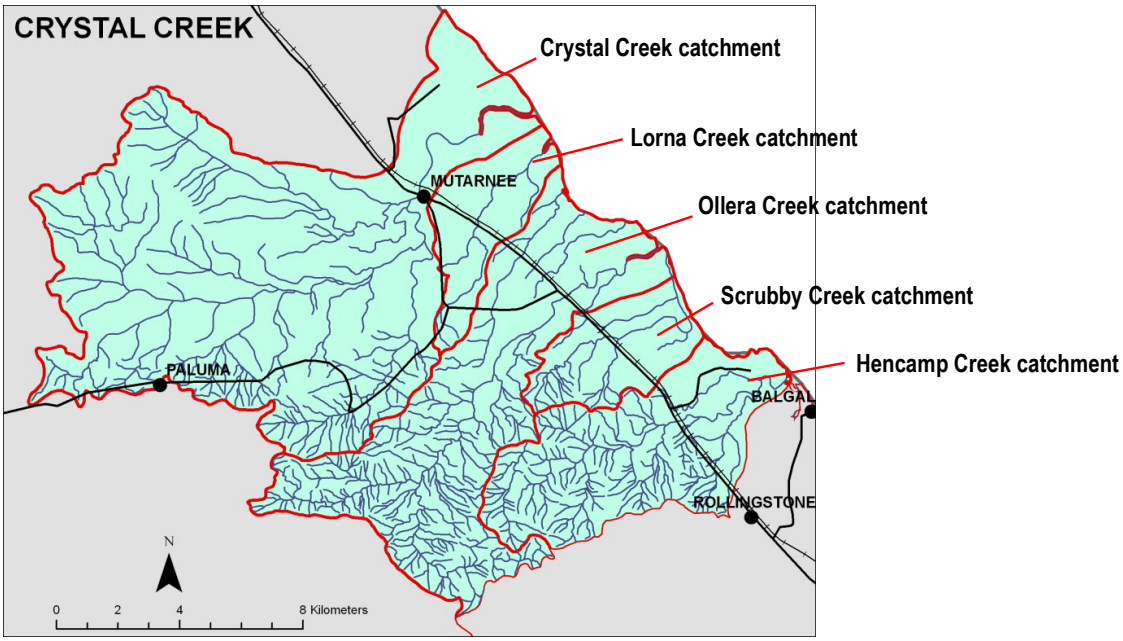
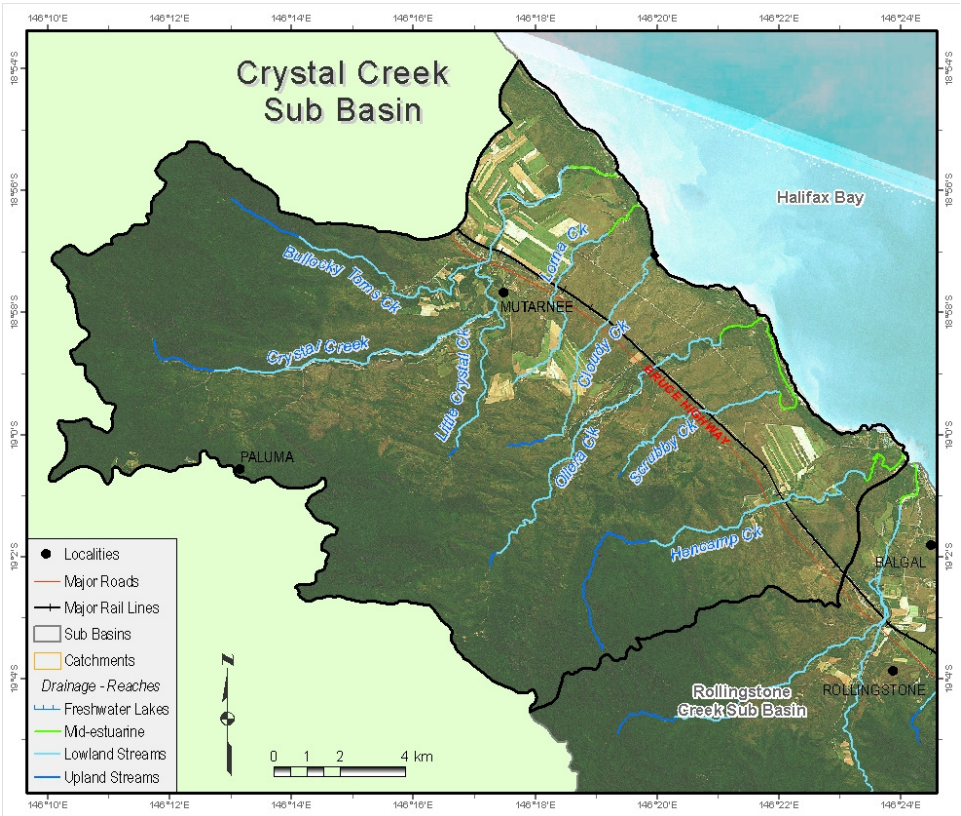


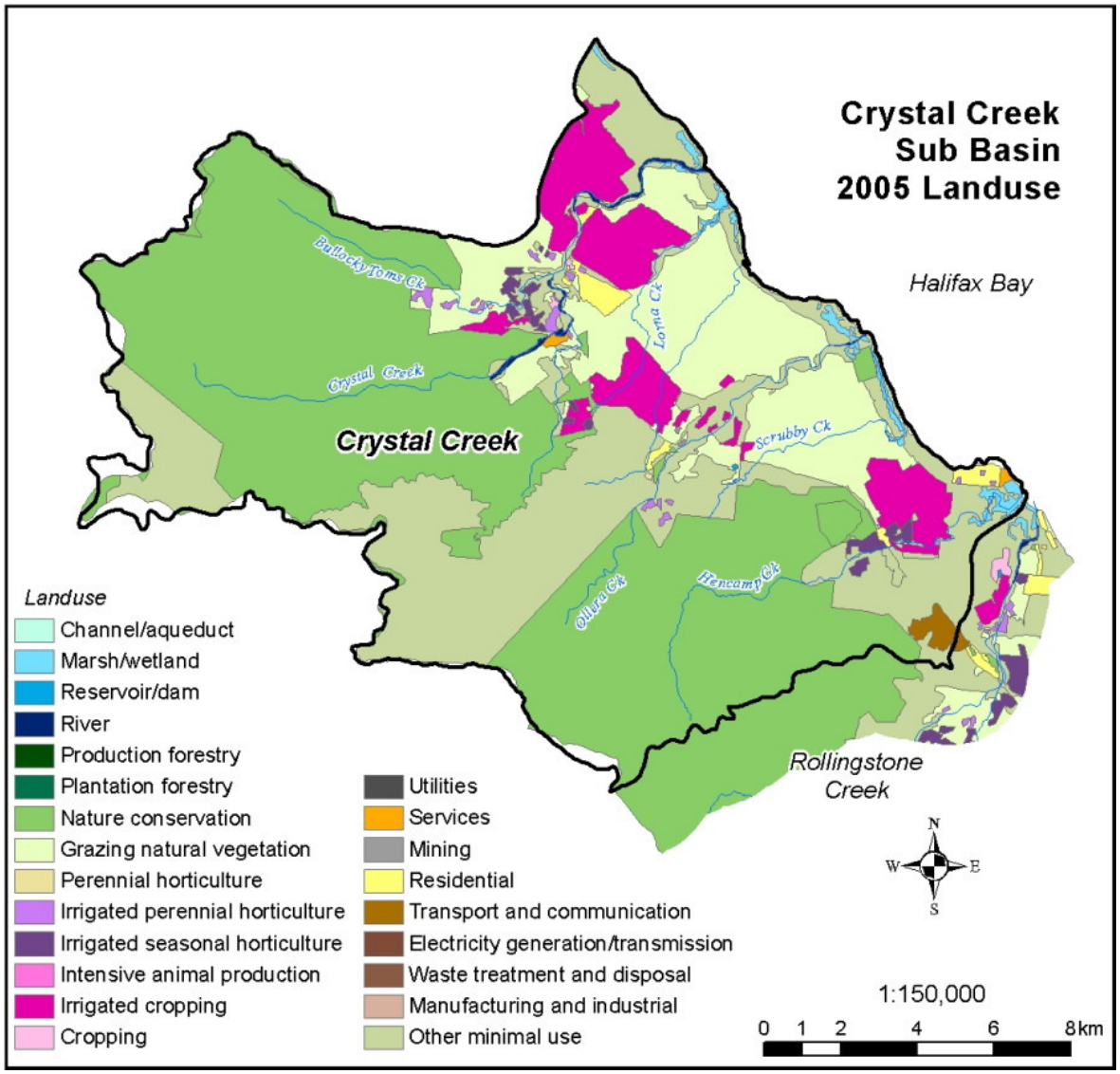
Figure 5.2 Crystal Creek Sub Basin Imagery



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 accounting for approximately 80% of the land area. Grazing (10%) and irrigated cropping (sugar cane) (7%) are the most dominant of the agricultural land uses (see Figure 5.3 and Table 5.1).

Figure 5.3 Crystal Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics)

Table 5.1 Crystal Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping (Dryland)	10	<0.1	10	<0.1
Grazing natural vegetation	3,597	14.8	2,287	9.5
Irrigated cropping	1,579	6.5	1,697	7.1
Irrigated perennial horticulture	89	0.4	88	0.4
Irrigated seasonal horticulture	160	0.7	178	0.7
Marsh/Wetland	205	0.8	205	0.9
Mining	4	<0.1	4	<0.1
Nature conservation	12,041	49.5	11,786	49.2
Other minimal use	6,291	25.8	7,365	30.7
Perennial horticulture (Dryland)	4	<0.1	4	<0.1
Production forestry	1	<0.1	1	<0.1
Reservoir/Dam	2	<0.1	2	<0.1
Residential	189	0.8	171	0.7
River	61	0.3	61	0.3
Services	25	0.1	25	0.10
Transport and communication	85	0.4	85	0.4
Total	24,343	100	23,967	100

Source: CSIRO generated data from QLUMP 1999. 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

5.2 Crystal Creek Sub Basin Demographics

The 2006 Census counted 339 people resident within the Paluma and Crystal Creek Sub Basin areas. Settlement is mainly confined to the hamlets of Paluma (142 people) and Mutarnee (not available). Dispersed settlement is associated with small-scale rural land holdings on the coastal plain, including sugar cane, exotic fruits and other crops. With the available figures it is estimated that the population of the Crystal Creek Sub Basin is 190 people.

Settlement in Paluma and the Crystal Creek Sub Basin is predominantly single-family dwellings with 80% of total dwelling stock comprised of separate dwellings (see Table 5.3).

Paluma and the Crystal Creek Sub Basin has a mature age population, particularly older couples, reflected in the high median age and the average household size, which at 2.5 persons is below the average occupancy of 2.8 for the Townsville local government area.1

A significant number of Paluma and the Crystal Creek Sub Basin residents reported that they worked from home (31 people), possibly reflecting employment on farms and smallholdings and owner-resident tourism industries.2

The location and geography, along with current land zonings for the area indicate that significant urban expansion is unlikely within Paluma and the Crystal Creek Sub Basin, however expanded or intensified rural activity, including grazing, smallholdings, and tourist industry development may occur in the future.

Future settlement patterns related to tourist development potentially may include caravan or cabin style accommodation, buildings housing tourist attractions, function or meeting spaces and hardstand car parking and access ways.

[1] All Dwelling, Household, and Median data is sourced from the 2006 Census Population and Housing Customised Basic Community Profile

[2] 2006 Census Population and Housing Customised Basic Community Profile (method of travel to work)

Selected medians and averages for Paluma and the Crystal Creek Sub Basin are shown in Table 5.2.

Table 5.2 Selected Medians and Averages [3]

Description	Crystal Creek	Townsville
Median age of persons	47	33
Median individual income ($/weekly)	330	531
Median family income ($/weekly)	843	1,237
Median household income ($/weekly)	629	1,101
Median housing loan repayment ($/monthly)	2,000	1,231
Median rent ($/weekly)	124	190
Average household size	2.5	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Crystal Creek is the Crystal Creek Customised Region and Townsville is Townsville City Council local government area.

Table 5.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	105	80.2	247	85.2
Flat, unit or apartment:				
Flat, unit or apartment Total	0		0	
Other dwelling:				
Caravan, cabin, houseboat	19	14.5	35	12.1
Improvised home, tent, sleepers out	7	5.3	8	2.8
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	26	19.8	43	14.8
Totals	**131**		**290**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Crystal Creek Customised Region.

[3] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

5.3 Crystal Creek Sub Basin Land Use by Catchment

Land use summaries of the main catchments of the Crystal Creek Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA Townsville, is included in Appendix E.

5.3.1 1-1 Crystal Creek catchment

The Crystal Creek catchment is approximately 11,600 hectares (~116 square kilometres) in area with the main land use being nature conservation and minimal use (84%). Grazing (8%) and irrigated cropping (sugar cane) (6%) are also significant land uses.

Table 5.4 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	7,105	59.8	7,047	60.8
	Natural feature protect.	240	2.0	130	1.1
	Other conserved area	9	0.1	9	0.1
Other minimal use		21	0.2	21	0.2
	Remnant native cover	2,637	22.2	2,528	21.8
Grazing natural veg.		870	7.3	869	7.5
Production forestry		1.4	0.0	0	0
Cropping		10	0.1	10	0.1
Perennial horticulture		1.2	<0.1	1.2	<0.1
Irrigated cropping	Irrigated sugar	708	6.0	711	6.1
Irrigated perennial horticulture	Irrigated tree fruits	65	0.5	64	0.5
Irrigated seasonal horticulture	Irrigated fruits	80	0.7	80	0.7
Residential	Rural residential	22	0.2	22	0.2
Services	Recreation and culture	13	0.1	13	0.1
River		58	0.5	58	0.5
Marsh/wetland		9	0.1	9	0.1
	Marsh/W Conservation	22	0.2	22	0.2
	Total	11,871		11,594	

Source: CSIRO calculation from QLUMP 1999 and 2005 calculation from land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

5.3.2 1-2 Lorna Creek catchment

The Lorna Creek catchment is approximately 1,420 hectares in area (~14 square kilometres) with the main land use being grazing in native pasture (45%). While it is not a large area in the context of the Black Ross WQIP area a significant proportion of the catchment is used for sugar cane production (30%).

Table 5.5 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	10	0.7
		Other conserved area	4	0.3
	Other minimal use	Remnant native cover	217	15.2
Production from relatively natural environments	Grazing natural vegetation		645	45.3
Production from dryland agriculture and plantations	Perennial horticulture		0.3	<0.1
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	425	29.9
	Irrigated perennial hort.	Irrigated tree fruits	1	0.1
	Irrigated seasonal hort.	Irrigated fruits	5	0.4

Intensive uses	Residential	Rural residential	82	5.8
Water	Marsh/wetland		2	0.1
		Marsh/W Conservation	32	2.2
		Total	1,423	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

5.3.3 1-3 Ollera Creek catchment

The Ollera Creek catchment is approximately 5,865 hectares in area (~59 square kilometres) with the main land use being nature conservation and minimal use (74%). Grazing accounts for 21% of the catchment with sugar cane occupying 3% of the land area.

Table 5.6 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	2,106	36.5
		Other conserved area	48	0.8
	Other minimal use	Remnant native cover	2,098	36.4
Production from relatively natural environments	Grazing natural vegetation		1,245	21.6
Production from dryland agriculture and plantations	Perennial horticulture		2	<0.1
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	183	3.2
	Irrigated perennial hort.	Irrigated tree fruits	17	0.3
Intensive uses	Residential	Rural residential	18	0.3
	Mining		4	0.1
Water	River		3	0.1
	Marsh/wetland		3	<0.1
		Marsh/W Conservation	42	0.7
		Total	5,769	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

5.3.4 1-4 Scrubby Creek catchment

The Scrubby Creek catchment is approximately 1,470 hectares in area (~15 square kilometres) with the main land use being grazing in native pasture (54%). Nature conservation and minimal use accounts for most of the remainder of the catchment (42%).

Table 5.7 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	22	1.5
		Natural feature protect.	308	21.0
		Other conserved area	3	0.2
	Other minimal use	Remnant native cover	296	20.2
Production from relatively natural environments	Grazing natural vegetation		794	54.1
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	10	0.7
	Reservoir/dam		2	0.1
Water	Marsh/wetland	Marsh/W Conservation	32	2.2
		Total	1,467	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

5.3.5 1-5 Hencamp Creek catchment

The Hencamp Creek catchment is approximately 3,720 hectares in area (~37 square kilometres) with the main land use being nature conservation and minimal use (74%). Dryland cropping is also a significant land use within the catchment (7%).

Table 5.8 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	76	2.0
		Natural feature protect.	2,023	54.4
	Other minimal use		96	2.6
		Remnant native cover	917	24.7
Production from relatively natural environments	Grazing natural vegetation		43	1.2
Production from dryland agriculture and plantations	Cropping		253	6.8
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	4	0.1
	Irrigated perennial horticulture	Irrigated tree fruits	1	<0.1
	Irrigated seasonal horticulture	Irrigated fruits	75	2.0
Intensive uses	Residential	Rural residential	67	1.8
	Services	Recreation and culture	12	0.3
	Transport and communication	Airports/aerodromes	85	2.3
Water	Marsh/wetland		2	0.1
		Marsh/W Conservation	62	1.7
		Total	3,716	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

Table 5.9 Catchments Land Use Summary

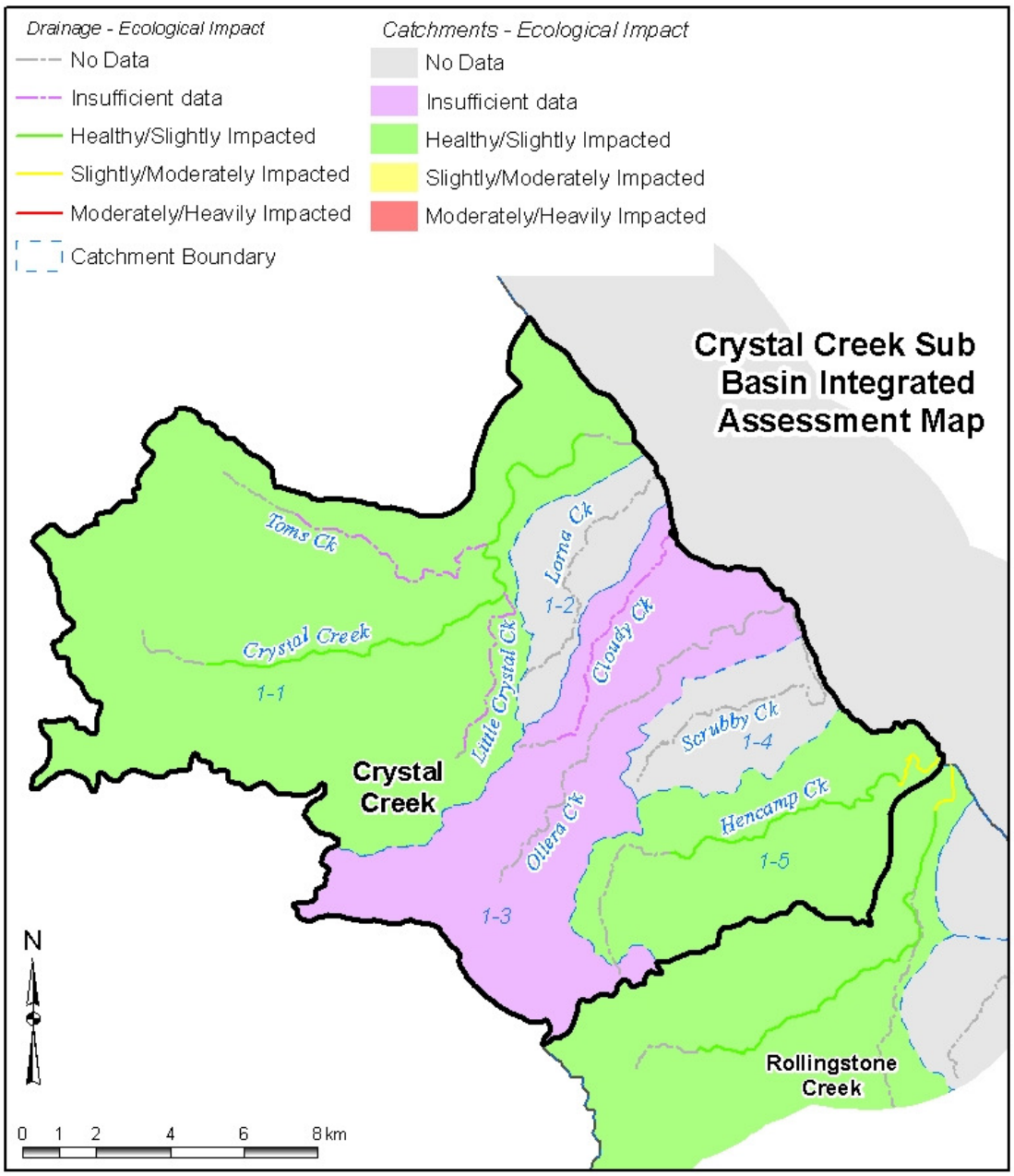
Principal Land Use	Crystal Creek (1-1)		Lorna Creek (1-2)		Ollera Creek (1-3)		Scrubby Creek (1-4)		Hencamp Creek (1-5)	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Conservation and natural areas	9,735	84.0	230	16.2	4,252	73.7	629	42.9	3,061	82.4
Grazing	870	7.5	645	45.3	1,245	21.6	749	51.0	24	0.6
Rural residential	22	0.2	82	5.8	18	0.3			67	1.8
Intensive agriculture	864	7.5	432	30.4	202	3.5	55	3.8	404	10.9
Urban	13	0.1			4	0.1			96	2.6
Water and wetlands	89	0.8	33	2.3	48	0.8	34	2.3	64	1.7
Totals	11,592		1,424		5,769		1,467		3,716	

5.4 Crystal Creek Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (Connell Wagner 2008) rated two of the catchments, Crystal Creek and Hencamp Creek, as healthy. There was generally insufficient information to assess the remaining waterways and catchments (see Figure 5.4).

While there is insufficient data for a percentile-based assessment of Ollera Creek, the median of the available 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



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

5.5 Water Quality and Water Quality Objectives (WQOs)

When the water quality data was assessed against the water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams (see Table 5.10), the water quality condition of the streams of the Crystal Creek Sub Basin met nearly all the corresponding WQOs. The only exception was for total suspended solids (TSS) in Hencamp Creek.

Table 5.10 Comparing WQOs (Central Coast values) with Water Quality

Crystal Creek Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Crystal Creek 1-1	√ 83%	√ 77%	√ 78%	√ 90%	√ 92%	√ 80%
Hencamp Creek 1-5	√ 56%	√ 29%	√ 32%	√ 75%	√ 60%	X 10%

Notes: Tick/cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No percentage is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

When comparing water quality condition to the WQOs derived from the Queensland Water Quality Guidelines (EPA 2006) based on the values for the Wet Tropics region lowland streams (see Table 5.11) (adopted in the Black Ross WQIP for the two northern sub basins), again Crystal Creek meets all the WQOs. Hencamp Creek however only meets one WQO out of the six water quality indicators i.e. dissolved inorganic nitrogen (DIN).

Table 5.11 Comparing WQOs (Wet Tropics values) with Water Quality

Crystal Creek Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Crystal Creek 1-1	√ 65%	√ 53%	√ 55%	√ 50%	√ 60%	√ 80%
Hencamp Creek 1-5	√13%	X 50%	X 52%	X 25%	X 100%	X 10%

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

6. Rollingstone Creek Sub Basin

The Rollingstone Creek Sub Basin 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 and Figure 6.2).

Figure 6.1 Rollingstone Creek Sub Basin and Drainage

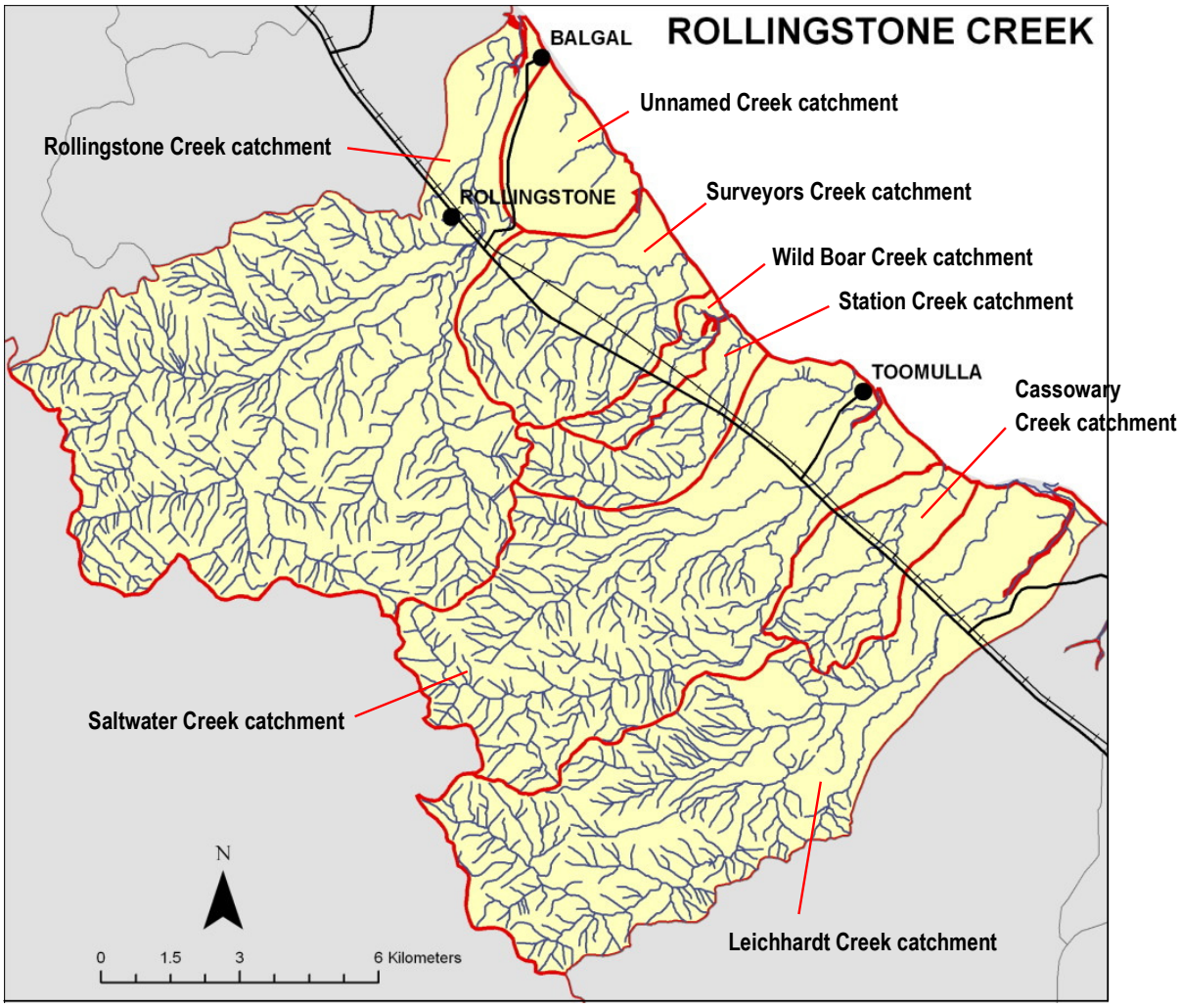
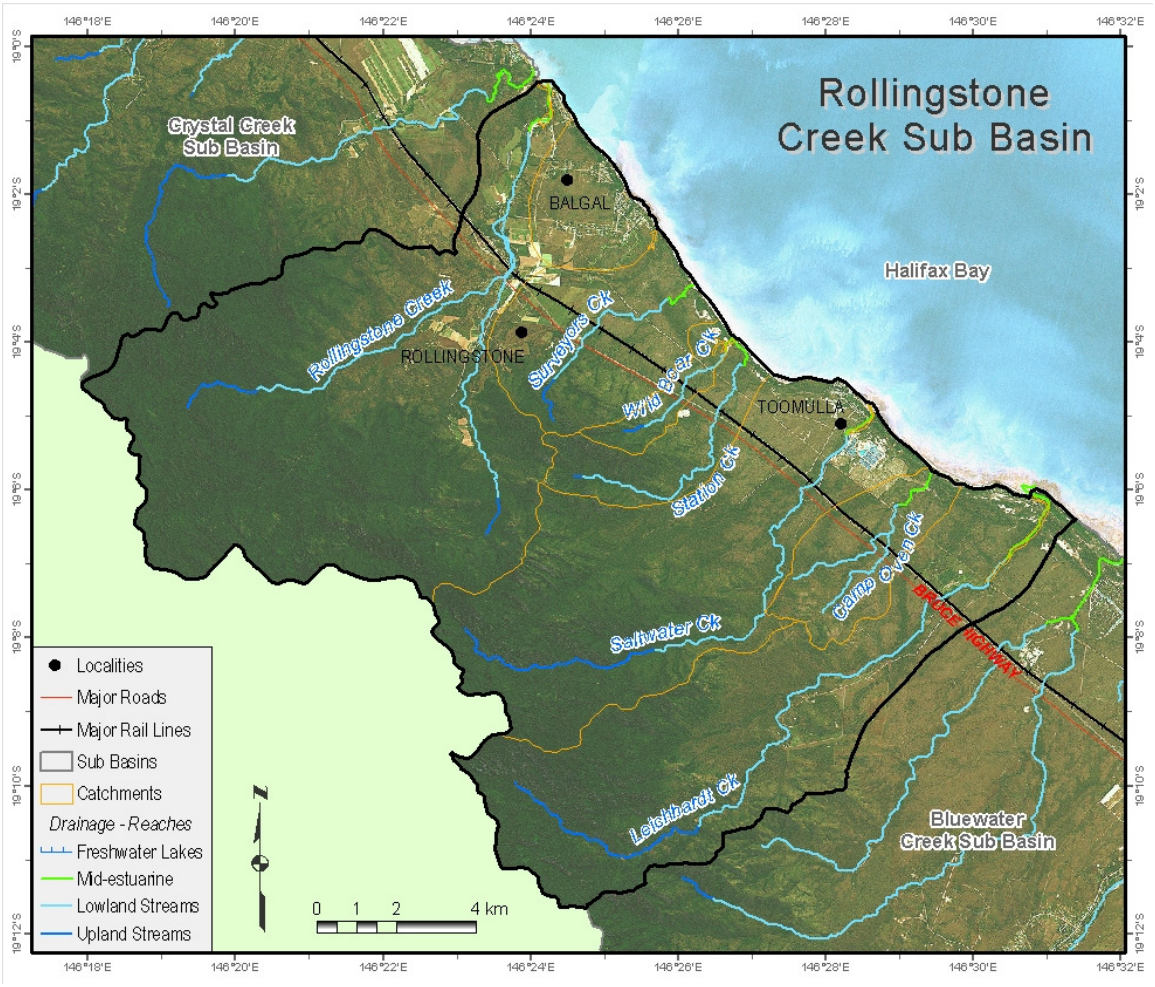


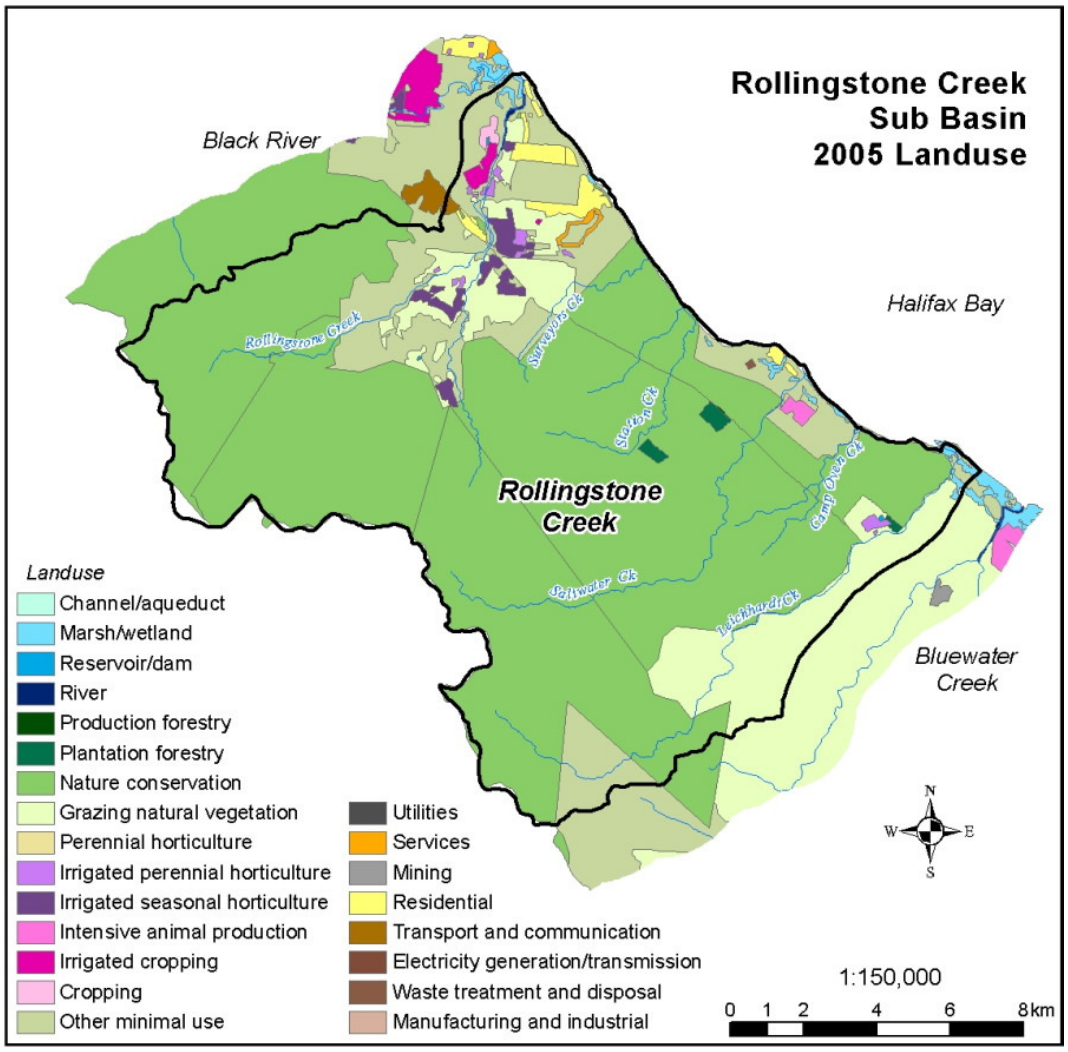
Figure 6.2 Rollingstone Creek Sub Basin Imagery



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 totalling 85% of the land area, with grazing (11%), horticulture (2%) and residential (1%) also being relatively significant land uses (see Figure 6.3 and Table 6.1) in the sub basin.

Figure 6.3 Rollingstone Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

Table 6.1 Rollingstone Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping (Dryland)	28	0.1	28	0.1
Grazing natural vegetation	2,392	10.8	2,382	10.8
Intensive animal prod./Aquaculture	0	0	40	0.2
Irrigated cropping	50	0.2	52	0.2
Irrigated perennial horticulture	70	0.3	70	0.3
Irrigated seasonal horticulture	210	1	215	1
Marsh/Wetland	95	0.4	96	0.4
Nature conservation	15,997	72.3	15,865	72.1
Other minimal use	2,906	13.1	2,863	13.0
Plantation forestry	70	0.3	70	0.3
Production forestry	2	<0.1	2	<0.1
Reservoir/Dam	5	<0.1	5	<0.1

Residential	247	1.1	253	1.2
River	10	0.1	10	<0.1
Services	34	0.2	34	0.2
Transport and Communication	15	<0.1	15	<0.1
Waste Treatment and Disposal	5	<0.1	5	<0.1
Total	22,136	100	22,003	100

Source: CSIRO generated data from QLUMP 1999. 2005 land use update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.2 Rollingstone Creek Sub Basin Demographics

The 2006 Census counted 863 people resident within the Rollingstone Creek Sub Basin area with settlement mainly confined to the townships of Rollingstone and Balgal Beach (>700 people) and the beachside area of Toomulla.

Residential development, with urban allotments ranging in size from around 600m² through to 2,000m², plus rural residential holdings make up the bulk of the settlement type. Dispersed settlement is associated with small scale rural cropping on the coastal plain, including pineapples, exotic tropical fruits and some sugar cane.

Settlement in the Rollingstone Creek Sub Basin consists predominantly of single family dwellings (98.5% of total dwelling stock) (see Table 6.3).

Rollingstone Creek Sub Basin has a mature age population, reflected in the high median age of 53 years, with a high percentage of couple families without children (68%). The average household size at 2.4 persons is below the average occupancy of 2.8 for the Townsville local government area. 4

A small proportion (3%) of Rollingstone Creek Sub Basin residents reported that they worked from home, with a very high proportion (64.5%) reliant on private vehicle (as the driver) for their journey to work.5

The location and geography, along with current land zonings for the area indicate that urban expansion for residential land use may occur in and around current centres.

The Urban Growth Boundaries identified in the Planning Scheme for the City of Thuringowa, which accommodate the City's future urban growth, include a very large area encompassing the hinterland surrounding Rollingstone and Balgal Beach, plus an area surrounding the settlement of Toomulla.

Inclusion within the Urban Growth boundary identifies land as being "*suitable for residential development and supporting community and commercial facilities, and can be effectively provided with infrastructure services*," however, the distance from established urban areas and reliance on the national arterial route for connection to Townsville's centres of employment and service, are important development considerations.

At Balgal Beach there are large land parcels with potential for future development, either for tourist or possibly residential use. However, lack of infrastructure services, particularly reticulated sewerage and costs associated with supply, represent barriers for urban residential development. Demand in the tourism industry, fuel costs and future availability of public transport will be key factors affecting the pace of future development, for an area remote from the main Townsville urban centre and its service and employment opportunities.

Tenure and ongoing use for nature conservation restrict future urban settlement for significant areas (almost 90%) of the Rollingstone Creek Sub Basin.

[4] All Dwelling, Household, and Median data is sourced from the 2006 Census Population and Housing Customised Basic Community Profile

[5] 2006 Census Population and Housing Customised Basic Community Profile (method of travel to work)

Selected medians and averages for the Rollingstone Creek Sub Basin are shown in Table 6.2.

Table 6.2 Selected Medians and Averages [6]

Description	Rollingstone Creek	Townsville
Median age of persons	53	33
Median individual income ($/weekly)	351	531
Median family income ($/weekly)	895	1,237
Median household income ($/weekly)	614	1,101
Median housing loan repayment ($/monthly)	973	1,231
Median rent ($/weekly)	151	190
Average household size	2.4	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Rollingstone Creek is the Rollingstone Creek Customised Region and Townsville is Townsville City Council local government area.

Table 6.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	351		734	
Flat, unit or apartment:				
Flat, unit or apartment Total	0		0	
Other dwelling:				
Caravan, cabin, houseboat	5		3	
Improvised home, tent, sleepers out	0		0	
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	5		3	
Totals	**356**		**737**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Rollingstone Creek Customised Region.

[6] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

6.3 Rollingstone Creek Sub Basin Land Use by Catchment

Land use summaries of the main catchments of the Rollingstone Creek Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA Townsville, is included in Appendix E.

6.3.1 2-1 Rollingstone Creek catchment

The Rollingstone Creek catchment is approximately 7,700 hectares in area (~77 square kilometres) with the main land use being nature conservation and minimal use (90%).

Table 6.4 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	2,543	32.9
		Natural feature protection	2,767	35.8
		Other conserved area	435	5.6
	Other minimal use		6	0.1
		Remnant native cover	1,201	15.5
Production from relatively natural environments	Grazing natural vegetation		425	5.5
Production from dryland agriculture and plantations	Cropping		28	0.4
Production from irrigated agriculture and plantations	Irrigated cropping	Irrigated sugar	50	0.6
	Irrigated perennial horticulture	Irrigated tree fruits	32	0.4
	Irrigated seasonal horticulture	Irrigated fruits	152	2.0
Intensive uses	Residential		21	0.3
		Rural residential	26	0.3
	Transport and communication	Airports/aerodromes	15	0.2
Water	Reservoir/dam		3	0.0
	River		10	0.1
	Marsh/wetland		<1	<0.1
		Marsh/W Conservation	18	0.2
		Total	7,732	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.3.2 2-2 An unnamed Creek

The unnamed creek catchment is approximately 730 hectares in area (~7 square kilometres) with the main land use being nature conservation and minimal use (50%). Grazing occupies 19% of the catchment with residential and associated services occupying 29%.

Table 6.5 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	5	0.6
	Other minimal use		32	4.4
		Remnant native cover	328	44.9
Production from relatively natural environments	Grazing natural vegetation		140	19.2
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	8	1.1
	Irrigated seasonal horticulture	Irrigated fruits	4	0.5
Intensive uses	Residential		112	15.3
		Rural residential	68	9.3
	Services	Recreation and culture	31	4.3
Water	Marsh/wetland		4	0.5
		Total	731	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.3.3 2-3 Surveyors Creek

The Surveyors Creek catchment is approximately 1,674 hectares in area (~17 square kilometres) with the main land use being nature conservation and minimal use (75%). Grazing land use occupies around 21% of the catchment.

Table 6.6 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	25.9
		Other conserved area	448	26.8
	Other minimal use		1	<0.1
		Remnant native cover	371	22.2
Production from relatively natural environments	Grazing natural vegetation		353	21.1
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	10	0.6
	Irrigated seasonal horticulture	Irrigated fruits	55	3.3
Intensive uses	Services	Recreation and culture	2	0.1
		Total	1,674	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.3.4 2-4 Wild Boar Creek

The Wild Boar Creek catchment is approximately 345 hectares in area (~3.5 square kilometres) with the only land use being nature conservation (100%).

Table 6.7 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	157	45.5
	Nature conservation	Other conserved area	188	54.5
		Total	345	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.3.5 2-5 Station Creek

The Station Creek catchment is approximately 880 hectares in area (~9 square kilometres) with the main land use being nature conservation and minimal use (99%).

Table 6.8 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	18.2
	Nature conservation	Other conserved area	687	77.9
	Other minimal use	Remnant native cover	26	2.9
Production from dryland agriculture and plantations	Plantation forestry		6	0.7
Water	Marsh/wetland		2	0.3
		Total	882	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.3.6 2-6 Saltwater Creek

The Saltwater Creek catchment is approximately 4,660 hectares in area (~47 square kilometres) with the main land use being nature conservation and minimal use (97%).

Table 6.9 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	1,775	37.9	1,753	37.6
	Other conserved area	2,386	50.9	2,386	51.2
Other minimal use		51	1.1	12	0.3
	Remnant native cover	357	7.6	354	7.6
Production forestry		2	<0.1	2	<0.1
Plantation forestry		54	1.2	54	1.2
Intensive animal production	Aquaculture			40	0.9
Residential		20	0.4	22	0.5
Waste treatment and disposal		5	0.1	5	0.1
Marsh/wetland		16	0.3	16	0.3
	Marsh/W Conservation	18	0.4	18	0.4
	Total	4,684		4,662	

Source: 1999 by CSIRO generated data from QLUMP 1999. 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.3.7 2-7 Cassowary Creek

The Cassowary Creek catchment is approximately 997 hectares in area (~10 square kilometres) with the main land use being nature conservation and minimal use (~100%).

Table 6.10 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	28.0
		Other conserved area	640	64.2
	Other minimal use	Remnant native cover	76	7.6
Water	Marsh/wetland	Marsh/W Conservation	2	0.2
		Total	997	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

6.3.8 2-8 Leichhardt Creek

The Leichhardt Creek catchment is approximately 5,000 hectares in area (~50 square kilometres) with the main land use being nature conservation and minimal use (69%). Grazing accounts for most of the remainder of the catchment land use (30%).

Table 6.11 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	2,204	44.2
		Other conserved area	779	15.6
	Other minimal use	Remnant native cover	458	9.2
Production from relatively natural environments	Grazing natural vegetation		1,473	29.6
Production from dryland agriculture and plantations	Plantation forestry		10	0.2

Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	20	0.4
Water	Reservoir/dam		2	<0.1
	Marsh/wetland		5	0.1
		Marsh/W Conservation	30	0.6
		Total	4,981	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

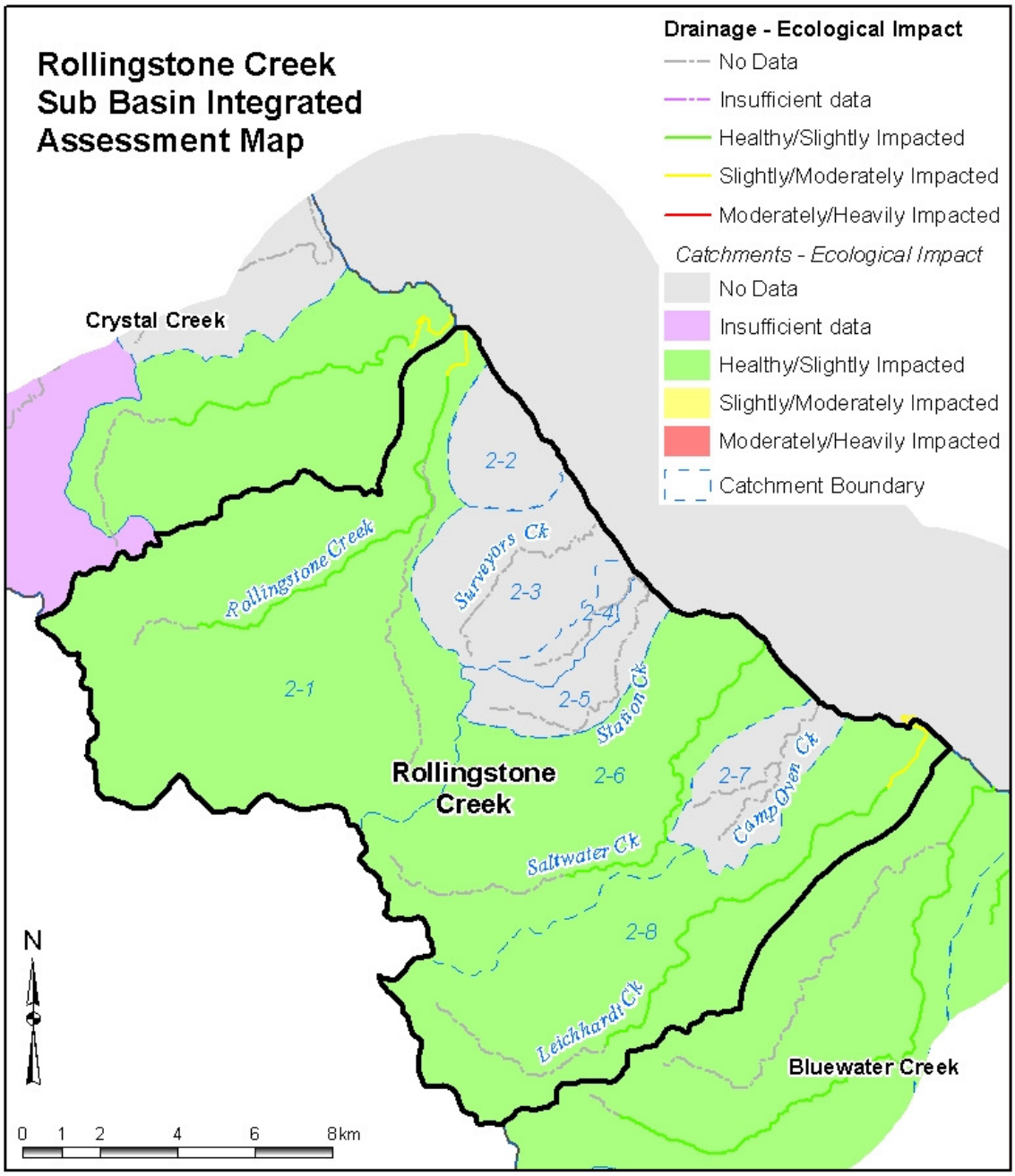
Table 6.12 Catchments Land Use Summary

Land Use	Rollingstone Creek (2-1)		unnamed Creek (2-2)		Surveyors Creek (2-3)		Wild Boar Creek (2-4)	
	Ha	%	Ha	%	Ha	%	Ha	%
Conservation and natural areas	6,952	89.9	364	49.9	1,254	74.9	344	100
Grazing	425	5.5	130	17.8	353	21.1	0	
Rural residential	26	0.3	68	9.3	0		0	
Intensive agriculture	262	3.4	18	2.4	65	3.9	0	
Urban	36	0.5	147	20.1	2	0.1	0	
Water and wetlands	31	0.4	4	0.5	0		0	
Totals	7,732		731		1,674		344	
Land Use	**Station Creek (2-5)**		**Saltwater Creek (2-6)**		**Cassowary Creek (2-7)**		**Leichhardt Creek (2-8)**	
	Ha	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
Conservation and natural areas	873	99.0	4,505	96.6	995	99.8	3,440	69.1
Grazing	0		2	0.0	0		1,473	29.6
Rural residential	0		0		0		0	
Intensive agriculture	6	0.7	54	1.2	0		30	0.6
Urban	0		67	1.4	0		0	
Water and wetlands	2	0.3	34	0.7	2	0.2	37	0.8
Totals	882		4,662		997		4,981	

6.4 Rollingstone Creek Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (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



6.5 Water Quality and Water Quality Objectives (WQOs)

When the water quality data was assessed against the water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams (see Table 6.13), the water quality condition of the streams of the Rollingstone Creek sub basin met virtually all of the corresponding WQOs. The only exception was total suspended solids (TSS) in Saltwater Creek.

Table 6.13 Comparing WQOs (Central Coast values) with Water Quality

Rollingstone Creek Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Rollingstone Creek 2-1	√ 50%	√ 29%	√ 28%	ND	√ 60%	√ 20%
Saltwater Creek 2-6	√ 81%	√ 52%	√ 55%	√ 75%	√ 60%	X 40%
Leichhardt Creek 2-8	√ 63%	√ 29%	√ 34%	ND	√ 60%	√

Notes: Tick/cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

When comparing water quality condition to the WQOs derived from the Queensland Water Quality Guidelines (EPA 2006) based on the values for the Wet Tropics region lowland streams (adopted in the Black Ross WQIP for the two northern sub basins), the streams only meet WQOs for 40-50% of the water quality indicators (see Table 6.14).

Table 6.14 Comparing WQOs (Wet Tropics values) with Water Quality

Rollingstone Creek Sub Basin	DIN	Org N	TN	FRP	TP	TSS
[1]Rollingstone Creek 2-1	√	X 100%	X 50%	ND	X 100%	√ 20%
[1]Saltwater Creek 2-6	√ 65%	√	√ 7%	X 25%	X 100%	X 40%
[1]Leichhardt Creek 2-8	√ 25%	X 100%	X 38%	ND	X 100%	√

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

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 and Figure 7.2).

Figure 7.1 Bluewater Creek Sub Basin and Drainage

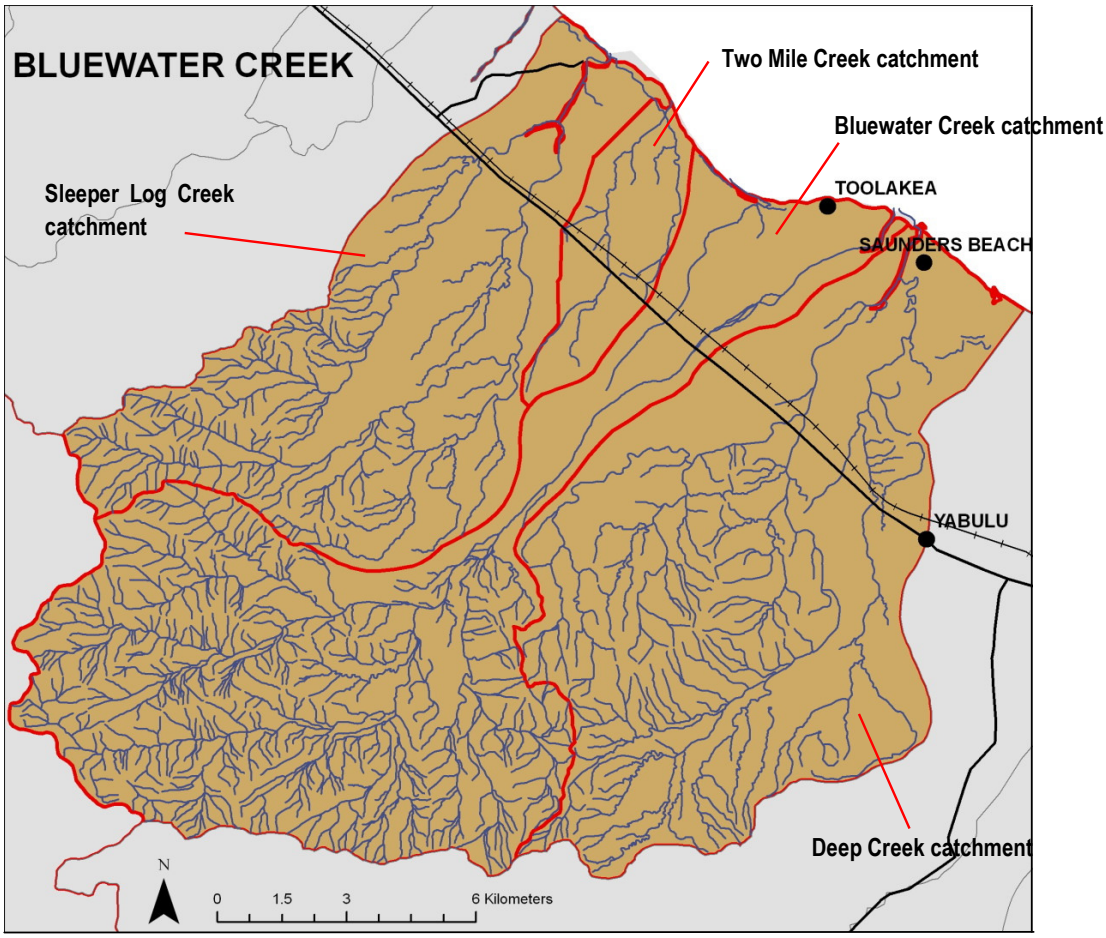
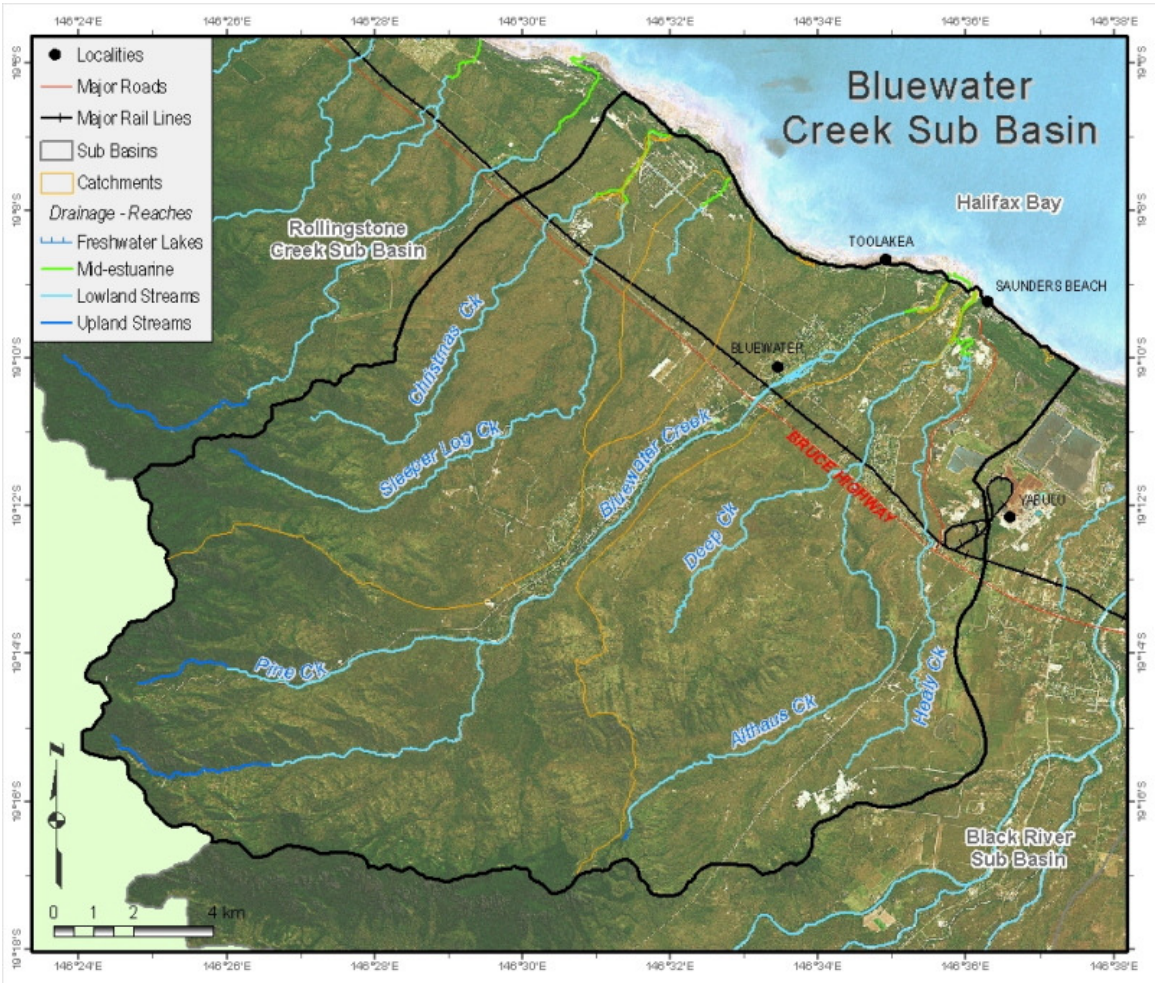


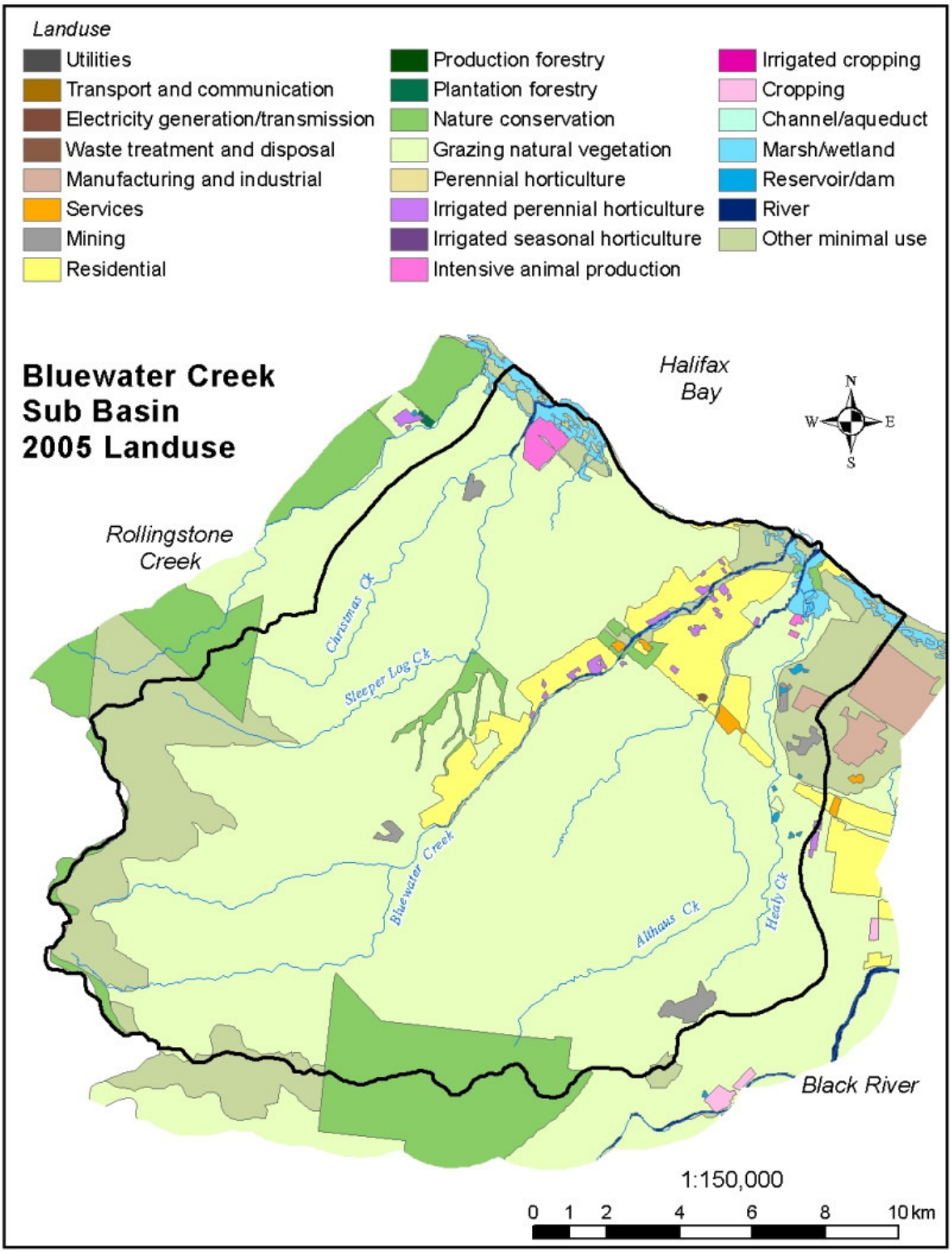
Figure 7.2 Bluewater Creek Sub Basin Imagery



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 (75%). Nature conservation and other minimal use (17%) is the next most prolific land use followed by residential (5%) (see Figure 7.3 and Table 7.1).

Figure 7.3 Bluewater Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

Table 7.1 Bluewater Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Channel/Aqueduct	7	<0.1	7	<0.1
Grazing natural vegetation	21,912	75.3	21,893	75.4
Intensive animal prod./Aquaculture	105	0.4	117	0.4
Irrigated perennial agriculture	77	0.3	77	0.3
Manufacturing and industrial	0	0	48	0.2
Marsh/Wetland	352	1.2	341	1.2
Mining	169	0.6	177	0.6
Nature conservation	1,682	5.8	1,645	5.7
Other minimal use	3,185	11	3,133	10.8
Reservoir/Dam	27	<0.1	20	<0.1
Residential	1,473	5.1	1,473	5.1
River	58	0.2	58	0.2
Services	45	0.2	45	0.2
Waste treatment and disposal	4	<0.1	4	<0.1
Total	29,096	100	29,037	100

Source: CSIRO generated data from QLUMP 1999. 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

7.2 Bluewater Creek Sub Basin Demographics

The 2006 Census counted 2,876 people resident within the Bluewater Creek Sub Basin area, which includes beachside settlements, rural residential development and parts of the Queensland Nickel Industry Yabulu manufacturing and refining plant. Selected medians and averages from the 2006 Census are provided for the Bluewater Creek Sub Basin in Table 7.2

Small urban residential settlement in the basin occurs at Toolakea and Saunders Beach, with significant rural residential style development between Toolakea and Bluewater Park, and at Yabulu. Rural residential development largely adopts a linear pattern taking advantage of existing road infrastructure. This is particularly evident along Forestry Road, which for part of its length runs parallels to Bluewater Creek.

Housing style in the Bluewater Creek Sub Basin is predominantly single-family dwellings with 936 dwellings being separate houses out of a total 1,022 dwellings in the area (see Table 7.3).

The median age of the Bluewater Creek Sub Basin population at 2006 is reported at 38 years. There is a high percentage of couple families without children (41%) with the average household size at 2.8 persons being the same as the average occupancy for the Townsville local government area..7

Very few Bluewater Creek Sub Basin residents reported that they worked from home, with a significant percentage (68%) reporting they travel to work as the driver of a private motor vehicle.8

Despite the Urban Growth Boundaries identified in the Planning Scheme for the City of Thuringowa, including a significant area to the north of Toolakea Beach, the distance from Townsville's established employment and service centres suggests that significant urban residential development is unlikely to occur within the near future, however expanded or intensified rural residential activity may occur.

[7] All Dwelling, Household, and Median data is sourced from the 2006 Census Population and Housing Customised Basic Community Profile

[8] 2006 Census Population and Housing Customised Basic Community Profile (method of travel to work)

Future development related to intensification at the existing refinery and nickel processing site may occur within the Bluewater Sub Basin, despite production cut backs in 2008/2009, resulting from the economic downturn.

Table 7.2 Selected Medians and Averages [9]

Description	Bluewater Creek	Townsville
Median age of persons	38	33
Median individual income ($/weekly)	502	531
Median family income ($/weekly)	1,156	1,237
Median household income ($/weekly)	1,086	1,101
Median housing loan repayment ($/monthly)	1,195	1,231
Median rent ($/weekly)	195	190
Average household size	2.8	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Bluewater Creek is the Bluewater Creek Customised Region and Townsville is Townsville City Council local government area.

Table 7.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	936		2,541	
Semi-detached, row or terrace house, townhouse etc:				
One storey	5		0	
Semi-detached, etc Total	5		0	
Flat, unit or apartment:				
In one or two storey block	13		34	
Flat, unit or apartment Total	13		34	
Other dwelling:				
Caravan, cabin, houseboat	57		110	
Improvised home, tent, sleepers out	8		19	
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	65		129	
Totals	**1,022**		**2,704**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Bluewater Creek Customised Region.

[9] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

7.3 Bluewater Creek Sub Basin Land Use by Catchment

Land use summaries of the main catchments of the Bluewater Creek Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA Townsville, is included in Appendix E.

7.3.1 3-1 Sleeper Log Creek

The Sleeper Log Creek catchment is approximately 7,170 hectares in area (~72 square kilometres) with the main land use being grazing in native pasture (77%).

Table 7.4 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	228	3.2
		Other conserved area	132	1.8
	Other minimal use	Remnant native cover	884	12.3
Production from relatively natural environments	Grazing natural vegetation		5,528	77.1
Intensive uses	Intensive animal production	Aquaculture	105	1.5
	Residential	Rural residential	98	1.4
	Mining		33	0.5
Water	River		8	0.1
	Channel/aqueduct		7	0.1
	Marsh/wetland		38	0.5
		Marsh/W Conservation	108	1.5
		Total	7,168	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

7.3.2 3-2 Two Mile Creek

The Two Mile Creek catchment is approximately 1,340 hectares in area (~13 square kilometres) with the main land use being grazing in native pasture (92%).

Table 7.5 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	1.6
	Other minimal use	Remnant native cover	49	3.7
Production from relatively natural environments	Grazing natural vegetation		1,235	92.3
Water	Channel/aqueduct		1	<0.1
	Marsh/wetland		18	1.3
		Marsh/W Conservation	14	1.1
		Total	1,338	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

7.3.3 3-3 Bluewater Creek

The Bluewater Creek catchment is approximately 10,500 hectares in area (~105 square kilometres) with the main land use being grazing in native pasture (68%).

Table 7.6 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	131	1.2	98	0.9
	Other conserved area	848	8.0	848	8.1
Other minimal use		85	0.8	85	0.8
	Remnant native cover	1,381	13.1	1,374	13.1
Grazing natural vegetation		7,189	68.3	7,189	68.5
Irrigated perennial horticulture		2	<0.1	2	<0.1
	Irrigated tree fruits	59	0.6	59	0.6
Residential		23	0.2	23	0.2
	Rural residential	725	6.9	725	6.9
Services		4	<0.1	4	<0.1
	Recreation and culture	7	0.1	7	0.1
Mining		16	0.2	16	0.2
River		43	0.4	43	0.4
Marsh/wetland		4	<0.1	4	<0.1
	Marsh/W Conservation	16	0.2	16	0.2
	Total	10,532		10,492	

Source: CSIRO calculation from QLUMP 1999 and 2005 calculation from land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

7.3.4 3-4 Deep Creek

The Deep Creek catchment is approximately 10,060 hectares in area (~100 square kilometres) with the main land use being grazing in native pasture (79%).

Table 7.7 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	323	3.2	323	3.2
Other minimal use		653	6.5	610	6.1
	Remnant native cover	133	1.3	133	1.3
Grazing natural vegetation		7,961	79.2	7,942	79.0
Irrigated perennial horticulture		3	<0.1	2.9	<0.1
	Irrigated tree fruits	13	0.1	13	0.1
Intensive animal production	Aquaculture			12	0.1
Manufacturing and industrial				48	0.5
Residential		150	1.5	150	1.5
	Rural residential	476	4.7	476	4.7
Services		2	<0.1	2	<0.1
	Recreation and culture	31	0.3	32	0.3
Mining		120	1.2	128	1.3
Waste treatment and disposal	Landfill	4	<0.1	4	<0.1
Reservoir/dam		21	0.2	21	0.2
	Reservoir – intensive use	5	0.1		
River		7	0.1	7	0.1
Marsh/wetland		84	0.8	84	0.8
	Marsh/W Conservation	71	0.7	71	0.7
	Total	10,057		10,057	

Source: CSIRO calculation from QLUMP 1999 and 2005 calculation from land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

Table 7.8 Catchments Land Use Summary

Land Use	Sleeper Log Creek (3-1)		Two Mile Creek (3-2)		Bluewater Creek (3-3)		Deep Creek (3-4)	
	Ha	%	Ha	%	Ha	%	Ha	%
Conservation and natural areas	1,244	17.4	71	5.3	2,404	22.9	1,066	10.6
Grazing	5,528	77.1	1,235	92.3	7,189	68.5	7,941	79.0
Rural residential	98	1.4	0		725	6.9	476	4.7
Intensive agriculture	0		0		61	0.6	16	0.2
Urban	138	1.9	0		51	0.5	376	3.7
Water and wetlands	161	2.2	33	2.4	63	0.6	182	1.8
Totals	7,169		1,338		10,492		10,057	

7.4 Bluewater Creek Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (Connell Wagner 2008) indicated that the water quality of this sub basin was generally representative of ecologically healthy lowland stream systems (see Figure 7.4). However, total suspended solids (sediment) (TSS) were found to be generally high for this sub basin while dissolved oxygen was generally low.

More recent data for Bluewater Creek shows that the dissolved oxygen is still low while TSS falls within the guideline limit.

7.5 Water Quality and Water Quality Objectives (WQOs)

When comparing water quality condition data with the WQOs for the Bluewater Creek Sub Bain we can see that the WQOs are met for the majority of the water quality indicators for each of the streams in the sub basin (see Table 7.9).

The exceptions are:

- Three of the four streams do not meet the WQO for total suspended solids (TSS),
- The fourth stream (Bluewater Creek) does not meet the WQO for dissolved inorganic nitrogen (DIN).

Table 7.9 Comparing WQOs with Water Quality

Bluewater Creek Sub Basin	DIN	Org N	TN	FRP	TP	TSS
[1]Sleeper Log Creek 3-1	√ 78%	√ 52%	√ 52%	√ 75%	√ 40%	X 70%
[1]Two Mile Creek 3-2	√ 76%	√ 52%	√ 54%	√ 55%	√ 20%	X 150%
Bluewater Creek 3-3	X 109%	√* 61%	√* 44%	√ 70%	√* 66%	√* 50%
[1]Deep Creek 3-4	√* 50%	√ 29%	√* 26%	ND	√* 60%	X 40%

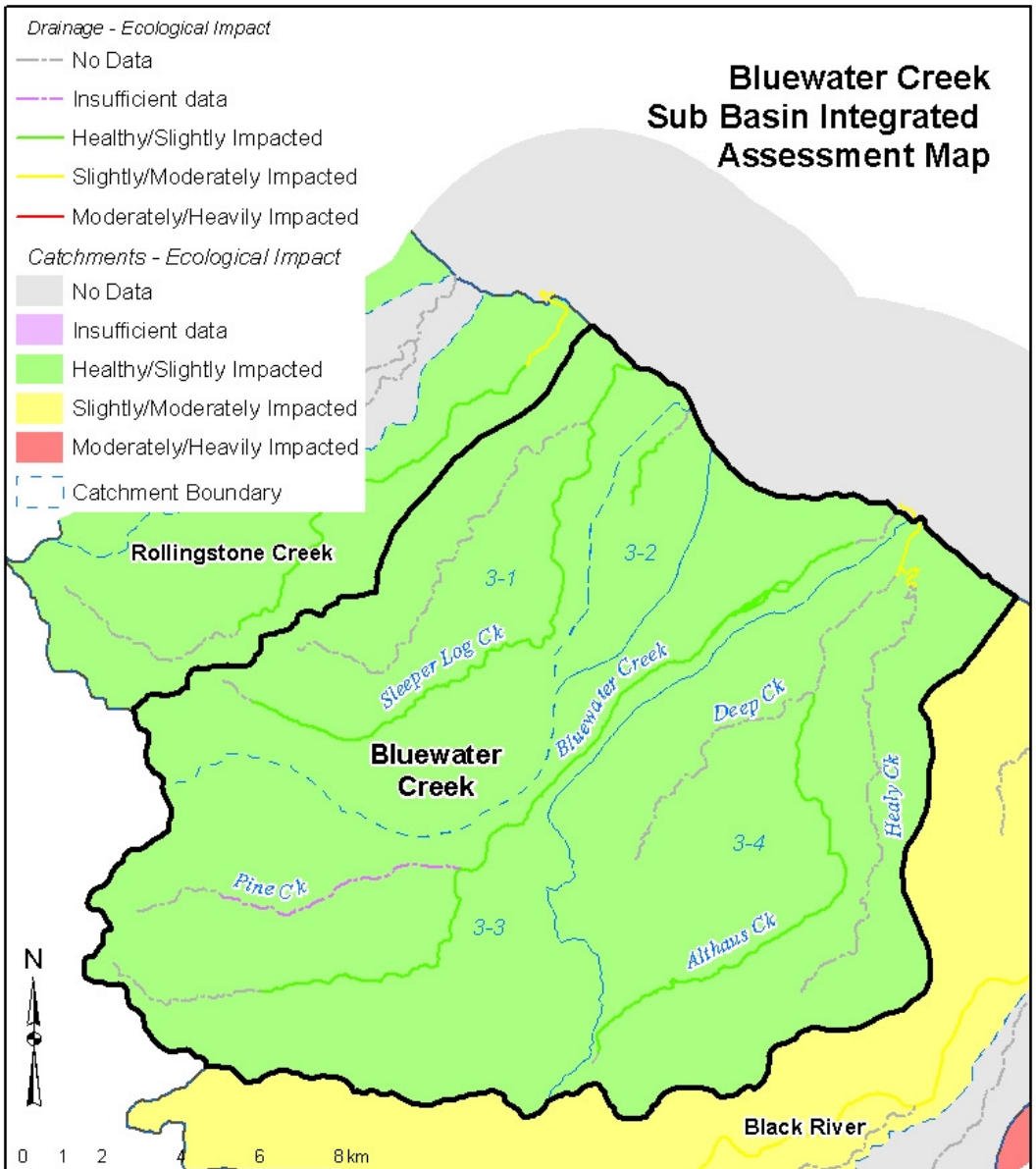
Notes: Tick/cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

Figure 7.4 Bluewater Creek Sub Basin Ecological Impact



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

8. Black River Sub Basin

The Black River Sub Basin (see Figure 8.1 and Figure 8.2) 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 waterways.

Figure 8.1 Black River Sub Basin and Drainage

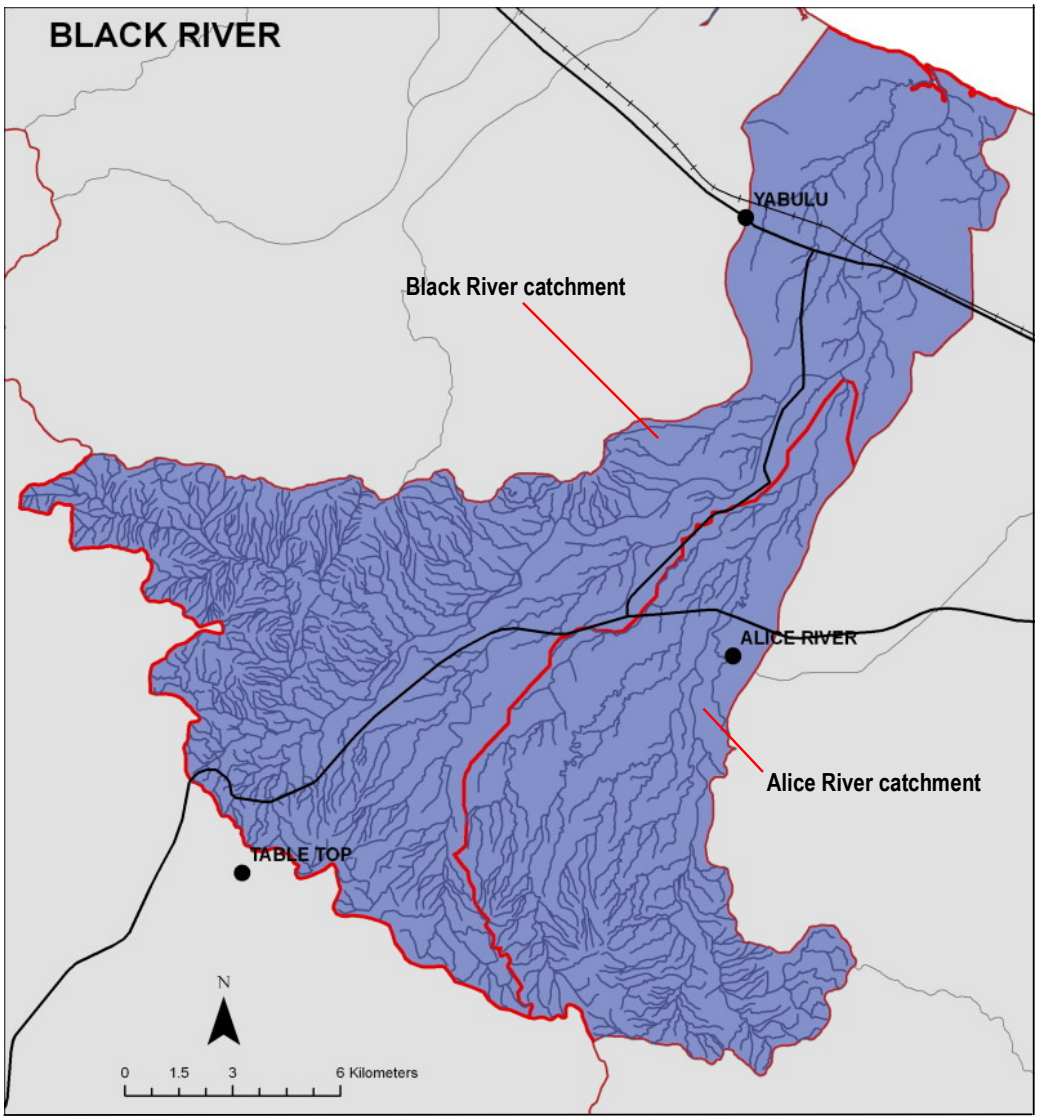
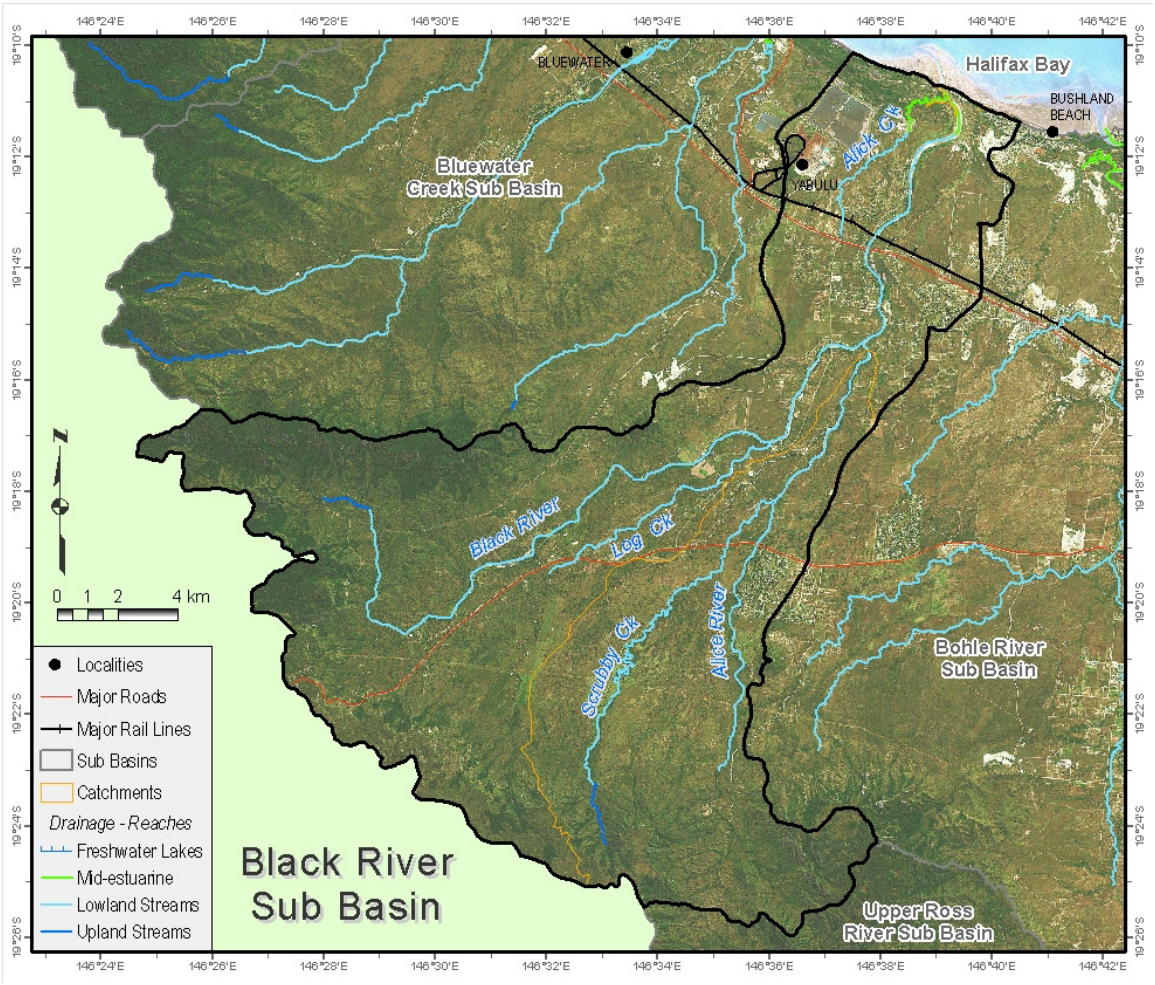


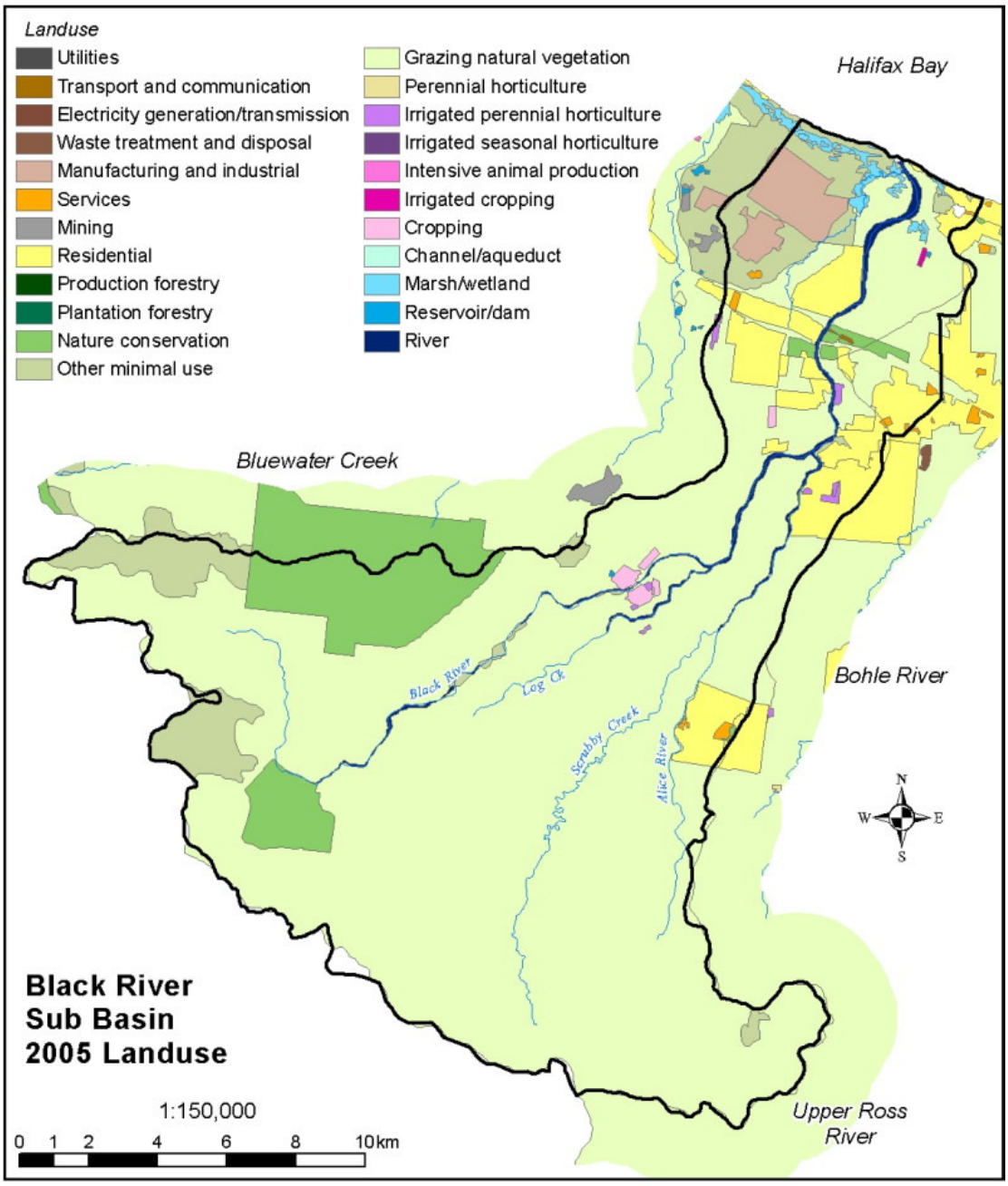
Figure 8.2 Black River Sub Basin Imagery



8.1 Black River Sub Basin Land Use

The Black River Sub Basin is approximately 304 square kilometres in size (~30,400 hectares). Land use in the Black River Sub Basin is dominated by grazing (76%). Nature conservation and other minimal use (13%) is the next most prolific land use followed by residential (7%) (see Figure 8.3 and Table 8.1).

Figure 8.3 Black River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

Table 8.1 Black River Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping	103	0.3	103	0.3
Grazing natural vegetation	23,295	76.2	23,063	75.9
Irrigated cropping	7	<0.1	7	<0.1
Irrigated perennial agriculture	58	0.2	58	0.2
Manufacturing and industrial	119	0.4	564	1.9

Marsh/Wetland	165	0.5	165	0.5
Nature conservation	1,963	6.4	1,962	6.5
Other minimal use	2,284	7.5	1,962	6.5
Reservoir/Dam	183	0.6	5	<0.1
Residential	1,979	6.5	2,081	6.9
River	343	1.1	343	1.1
Services	53	0.2	58	0.2
Transport and communication	7	<0.1	7	<0.1
Total	30,559	100	30,377	100

Source: CSIRO generated data from QLUMP 1999. 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

8.2 Black River Sub Basin Demographics

The 2006 Census counted 4,917 people resident within the Black River Sub Basin. The sub basin stretches from Herveys Range to the coast and includes the northern parts of the Bushland Beach residential area, the majority of the Queensland Nickel Industry (QNI) Yabulu manufacturing and refining plant, and rural residential estates including most of Rupertswood (Alice River).

Housing in the Black River Sub Basin consists predominantly of single family dwellings with 1,602 dwellings being separate houses out of a total 1619 dwellings in the area (see Table 8.3).

At the 2006 Census the median age of the Black River Sub Basin population is reported at 36 years. There is a high percentage of couple families without children (38%) and an equally high percentage (38%) with children under 15 years old.

Average household size at 3.2 people per household is well above the average occupancy of 2.8 for the Townsville local government area. Overall, 36% of Black River households are comprised of four people, or more.[10]

The majority of employed Black River Sub Basin residents reported that they travel to work as the driver of a private motor vehicle, indicating a very strong commuter trend.[11]

Current development approvals suggest that significant urban residential development is likely to occur in the Black River Sub Basin, within the very near future, particularly in and around the Bushland Beach / Beachholm area, with expansion to the north of Mt Low Parkway.

Expansion and/or intensification of existing rural residential use is likely to occur along the Black River Road area and at Alice River.

Future intensified development related to the existing nickel refinery may also occur in the future despite the winding back of activity during the 2008/09 economic downturn.

Selected medians and averages for the Black River Sub Basin from the 2006 Census are included in Table 8.2.

[10] All Dwelling, Household, and Median data is sourced from the 2006 Census Population and Housing Customised Basic Community Profile

[11] 2006 Census Population and Housing Customised Basic Community Profile (method of travel to work)

Table 8.2 Selected Medians and Averages [12]

Description	Black River	Townsville
Median age of persons	36	33
Median individual income ($/weekly)	576	531
Median family income ($/weekly)	1,361	1,237
Median household income ($/weekly)	1,332	1,101
Median housing loan repayment ($/monthly)	1,273	1,231
Median rent ($/weekly)	268	190
Average household size	3.2	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Black River is the Black River Customised Region and Townsville is Townsville City Council local government area.

Table 8.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	1,602		4,735	
Semi-detached, row or terrace house, townhouse etc:				
One storey	3		7	
Semi-detached, etc Total	3		7	
Flat, unit or apartment:				
Flat, unit or apartment Total	0		0	
Other dwelling:				
Caravan, cabin, houseboat	11		26	
Improvised home, tent, sleepers out	3		5	
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	14		31	
Totals	**1,619**		**4,773**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Black River Customised Region.

[12] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

8.3 Black River Sub Basin Land Use by Catchment

Land use summaries for the main catchments of the Black River Sub Basin are provided below.

8.3.1 4-1 Black River Catchment

The Black River catchment is approximately 20,400 hectares in area (~204 square kilometres) with the main land use being grazing in native pasture (67%).

Table 8.4 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	1,953	9.6
	Other minimal use		595	2.9
		Remnant native cover	1323	6.5
Production from relatively natural environments	Grazing natural vegetation		13,646	66.9
Production from dryland agriculture and plantations	Cropping		103	0.5
Production from irrigated agriculture and plantations	Irrigated cropping		7	<0.1
	Irrigated perennial horticulture		35	0.2
		Irrigated tree fruits	18	0.1
Intensive uses	Manufacturing and industrial		564	2.8
	Residential		650	3.2
		Rural residential	979	4.8
	Services	Recreation and culture	29	0.1
			7	<0.1
	Transport and communication	Railways	7	<0.1
Water	Reservoir/dam		5	<0.1
	River		304	1.5
	Marsh/wetland		82	0.4
		Marsh/W Conservation	83	0.4
		Total	20,389	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

8.3.2 4-2 Alice River

The Alice River catchment is approximately 10,000 hectares in area (~100 square kilometres) with the main land use being grazing in native pasture (94%).

Table 8.5 Alice River Catchment Land Use 1999 and 2005

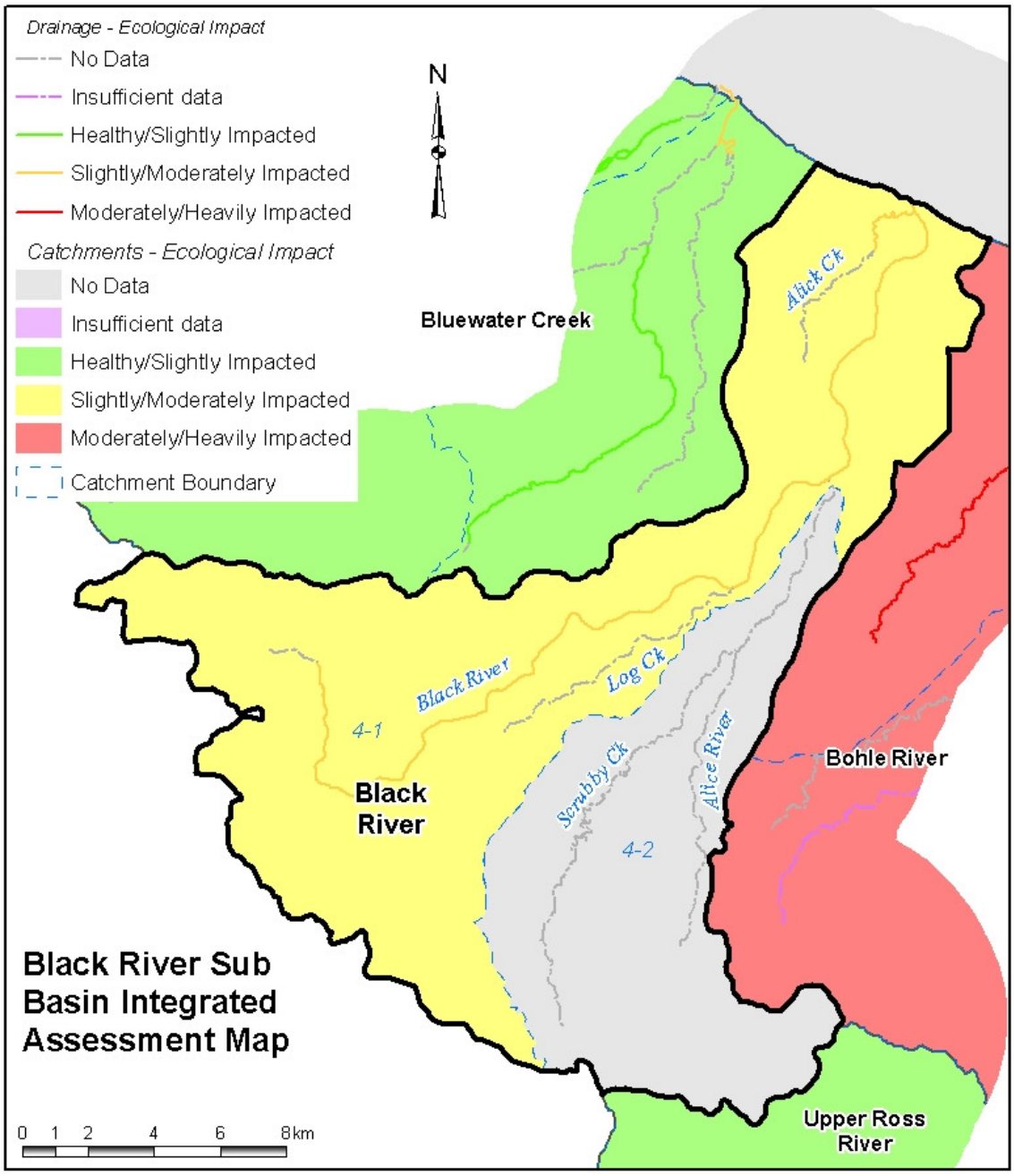
Secondary Land Use - Tertiary Land Use		QLUMP 1999		2005 Update	
		Area (ha)	%	Area (ha)	%
Nature conservation	Other conserved area	8	0.1	8	0.1
Other minimal use	Remnant native cover	44	0.4	44	0.4
Grazing natural vegetation		9,453	94.5	9,417	94.3
Irrigated perennial horticulture		5	0.1	5	0.1
Residential		295	2.9	312	3.1
Residential	Rural residential	140	1.4	140	1.4
Services	Recreation and culture	23	0.2	23	0.2
River		39	0.4	39	0.4
		10,007		9,988	

Source: CSIRO calculation from QLUMP 1999 and 2005 calculation from land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

8.4 Black River Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (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 solids (sediment) (TSS) for the Black River was above the guideline. Recent data for the Black River indicates that TSS is trending higher. Confirmation of this assessment through additional water quality monitoring is recommended.

Figure 8.4 Black River Sub Basin Ecological Impact



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

8.5 Water Quality and Water Quality Objectives (WQOs)

When comparing water quality condition data with the WQOs for the Black River we can see that the WQOs are met for some of the water quality indicators including total nitrogen and total phosphorus. The water quality condition data was above the WQOs for filterable reactive phosphorus (FRP) and total suspended solids (TSS) (see Table 8.6).

Table 8.6 Comparing WQOs with Water Quality

Black River Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Black River 4-1	√* 50%	√ 28%	√* 33%	X 75%	√* 36%	X 60%

Notes: Tick/cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

9. Bohle River Sub Basin

The Bohle River Sub Basin is dominated by the Bohle River with the relatively small Shelly Beach catchment located in the northeast corner of the sub basin. There are also a number of smaller waterways in the sub basin however most of the waterways are tributaries of the Bohle River including the Little Bohle River, Louisa Creek, Saunders Creek and Stoney Creek (see Figure 9.1 and Figure 9.2).

Figure 9.1 Bohle River Sub Basin and Drainage

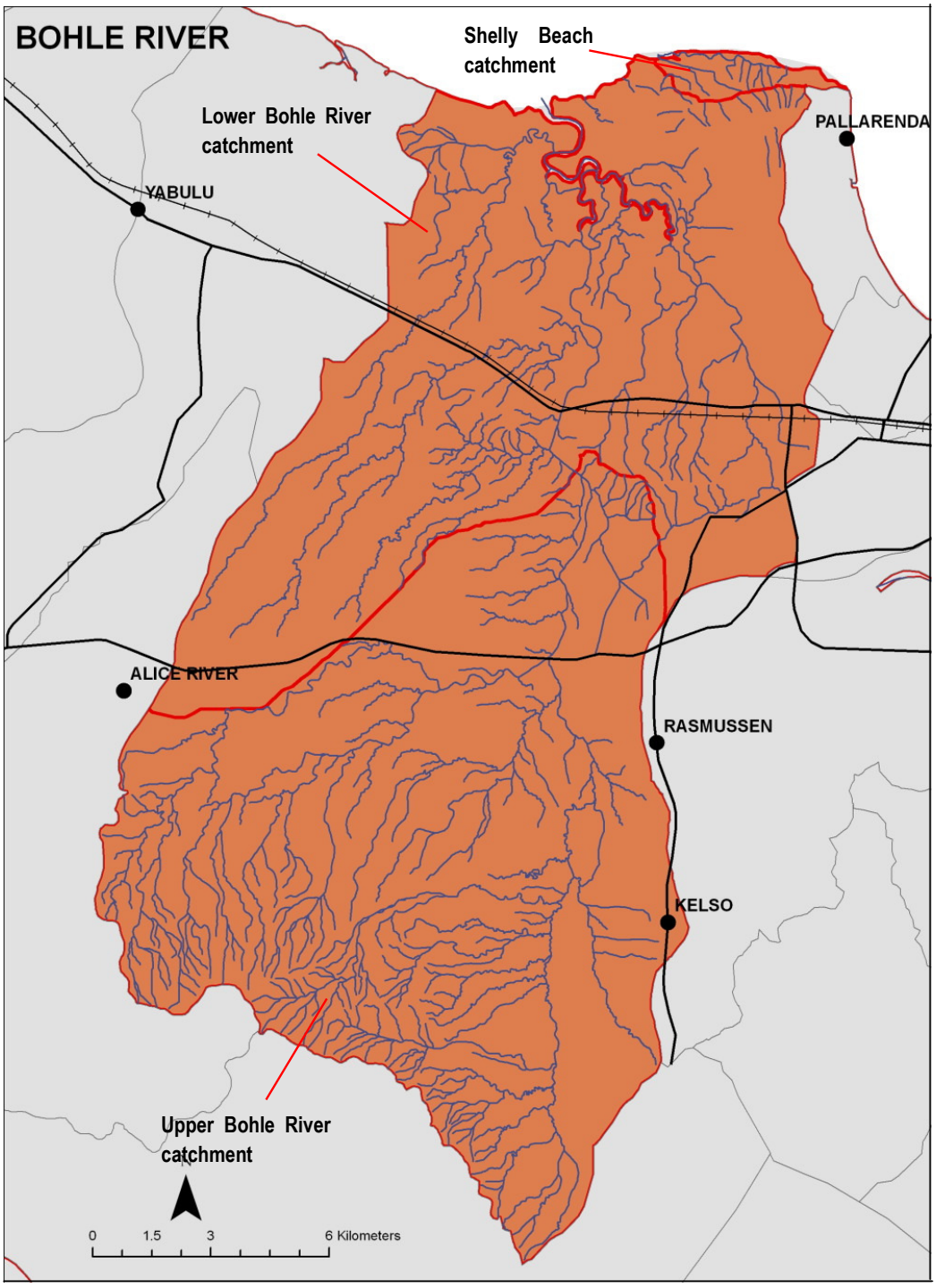
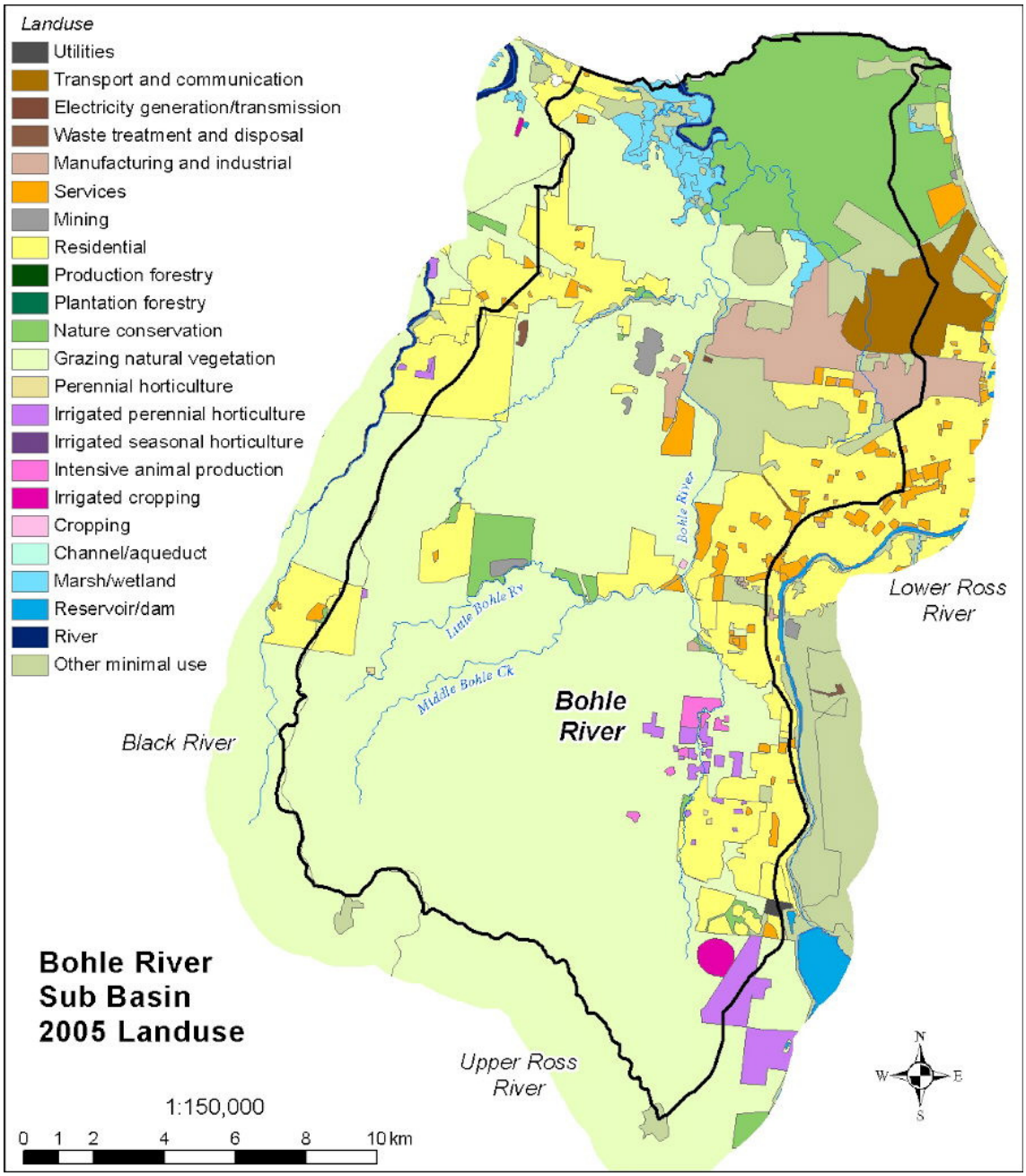


Figure 9.2 Bohle River Sub Basin Imagery

9.1 Bohle River Sub Basin Land Use

The Bohle River Sub Basin is approximately 322 square kilometres in size (~32,200 hectares). Land use in the Bohle River Sub Basin is dominated by grazing (59%). Combined nature conservation and other minimal use (16%) occupies a significant area of the sub basin while residential and associated urban land uses dominate a number of Bohle River tributary catchments and account for over 20% of the total sub basin land area (see Figure 9.3 and Table 9.1).

Figure 9.3 Bohle River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

Table 9.1 Bohle River Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Cropping	4	<0.1	4.3	<0.1
Grazing natural vegetation	19,965	62	19,019	59
Intensive animal production	90	0.3	101	0.3
Irrigated cropping			88	0.3
Irrigated perennial agriculture	254	0.8	299	0.9
Manufacturing and industrial	837	2.6	1,007	3.1
Marsh/Wetland	529	1.6	514	1.6
Mining	95	0.3	110	0.3
Nature conservation	3,185	9.9	3,197	9.9
Other minimal use	2,115	6.6	2,053	6.4
Perennial horticulture	27	<0.1	10	<0.1
Reservoir/Dam	3	<0.1	3	<0.1
Residential	3,944	12.24	4,755	14.8
River	16	<0.1	16	<0.1
Services	694	2.22	532	1.7
Transport and communication	443	1.4	485	1.5
Utilities	17	<0.1	21	<0.1
Waste treatment and disposal	12	<0.1	17	<0.1
	32,230	100	32,229	100

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

9.2 Bohle River Sub Basin Demographics

The 2006 Census counted 62,026 people resident within the Bohle River Sub Basin. The sub basin stretches from the Pinnacles to the coast and includes the bulk of the Bushland Beach suburb, plus established residential areas below the Ross River Dam, and Townsville's northwestern suburbs including Mount Louisa, Heatley and Kirwan. Selected medians and averages for the Bohle River Sub Basin from the 2006 Census are provided in Table 9.2

Significant areas of the sub basin are earmarked for residential development in the near future i.e. one to 10 years, including the planned new suburb of Cosgrove, the proposed 'Greater Ascot' development in the Shaw's Road vicinity, Stockland's North Shore development at Burdell, Devine residential estate at Dunlop Street Kelso, and Kalynda Chase.

The lower reaches of the sub basin are dominated by industrial and commercial use including Defence lands and the Townsville Airport and RAAF base.

Housing in the Bohle Sub Basin consists predominantly of single family dwellings with 18,355 dwellings being separate houses out of a total 20,143 dwellings in the area (see Table 9.3).

The median age of the Bohle River Sub Basin population at the 2006 Census was 31 years. Family characteristics vary throughout the sub basin, with a higher proportion of couples with children living in suburban areas, including in the Upper Ross and Bushland Beach areas. Almost 15% of total households in the sub basin report only one person usually resident. This may reflect the presence of retirement style housing and unit development in particular areas.

The average household size of the Bohle River Sub Basin, at 3.1 people per household, is above the average occupancy rate of 2.8 people for the Townsville local government area.

Table 9.2 Selected Medians and Averages [13]

Description	Bohle River	Townsville
Median age of persons	31	33
Median individual income ($/weekly)	532	531
Median family income ($/weekly)	1,227	1,237
Median household income ($/weekly)	1,152	1,101
Median housing loan repayment ($/monthly)	1,246	1,231
Median rent ($/weekly)	198	190
Average household size	3.1	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Bohle River is the Bohle River Customised Region and Townsville is Townsville City Council local government area.

Table 9.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	18,355		57,771	
Semi-detached, row or terrace house, townhouse etc:				
One storey	713		1,429	
Two or more storeys	46		90	
Semi-detached, etc Total	759		1,519	
Flat, unit or apartment:				
In one or two storey block	855		1,629	
In a three storey block	3		7	
In a four or more storey block	7		17	
Attached to a house	3		17	
Flat, unit or apartment Total	868		1,670	
Other dwelling:				
Caravan, cabin, houseboat	138		230	
Improvised home, tent, sleepers out	9		22	
House or flat attached to a shop, office, etc.	14		24	
Other dwelling Total	161		276	
Totals	**20,143**		**58,236**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Bohle River Customised Region.

[13] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

9.3 Bohle River Sub Basin Land Use by Catchments

Land use summaries of the main catchments of the Bohle River Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA Townsville, is included in Appendix E.

9.3.1 5-1 Lower Bohle River

The lower Bohle River catchment is approximately 14,580 hectares (~146 square kilometres) in area with the main land use being grazing in native pasture (38%). Urban land uses account for approximately 29% of the catchment with nature conservation and minimal use occupying a similar percentage of the catchment land area.

Table 9.4 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	2,437	16.7	2,451	16.8
	Other conserved area	247	1.7	255	1.8
Other minimal use		1,452	10.0	1,478	8.8
	Defence			189	1.3
	Remnant native cover	166	1.1	144	1.0
Grazing natural vegetation		5,979	41.0	5,529	37.9
Perennial horticulture		2	<0.1	2	<0.1
Irrigated perennial horticulture		3	<0.1	4	<0.1
Manufacturing and industrial		823	5.6	990	6.8
Residential		1,543	10.6	1,922	13.2
	Rural residential	455	3.1	455	3.1
Services		77	0.5	79	0.5
	Commercial services	195	1.3	29	0.2
	Recreation and culture	131	0.9	131	0.9
Utilities - Electricity generation/transmission				4	<0.1
Transport and communication	Airports/aerodromes	437	3.0	478	3.3
	Railways	1	<0.1	14	<0.1
Mining		77	0.5	82	0.6
Waste treatment and disposal - Landfill		12	0.1	17	0.1
Reservoir/dam		3	<0.1	3	<0.1
River		16	0.1	16	0.1
Marsh/wetland		290	2.0	275	1.2
	Marsh/W Conservation	239	1.6	239	1.6
	Total	14,583		14,583	

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

9.3.2 5-2 Upper Bohle River

The upper Bohle River catchment is approximately 17,280 hectares (~173 square kilometres) in area and is dominated by grazing (78%). Urban land uses occupy approximately 16% of the catchment.

Table 9.5 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	1.0	168	1.0
Other minimal use		448	2.6	382	2.2
	Remnant native cover	15	<0.1	15	<0.1
Grazing natural vegetation		13,987	80.9	13,489	78.0

Cropping		4	0.0	4	<0.1
Perennial horticulture		25	0.1	8	<0.1
Irrigated perennial horticulture		103	0.6	88	0.5
	Irrigated tree fruits	139	0.8	125	0.7
	Irrigated tree nuts	9	<0.1	171	1.0
Intensive animal production	Poultry	10	<0.1	12	<0.1
	Aquaculture	81	0.5	88	0.5
Manufacturing and industrial		15	0.1	17	0.1
Residential		1,348	7.8	1,643	9.5
	Rural residential	599	3.5	734	4.3
Services		77	0.4	78	0.5
	Commercial services	24	0.1	24	0.1
	Recreation and culture	191	1.1	191	1.1
Utilities - Electricity generation/transmission		17	0.1	17	0.1
Transport and communication - Railways		6	<0.1	6	<0.1
Mining		18	0.1	28	0.2
	Total	17,291		17,289	

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

9.3.3 5-3 Shelly Beach

The Shelly Beach catchment is approximately 360 hectares (~4 square kilometres) in area. The catchment is composed entirely of nature conservation and minimal use areas.

Table 9.6 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	90.4
	Other minimal use		34	9.6
		Total	357	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

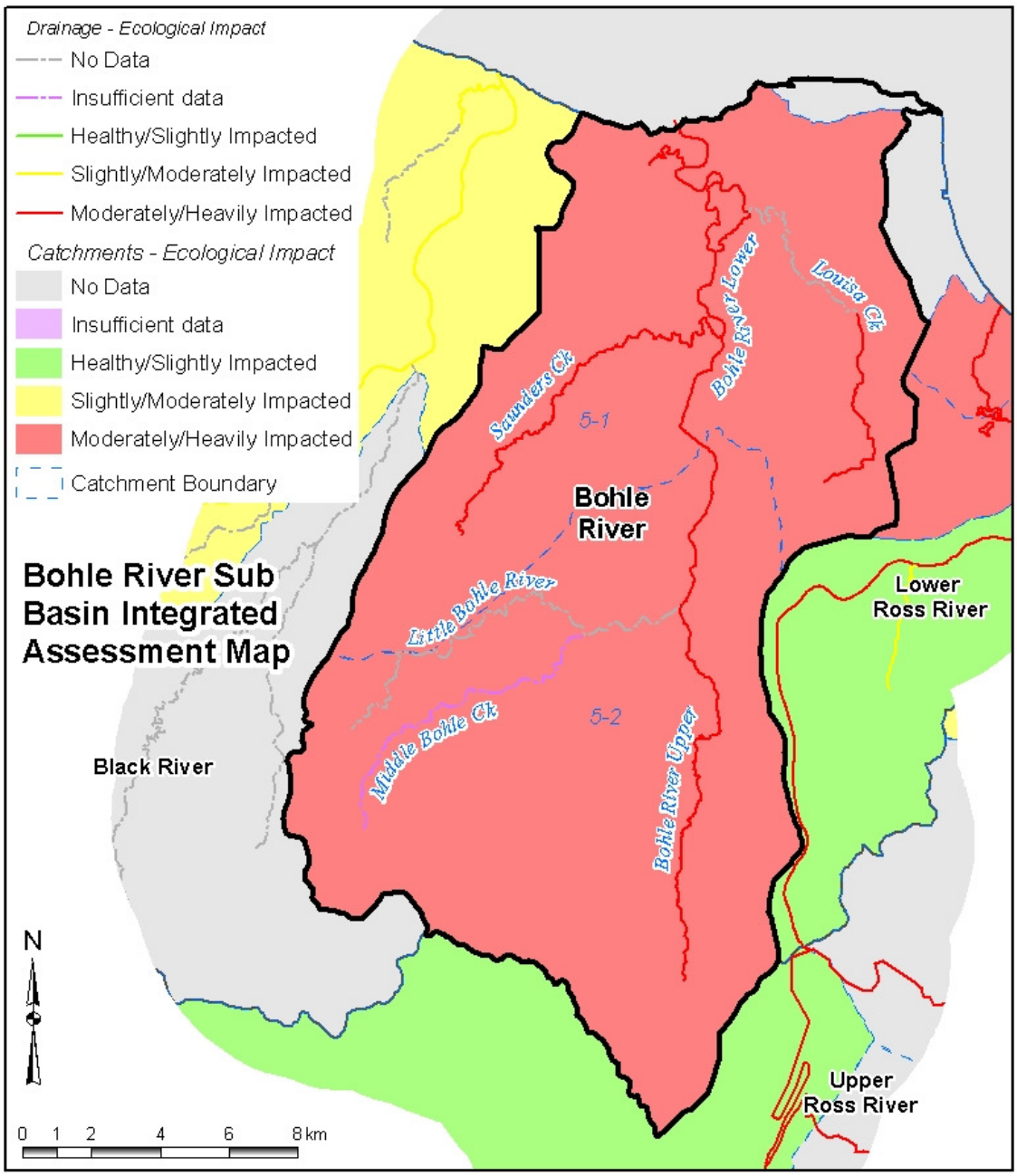
Table 9.7 Catchments Land Use Summary

Land Use	Lower Bohle River (5-1)		Upper Bohle River (5-2)		Shelly Beach (5-3)	
	Ha	%	Ha	%	Ha	%
Conservation and natural areas	4,328	29.7	565	3.3	357	100.0
Grazing	5,529	37.9	13,489	78.0	0	
Rural residential	455	3.1	734	4.2	0	
Intensive agriculture	6	0.0	396	2.3	0	
Urban	3,733	25.6	2,105	12.2	0	
Water and wetlands	532	3.6	0		0	
Totals	14,583		17,289		357	

9.4 Bohle River Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (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



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

Data indicates that nutrients, in particular filterable reactive (dissolved inorganic) phosphorus (FRP) is at very high levels. This trend is consistent across all of the lowland stream reaches where monitoring occurred while phosphorus levels were 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.

9.5 Water Quality and Water Quality Objectives (WQOs)

When we compare water quality condition data with the WQOs for the Bohle River sub basin we are confronted with the most degraded waterways in the Black Ross WQIP area. The only WQO that is met in the Bohle River is dissolved inorganic nitrogen (DIN) (below the Bruce Highway) (see Table 9.8).

Soluble forms of nutrients are particularly high in the middle and lower freshwater reaches of the Bohle River, suggesting a significant impact associated with the discharge from the wastewater treatment plants in the sub basin.

Table 9.8 Comparing WQOs with Water Quality

Bohle River Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Bohle R (below H'way) 5-1	√* 14%	X 16%	X 24%	X 330%	X 160%	X 110%
Bohle R (above H'way) 5-2	X 1,064%	X 138%	X 264%	X 19,900%	X 4,900%	X 140%

Notes: Tick/cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

10. Lower Ross River Sub Basin

The Lower Ross River Sub Basin (see Figure 10.1 and Figure 10.2) 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 waterways.

Figure 10.1 Lower Ross River Sub Basin and Drainage

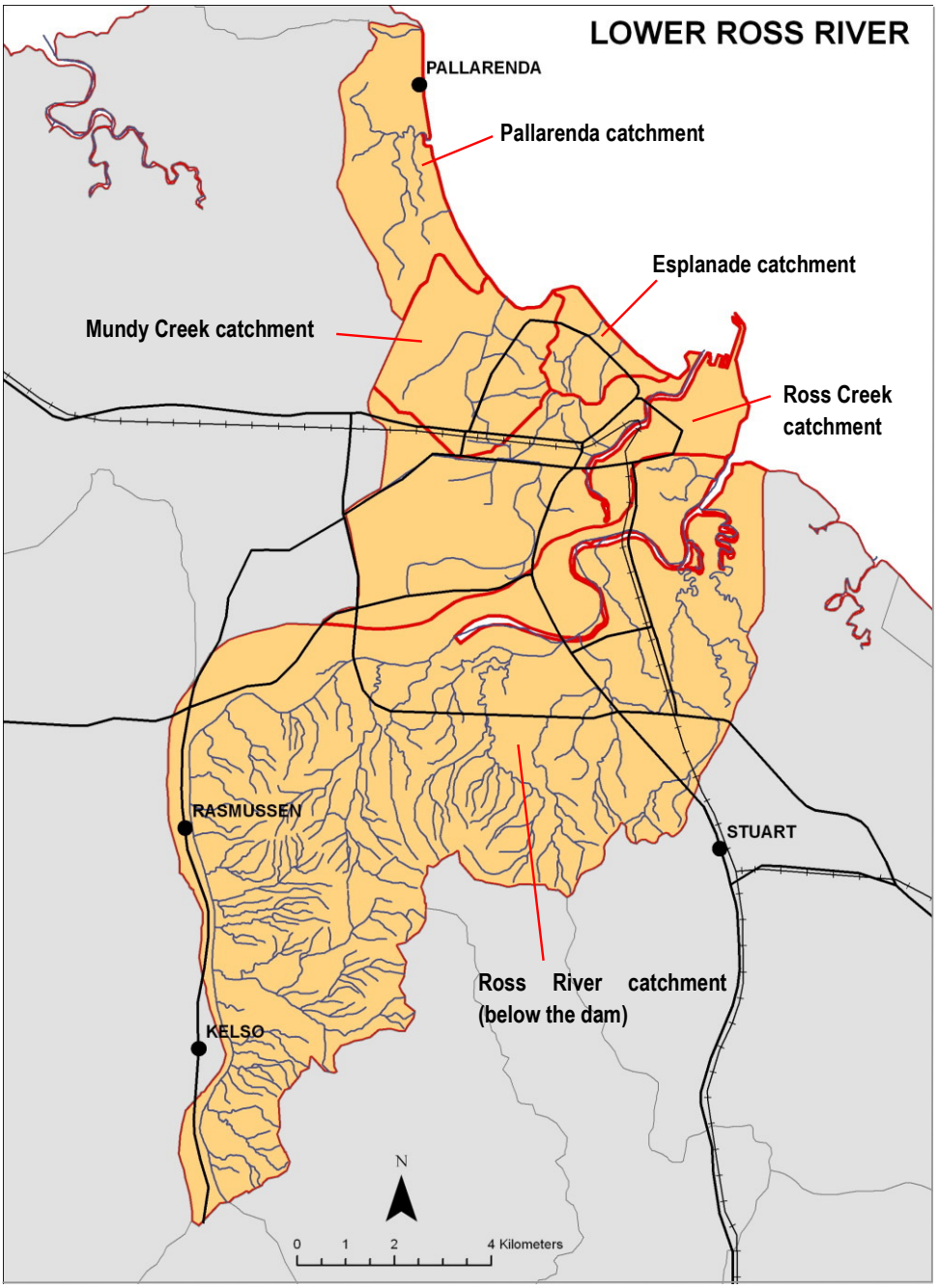
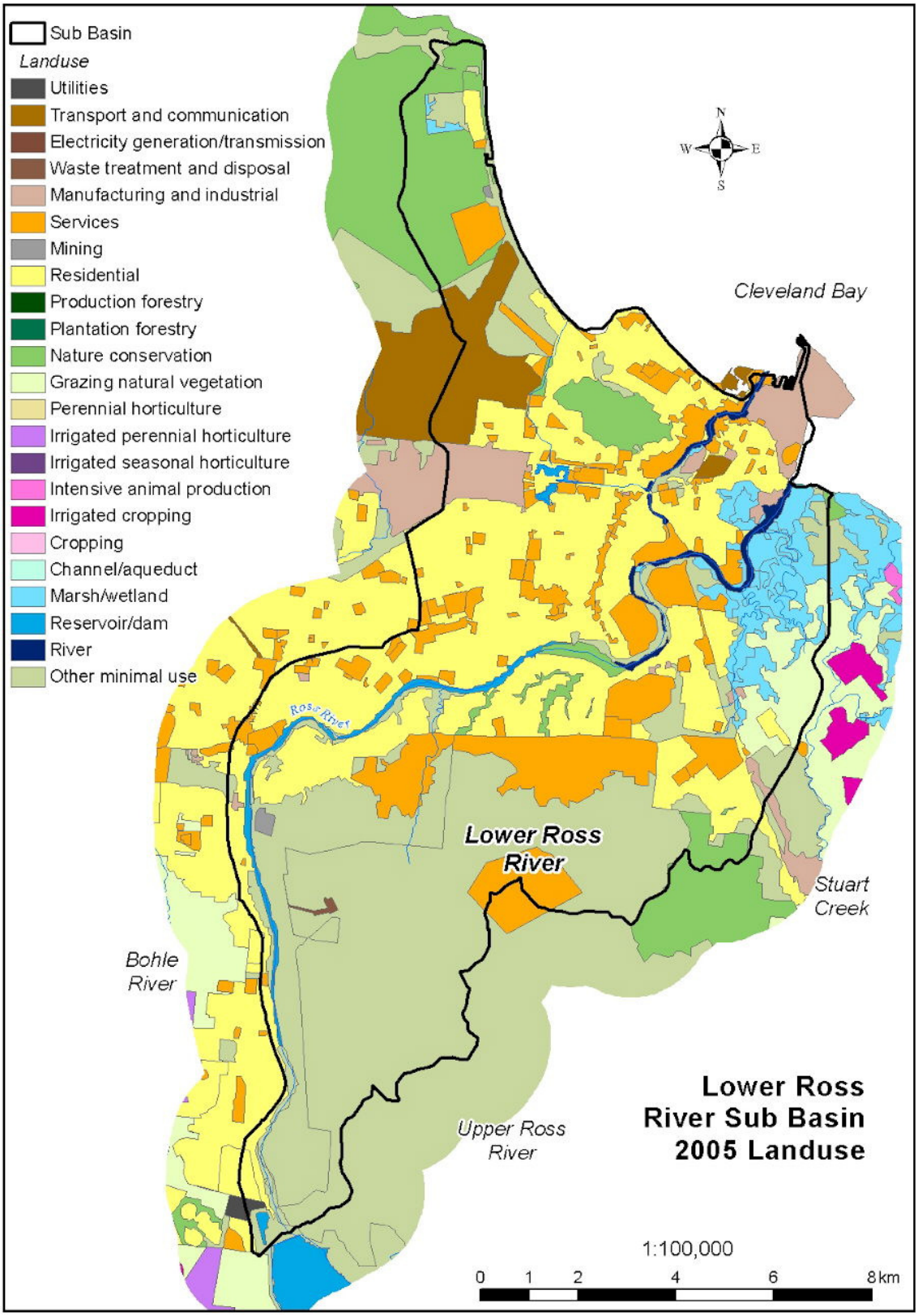


Figure 10.2 Lower Ross River Sub Basin Imagery

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 (34%) (Defence land) and nature conservation (Town Common and Castle Hill) and are also significant land uses in the Lower Ross River Sub Basin (see Figure 10.3 and Table 10.1).

Figure 10.3 Lower Ross River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

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	2.4	316	2.4
Manufacturing and industrial	268	2.0	381	2.8
Marsh/Wetland	516	3.8	515	3.8
Mining	21	0.2	21	0.2
Nature conservation	944	7.0	944	7.0
Other minimal use	5,016	37.2	4,584	34.0
Reservoir/Dam	149	1.1	149	1.1
Residential	3,737	27.7	4,046	30.0
River	92	0.7	91	0.7
Services	2,017	15.0	2,004	14.9
Transport and communication	390	2.9	416	3.1
Utilities	9	<0.1	9	<0.1
	13,475	100	13,475	100

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

10.2 Lower Ross River Sub Basin Demographics

The 2006 Census counted 76,541 people resident within the Lower Ross River Sub Basin. The sub basin extends from Pallarenda in the north to the Ross River Dam wall in the south, including Townsville's major inner urban suburbs, the Port and CBD precincts. It also includes major new residential development in the Fairfield Waters (Idalia) and Douglas areas, plus the Laverack Army Base.

Housing in the Lower Ross River Sub Basin has a higher percentage of flats and units than other sub basins in the WQIP area with 6,025 dwellings of the 27,757 dwellings in the sub basin being flats, units or apartments. Single-family dwellings account for 19,895 of the dwellings in the sub basin (see Table 10.3)

The median age of the Lower Ross River sub-basin population is reported at 34 years (2006 Census). Family characteristics vary throughout the sub basin, with a higher proportion of families with children living in more recently established suburban areas, including at Douglas.

Over 26% of total households in the sub basin report only one person usually resident. Average household size at 2.6 people per household is lower than the average occupancy of 2.8 people for the Townsville local government area.

Future growth in the Lower Ross Sub Basin is likely to include urban infill with an intensification of residential density through redevelopment. No large 'greenfield' sites suitable for significant residential development remain within the sub basin.

Selected medians and averages from the 2006 Census for the Lower Ross River Sub Basin are presented in Table 10.2

Table 10.2 Selected Medians and Averages [14]

Description	Lower Ross River	Townsville
Median age of persons	34	33
Median individual income ($/weekly)	538	531
Median family income ($/weekly)	1,270	1,237
Median household income ($/weekly)	1,067	1,101
Median housing loan repayment ($/monthly)	1,217	1,231
Median rent ($/weekly)	185	190
Average household size	2.6	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Lower Ross River is the Lower Ross River Customised Region and Townsville is Townsville City Council local government area.

Table 10.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	19,895		54,627	
Semi-detached, row or terrace house, townhouse etc:				
One storey	1,045		1,624	
Two or more storeys	510		903	
Semi-detached, etc Total	1,555		2,527	
Flat, unit or apartment:				
In one or two storey block	4,726		8,033	
In a three storey block	631		1,123	
In a four or more storey block	661		1,221	
Attached to a house	7		26	
Flat, unit or apartment Total	6,025		10,403	
Other dwelling:				
Caravan, cabin, houseboat	193		295	
Improvised home, tent, sleepers out	41		46	
House or flat attached to a shop, office, etc.	37		84	
Other dwelling Total	271		425	
Dwelling structure not stated	11		14	
Totals	**27,757**		**57,996**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Lower Ross River Customised Region.

[14] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

10.3 Lower Ross River Sub Basin Land Use by Catchment

Land use summaries for the main catchments of the Lower Ross River Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA Townsville, is included in Appendix E.

10.3.1 6-1 Pallarenda

The Pallarenda catchment is approximately 960 hectares (~10 square kilometres) in area with the main land use being conservation and natural environments (76%), including water. The remainder of the catchment consists of urban land uses.

Table 10.4 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	520	54.0
		Other conserved area	24	2.5
	Other minimal use		165	17.1
Intensive uses	Residential		43	4.5
	Services	Recreation and culture	92	9.5
	Transport and communication	Airports/aerodromes	100	10.3
	Mining		4	0.4
Water	Marsh/wetland		17	1.7
		Total	963	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

10.3.2 6-2 Mundy Creek

The Mundy Creek catchment is approximately 970 hectares (~10 square kilometres) in area. The main land uses are urban associated with residential areas accounting for 38% of the catchment. Nature conservation and minimal use areas account for 23% of the catchment.

Table 10.5 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	94	9.6	93	9.6
Other minimal use		143	14.7	118	12.1
	Remnant native cover	15	1.6	15	1.6
Manufacturing and industrial		13	1.3	32	3.2
Residential		365	37.5	366	37.7
Services		5	0.5	5	0.5
	Commercial services	32	3.2	14	1.4
	Recreation and culture	38	3.9	63	6.4
Transport and communication	Airports/aerodromes	260	26.8	260	26.8
Reservoir/dam		8	0.8	6	0.7
	Total	971		971	

Source: QLUMP 1999 calculations from CSIRO and 2005 calculation from land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

10.3.3 6-3 Esplanade

The Mundy Creek catchment is approximately 290 hectares (~3 square kilometres) in area. The main land use is residential (61%).

Table 10.6 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	15.1
	Other minimal use	Remnant native cover	8	2.7
Intensive uses	Residential		179	61.2
	Services		38	13.1
		Commercial services	12	4.1
		Recreation and culture	11	3.8
		Total	292	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

10.3.4 6-4 Ross Creek

The Ross Creek catchment is approximately 2,220hectares (~22 square kilometres) in area. The main land uses are urban associated with residential areas accounting for 57% of the catchment.

Table 10.7 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	77	3.4	7	3.4
Other minimal use		18	0.8	16	0.7
Manufacturing and industrial		201	9.1	296	13.3
Residential		1,315	59.1	1,274	57.2
Services		60	2.7	64	2.9
	Commercial services	301	13.5	235	10.6
	Recreation and culture	148	6.6	159	7.2
Transport and communication	Airports/aerodromes	32	1.5	32	1.5
	Railways	24	1.1	24	1.1
Reservoir/dam		13	0.6	14	0.6
River		36	1.6	34	1.5
Marsh/wetland	Marsh/W conservation	0.9	<0.1	0.9	<0.1
	Total	2,225		2,225	

Source: QLUMP 1999 calculations from CSIRO and 2005 calculation from land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

10.3.5 6-5 Ross River (below the dam)

The Ross River catchment below the dam is approximately 9,020 hectares (~90 square kilometres) in area with the largest single land use being minimal use (47%) with Defence land comprising most of this area and accounting for 31% of the catchment. Urban areas comprise around 40% of the catchment with residential being the dominant urban land use category occupying 24% of the catchment area.

Table 10.8 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	2.1	186	2.1
Other minimal use		1,697	18.8	1,353	15.0
	Defence	2,853	31.6	2,823	31.3

	Remnant native cover	91	1.0	87	1.0
Grazing natural vegetation		316	3.5	316	3.5
Manufacturing and industrial		53	0.6	53	0.6
Residential		1,804	20.0	2,154	23.9
	Rural residential	30	0.3	30	0.3
Services		431	4.8	430	4.8
	Commercial services	51	0.6	48	0.5
	Recreation and culture	385	4.3	381	4.2
	Defence facilities	352	3.9	371	4.1
	Research facilities	64	0.7	71	0.8
Utilities	Electricity generation/transmission	9	0.1	9	0.1
Mining		17	0.2	17	0.2
Waste treatment and disposal				11	0.1
Reservoir/dam		129	1.4	129	1.4
River		56	0.6	56	0.6
Marsh/wetland		222	2.5	222	2.5
	Marsh/W Conservation	277	3.1	275	3.0
	Total	9,026		9,023	

Source: QLUMP 1999 calculations from CSIRO and 2005 calculation from land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

Table 10.9 Catchments Land Use Summary

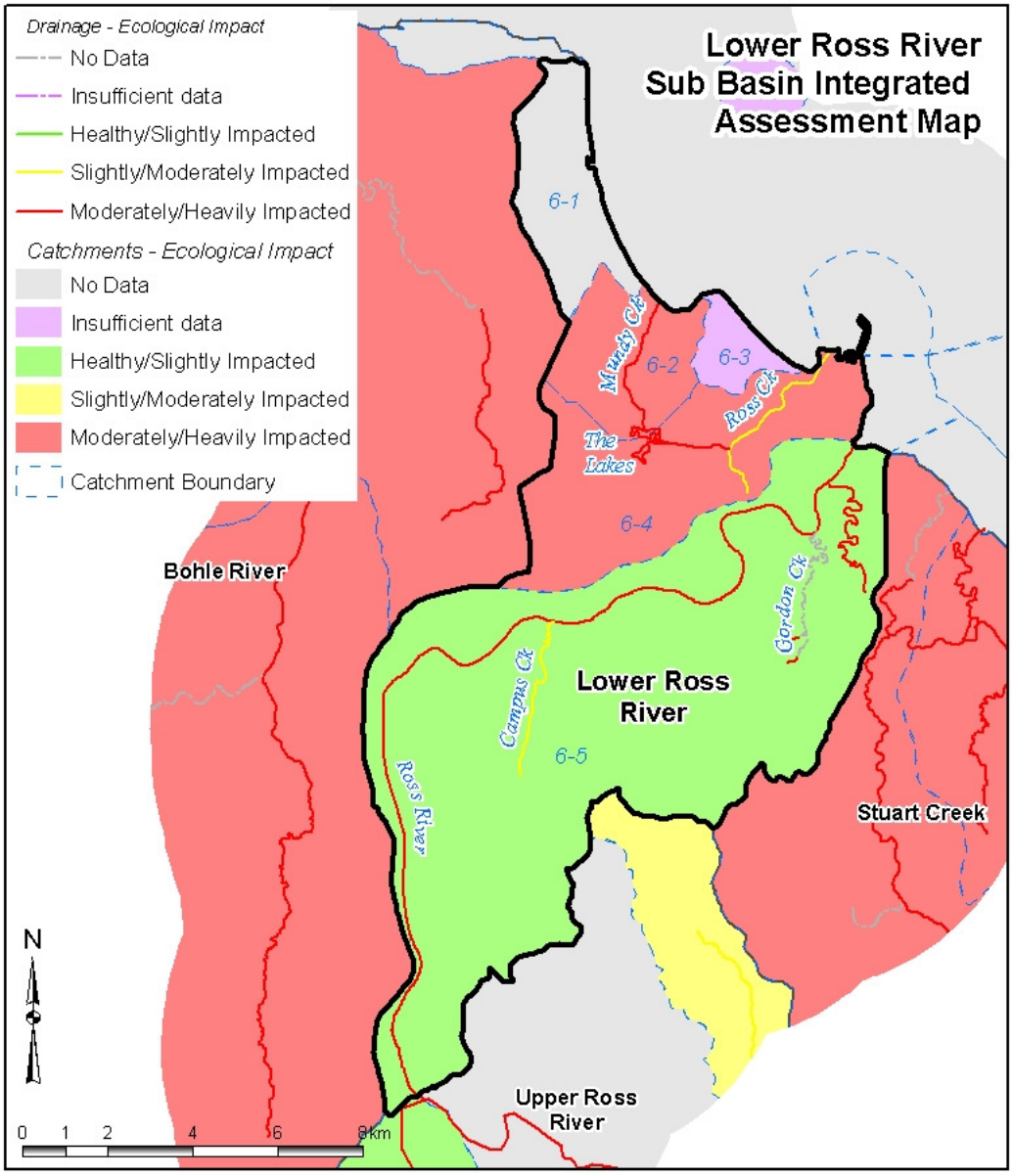
Land Use	Pallarenda (6-1)		Mundy Creek (6-2)		Esplanade (6-3)		Ross Creek (6-4)		Ross River (btd) (6-5)	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Conservation and natural areas	709	73.6	225	23.2	52	17.9	92	4.1	4,449	49.3
Grazing	0		0		0		0		316	3.5
Rural residential	0		0		0		0		30	0.3
Intensive agriculture	0		0		0		0		0	
Urban	238	24.7	739	76.1	240	82.2	2,084	93.6	3,545	39.3
Water and wetlands	17	1.8	6	0.7	0	0.0	49	2.2	682	7.6
Totals	963		971		292		2,225		9,023	

10.4 Lower Ross River Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (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 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 probably reflective of the continual expansion of urban land uses within this catchment.

Figure 10.4 Lower Ross River Sub Basin Ecological Impact



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

10.5 Water Quality and Water Quality Objectives (WQOs)

While the combined water quality condition data seems to compare reasonably with the WQOs (see Table 10.10), the data is often inconsistent or dated.

More recent data for the Ross River sub basin shows deterioration in water quality and the need for a more comprehensive monitoring program to assess the current condition of Townsville's urban waterways and identify the key pollutant sources contributing to the suspected degradation.

Table 10.10 Comparing WQOs with Water Quality

Lower Ross River Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Mundy Creek 6-2	ND	√ 15%	X 28%	X 590%	X 390%	X 50%
[1]Esplanade 6-3	√ 63%	√* 29%	√* 31%	ND	√ 20%	ND
Ross Creek 6-4	√ 29%	√ 33%	√ 29%	√	√* 20%	X 80%
Ross River (below Dam) 6-5	√* 50%	√* 20%	√* 14%	√ 40%	√ 6%	X 50%

Notes: Tick / cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

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 waterways (see Figure 11.1 and Figure 11.2).

Figure 11.1 Upper Ross River Sub Basin and Drainage

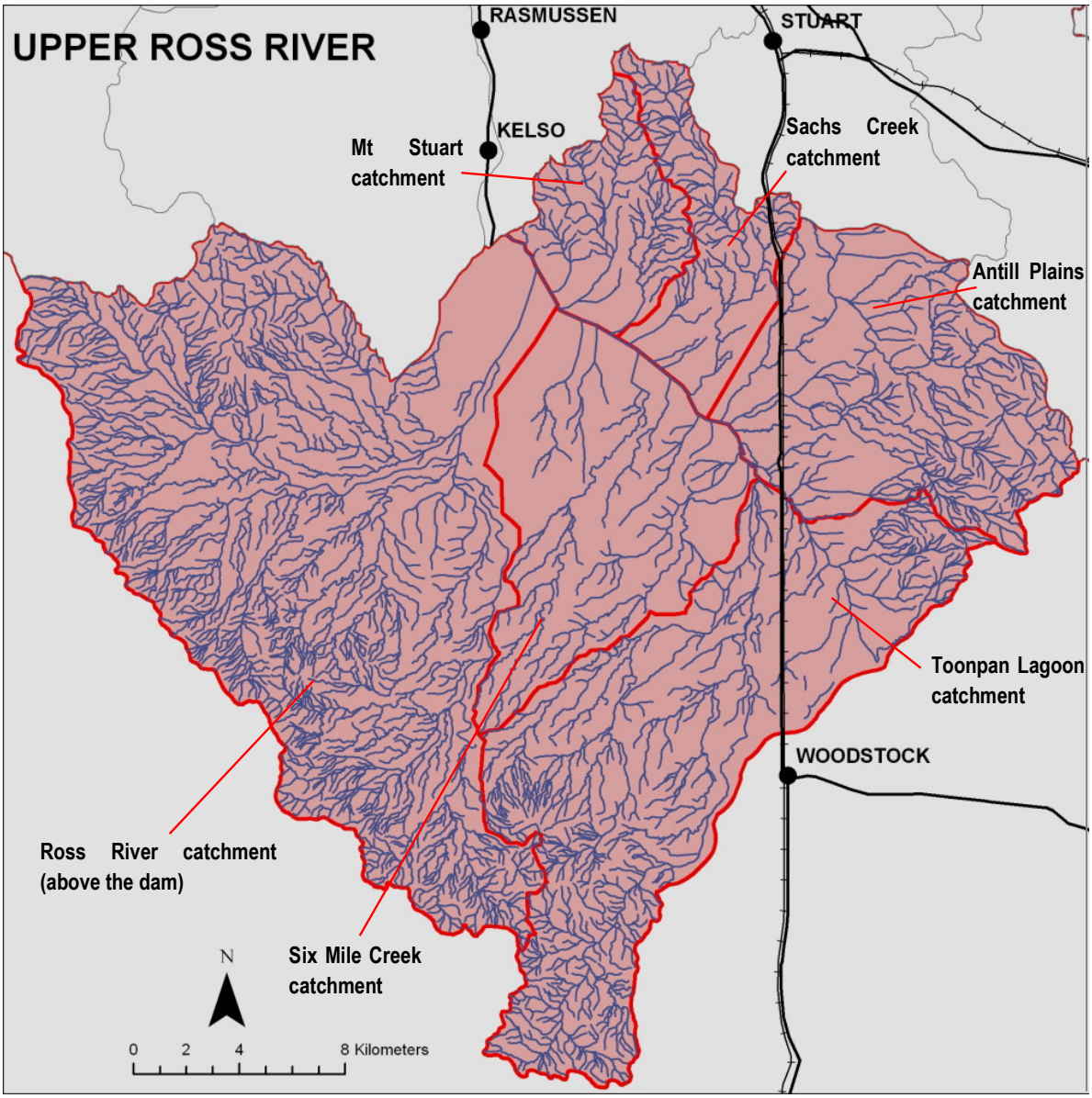
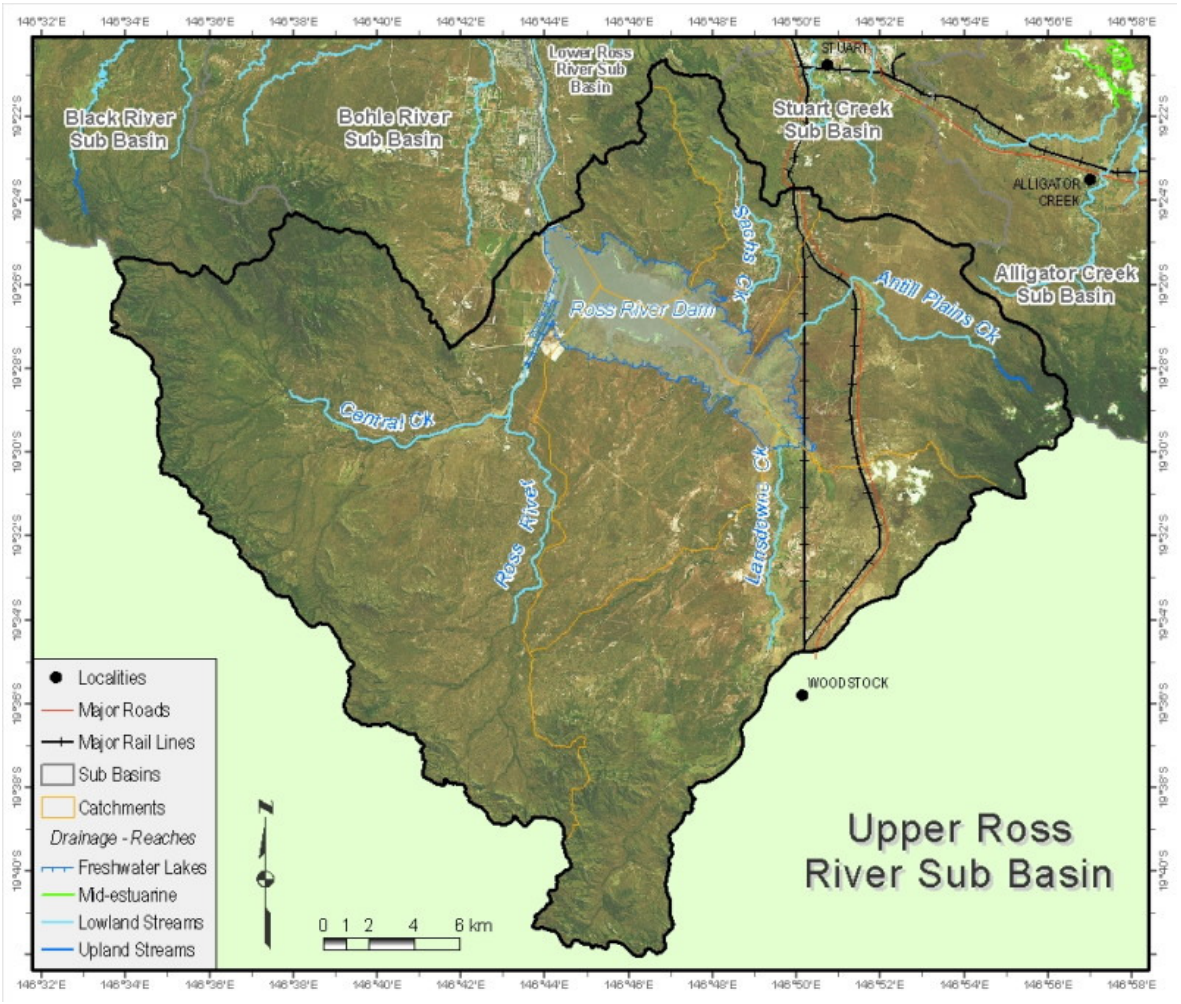


Figure 11.2 Upper Ross River Sub Basin Imagery

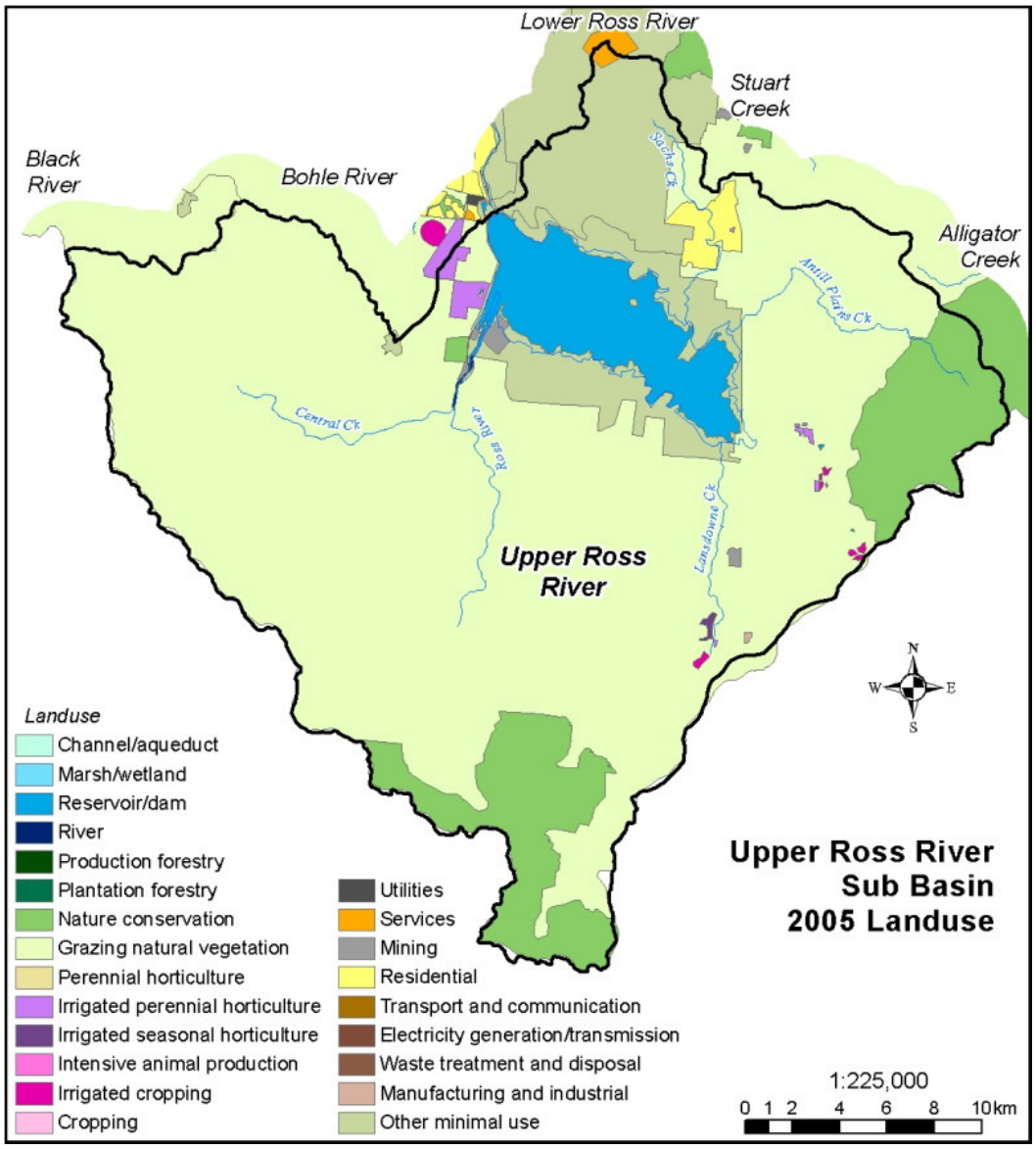


11.1 Upper Ross River Sub Basin Land Use

The Upper Ross River Sub Basin is 755 square kilometres in size (~75,500 hectares). The Upper Ross River Sub Basin is the catchment for the Ross River Dam, Townsville's main drinking water supply.

Land use in the Upper Ross Sub Basin is dominated by grazing (72%) and nature conservation/minimal use (22%). The Ross River Dam occupies approximately 6% of the sub basin area (see Figure 11.3 and Table 11.1).

Figure 11.3 Upper Ross River Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

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	54,437	71.67	54,082	71.7
Irrigated cropping	63	<0.1	63	<0.1
Irrigated perennial horticulture	323	0.4	323	0.4
Irrigated seasonal horticulture	35	<0.1	35	<0.1
Manufacturing and industrial	11	<0.1	11	<0.1
Marsh/Wetland			12	<0.1
Mining	53	<0.1	173	0.2
Nature conservation	8,367	11.0	8,218	10.9
Other minimal use	7,580	10.0	7,461	10.0

Reservoir/Dam	4,335	5.7	4,332	5.7
Residential	647	0.9	647	0.9
River	27	<0.1	27	<0.1
Services	75	0.1	75	0.1
	75,953	100	75,460	100

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

11.2 Upper Ross River Sub Basin Demographics

The 2006 Census counted 1,357 people resident within the Upper Ross River Sub Basin. The sub basin includes the catchments of the Ross River Dam, incorporating areas to the west of Mount Stuart and rural lands towards Woodstock. Woodstock township is not included in the Upper Ross River Sub Basin.

Housing in Upper Ross River Sub Basin is predominantly single family dwellings with 410 separate houses out of a total 443 dwellings in the area (see Table 11.3).

The median age of the Upper Ross River Sub Basin population is reported at 38 years (2006 Census). Of the 375 families usually resident in the sub basin at the 2006 Census, 142 were couples without children and 189 were couples with children.

16% of total households in the sub basin report only one person usually resident. This may reflect the median age profile, which is greater than that of the Townsville LGA.

Average household size at 3.0 people per household is above the average occupancy for the Townsville local government area (2.8 people). Overall, 33.7% of Upper Ross River households have four people, or more usually resident.[15] Selected medians and averages from the 2006 Census for the Upper Ross River Sub Basin are presented in Table 11.2.

Table 11.2 Selected Medians and Averages [16]

Description	Upper Ross River	Townsville
Median age of persons	38	33
Median individual income ($/weekly)	471	531
Median family income ($/weekly)	1,167	1,237
Median household income ($/weekly)	1,080	1,101
Median housing loan repayment ($/monthly)	1,171	1,231
Median rent ($/weekly)	134	190
Average household size	3.0	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Upper Ross River is the Upper Ross River Customised Region and Townsville is Townsville City Council local government area.

[15] All Dwelling, Household, and Median data is sourced from the 2006 Census Population and Housing Customised Basic Community Profile

[16] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

Table 11.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	410		1,255	
Semi-detached, row or terrace house, townhouse etc:				
Semi-detached, etc Total	0		0	
Flat, unit or apartment:				
Flat, unit or apartment Total	0		0	
Other dwelling:				
Caravan, cabin, houseboat	20		26	
Improvised home, tent, sleepers out	13		18	
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	33		44	
Totals	**443**		**1,305**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Upper Ross River Customised Region.

11.3 Upper Ross River Sub Basin Land Use by Catchment

Land use summaries of the main catchments of the Upper Ross River Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA Townsville, is included in Appendix E.

11.3.1 7-1 Ross River (above the dam)

The Ross River catchment above the dam is approximately 30,250 hectares in area (~300 square kilometres) with the main land use being grazing in native pasture (91%).

Table 11.4 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	1,443	4.7	1,419	4.7
Other minimal use		240	0.8	147	0.5
	Remnant native cover	60	0.2	60	0.2
Grazing natural vegetation		27,737	90.9	27,488	90.9
Irrigated perennial horticulture	Irrigated tree fruits	279	0.9	279	0.9
Residential		<1	<0.1	<1	<0.1
Mining		13	<0.1	109	0.4
Reservoir/dam		722	2.4	719	2.4
River		27	0.1	27	0.1
	Totals	30,520		30,247	

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

11.3.2 7-2 Six Mile Creek

The Six Mile Creek catchment is approximately 9,625 hectares in area (~96 square kilometres) with the main land use being grazing in native pasture (63%). Ross River Dam also takes up a considerable amount of this catchment (18%), as does minimal use (19%).

Table 11.5 Six Mile Creek Catchment Land Use 2005

Primary Land Use	Secondary Land Use	Area (ha)	%
Conservation and natural environments	Other minimal use	1,847	19.2
Production from relatively natural environments	Grazing natural vegetation	6,077	63.1
Water	Reservoir/dam	1,701	17.7
	Total	9,625	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

11.3.3 7-3 Toonpan Lagoon

The Toonpan Lagoon catchment is approximately 16,900 hectares in area (~170 square kilometres) with the main land use being grazing in native pasture (75%).

Table 11.6 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	4.3
	Other minimal use		3,174	18.7
		Remnant native cover	88	0.5
Production from relatively natural environments	Grazing natural vegetation		12,757	75.3
Production from irrigated agriculture and plantations	Irrigated cropping		63	0.4
	Irrigated perennial horticulture	Irrigated tree fruits	13	0.1
		Irrigated vegetables & herbs	35	0.2
Intensive uses	Manufacturing and industrial		11	0.1
	Mining		38	0.2
Water	Reservoir/dam		22	0.1
	Marsh/wetland	Marsh/wetland conserve	12	0.1
		Total	16,935	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

11.3.4 7-4 Antill Plains Creek

The Antill Plains Creek catchment is approximately 10,730 hectares in area (~107 square kilometres) with the main land use being grazing in native pasture (64%).

Table 11.7 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	2,904	27.1
	Other minimal use		410	3.8
Production from relatively natural environments	Grazing natural vegetation		6,888	64.0
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	29	0.3
Intensive uses	Residential	Rural residential	11	0.1

Water	Reservoir/dam		484	4.5
		Total	10,726	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

11.3.5 7-5 Sachs Creek

The Sachs Creek catchment is approximately 4,130 hectares in area (~41 square kilometres) with the main land use being minimal use (Defence). Minimal use (18%), rural residential (15%) and Ross River Dam (16%) are also significant land uses in the catchment.

Table 11.8 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	<1	<0.1
	Other minimal use		721	17.5
		Defence	1,152	27.9
Production from relatively natural environments	Grazing natural vegetation		872	21.1
Production from irrigated agriculture and plantations	Irrigated perennial horticulture	Irrigated tree fruits	3	0.1
Intensive uses	Residential	Rural residential	634	15.4
	Services		75	1.8
Water	Reservoir/dam		673	16.3
		Total	4,130	

Source2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

11.3.6 7-6 Mt Stuart

The Mt Stuart catchment is approximately 3,800 hectares in area (~38 square kilometres) with the main land use being grazing in native pasture. The Ross River Dam also takes up a significant portion of the catchment (19%).

Table 11.9 Mt Stuart Catchment land Use 2005

Primary Land Use	Secondary Land Use	Tertiary Land Use	Area (ha)	%
Conservation and natural environments	Other minimal use		501	13.2
		Defence	2562	67.4
Production from relatively natural environments	Grazing natural vegetation		1	<0.1
Intensive uses	Residential	Rural residential	2	<0.1
Water	Reservoir/dam		733	19.3
		Total	3,798	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

Table 11.10 Catchments Land Use Summary

Land Use	Ross River (atd) (7-1)		Six Mile Creek (7-2)		Toonpan Lagoon (7-3)	
	Ha	%	Ha	%	Ha	%
Conservation and natural areas	1,626	5.4	1,821	18.9	3,983	23.5
Grazing	27,487	90.9	6,077	63.1	12,757	75.3
Rural residential	0		0		0	
Intensive agriculture	279	0.9	0		112	0.7
Urban	109	0.4	26	0.3	49	0.3
Water and wetlands	747	2.5	1,701	17.7	34	0.2
Totals	30,247	100.0	9,625	100.0	16,935	100.0
Land Use	**Antill Plains Creek (6-4)**		**Sachs Creek (7-5)**		**Mt Stuart (7-6)**	
	Ha	Ha	%	Ha	%	%
Conservation and natural areas	3,315	30.9	1,873	45.3	3,062	80.6
Grazing	6,888	64.2	872	21.1	1	0.0
Rural residential	11	0.1	634	15.4	2	0.0
Intensive agriculture	29	0.3	3	0.1	0	
Urban	0		75	1.8	0	
Water and wetlands	484	4.5	673	16.3	733	19.3
Totals	10,726	100.0	4,130	100.0	3,798	100.0

Note: atd is above the dam

11.4 Upper Ross River Sub Basin Resource Condition

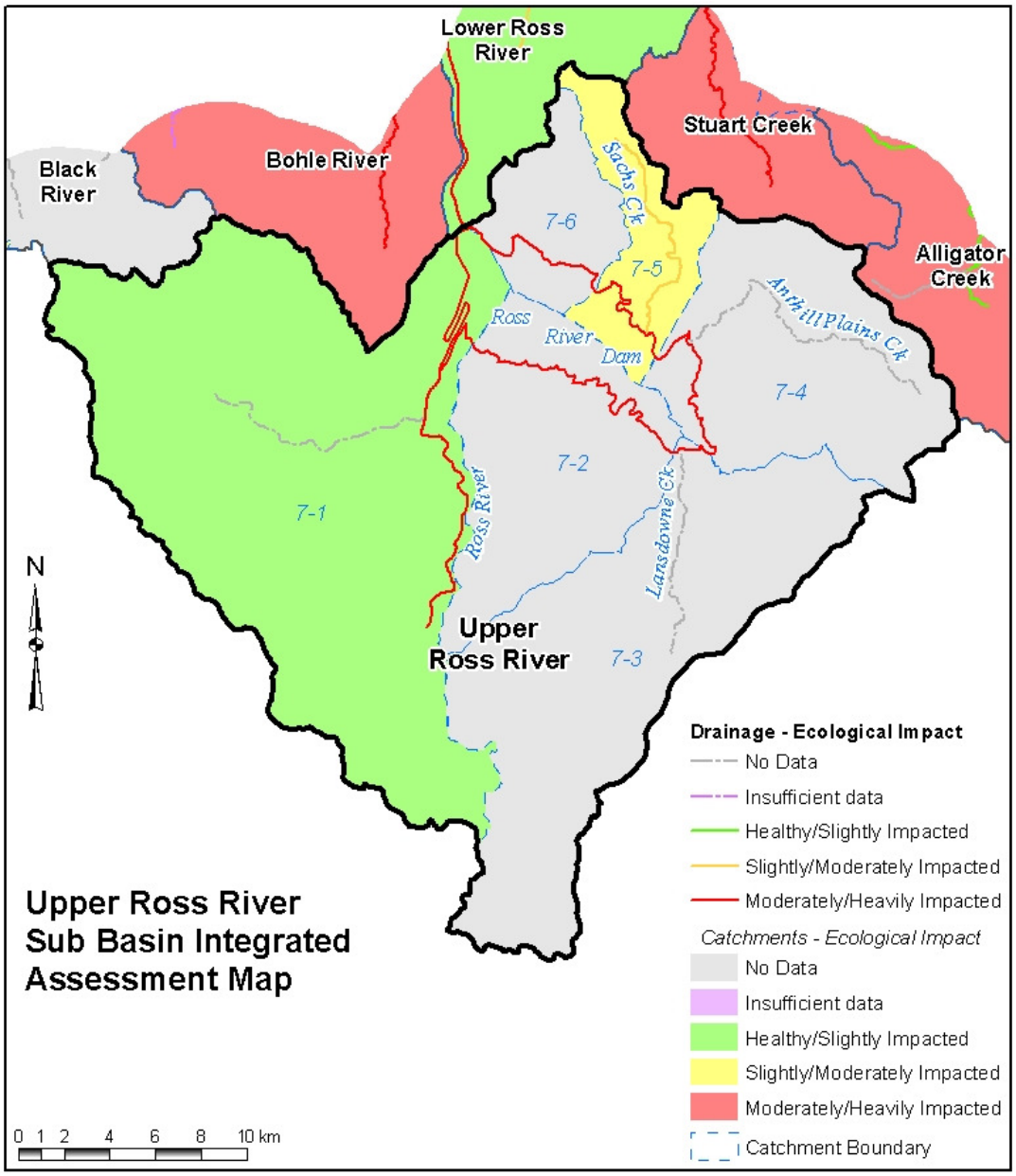
Despite a very limited dataset, the water quality condition assessment for Black Ross WQIP area (Connell Wagner 2008) indicated that the water quality of this sub basin was most likely to be slightly to moderately impacted (see Figure 11.4). The data associated with the Ross Dam catchment was all taken from within the Ross River Dam so it was not considered to be representative of the various catchments feeding into the dam. Recent data from Sachs Creek generally confirms the rating for this sub basin i.e. slightly to moderately impacted. However this may only be indicative of the land use and management activities of the Sachs Creek catchment and not of the whole sub basin.

11.5 Water Quality and Water Quality Objectives (WQOs)

The water quality condition data does not match the WQOs for many of the water quality indicators in the Upper Ross River sub basin (see Table 11.11). It should be noted that the water quality data for Lake Ross has been compared to the WQOs for lakes, which are more stringent than the WQOs for lowland streams.

The water quality data from Sachs Creek indicates above average concentrations of nutrients, which also have the potential to impact water quality in Lake Ross.

Figure 11.4 Upper Ross River Sub Basin Ecological Condition



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

Table 11.11 Comparing WQOs with Water Quality

Upper Ross River Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Lake Ross (Ross Dam) 7-1	X 100%	X 52%	X 60%	X 200%	X 200%	√* 80%
Sachs Creek 7-5	ND	√ 41%	X 13%	X 45%	√	√* 30%

Notes: Tick/cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

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 and Figure 12.2).

Figure 12.1 Stuart Creek Sub Basin and Drainage

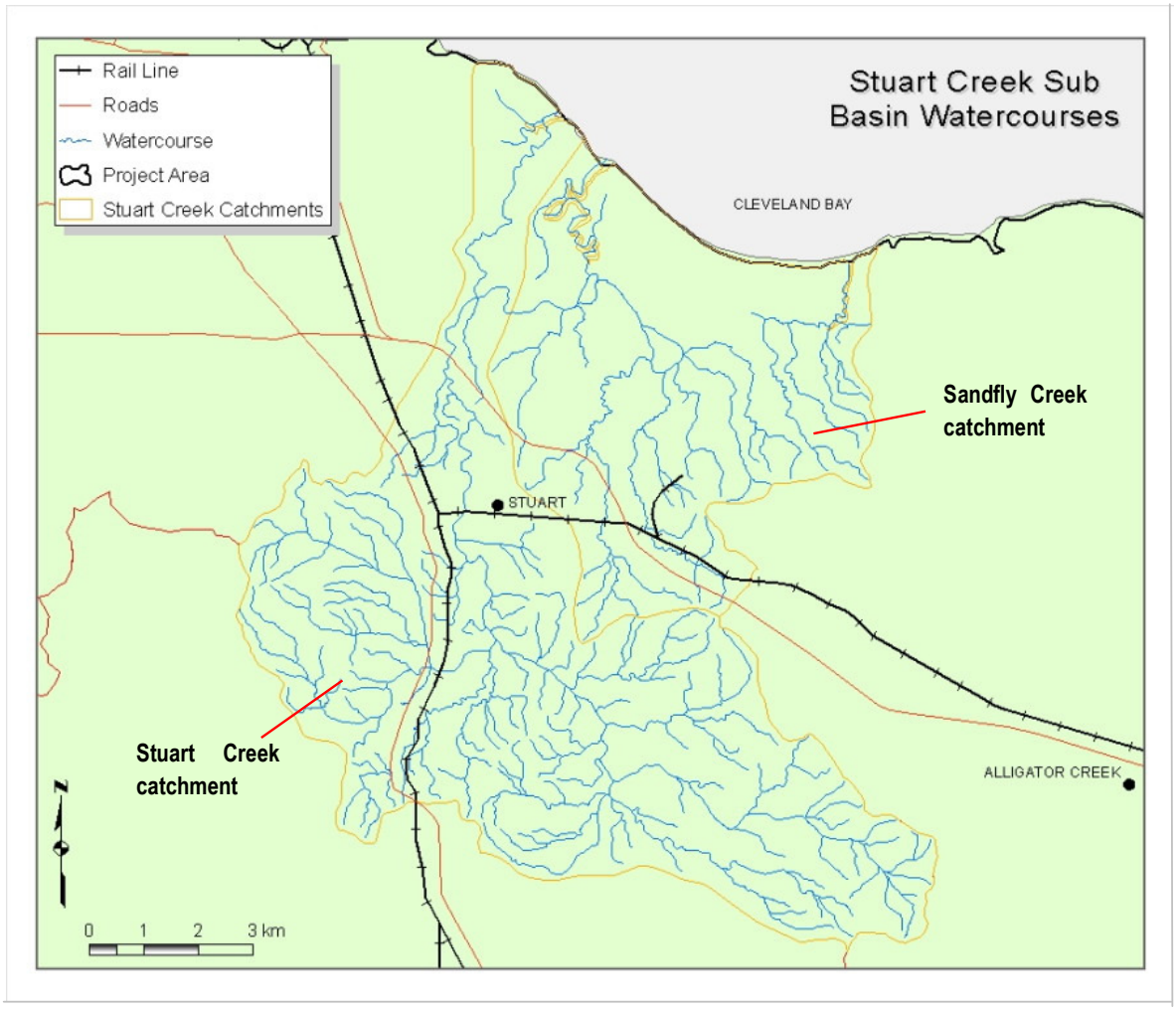
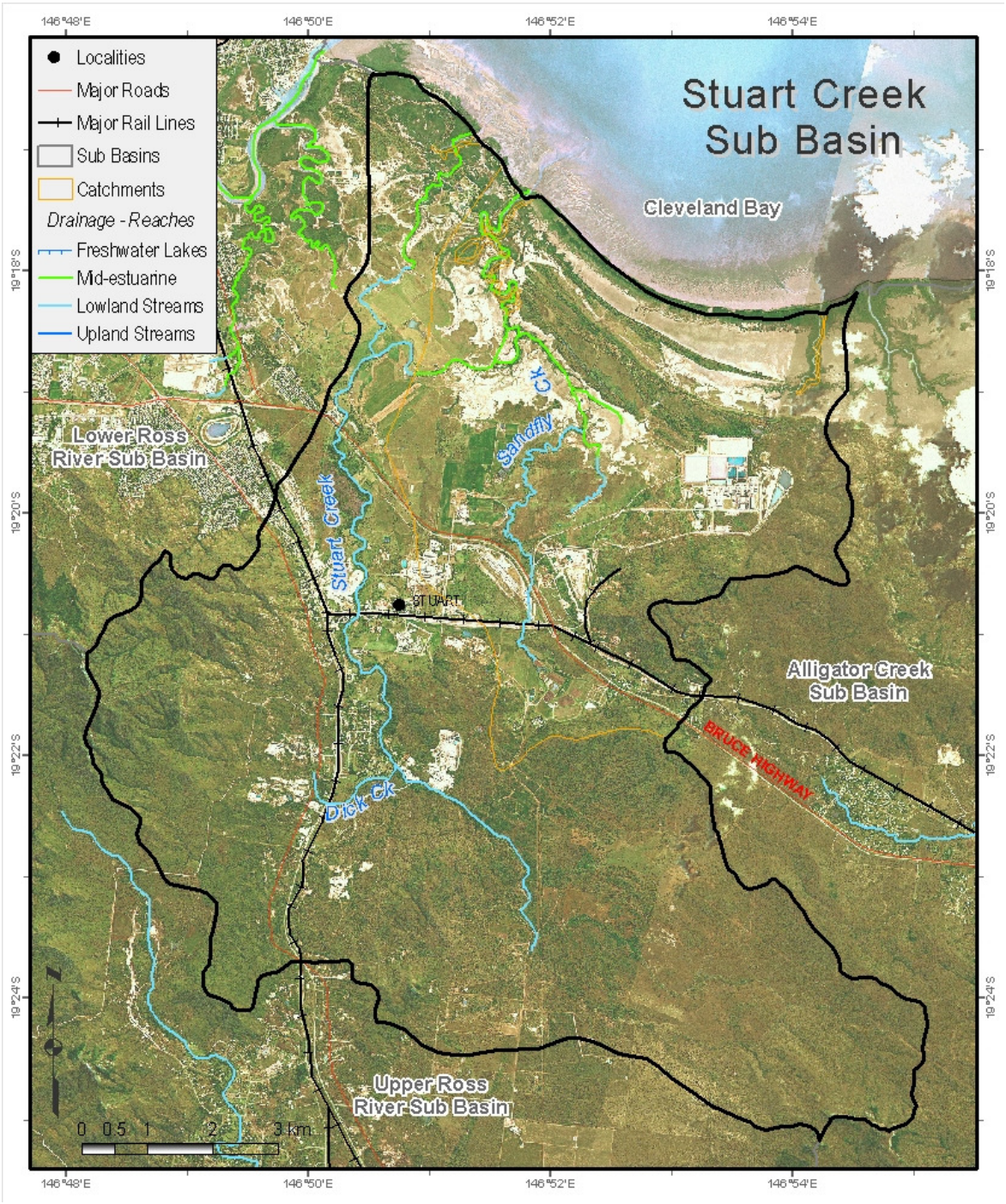


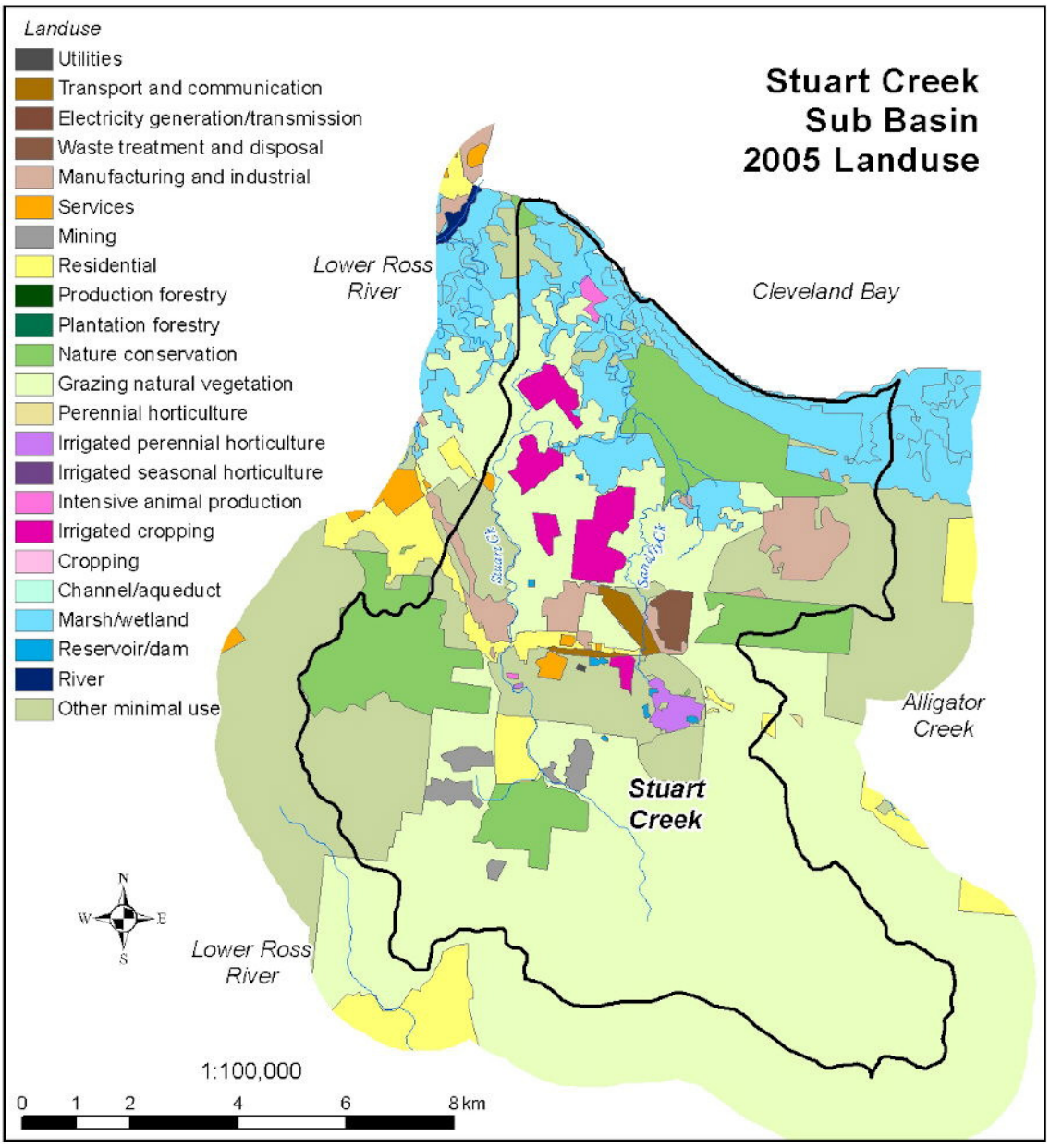
Figure 12.2 Stuart Creek Sub Basin Imagery



12.1 Stuart Creek Sub Basin Land Use

The Stuart Creek Sub Basin is approximately 104 square kilometres in size (~10,400 hectares). Grazing (49%) is the main land use in the Stuart Creek Sub Basin followed by other minimal use (including Defence land) (16%) and nature conservation (13%). While being a significant economic driver for Townsville, and concentrated in the Stuart Creek Sub Basin, the manufacturing and industrial sector accounts for less than 4% of the land use in the Stuart Creek Sub Basin (see Figure 12.3 and Table 12.1).

Figure 12.3 Stuart Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

Table 12.1 Stuart Creek Sub Basin Land Use

Land Use	QLUMP 1999		2005 Update	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Grazing natural vegetation	5,203	50.2	5,054	48.7
Intensive animal production	23	0.2	23	0.2
Irrigated cropping	234	2.3	299	2.9
Irrigated perennial horticulture	56	0.5	56	0.5
Manufacturing and industrial	359	3.5	353	3.4
Marsh/Wetland	1,033	10.0	1,033	10.0
Mining	109	1.1	116	1.1

Nature conservation	1,366	13.2	1,366	13.2
Other minimal use	1,753	16.9	1,704	16.4
Reservoir/Dam	16	0.2	14	0.1
Residential	173	1.7	191	1.8
Services	33	0.3	32	0.3
Transport and communication	14	0.1	68	0.7
Utilities	2	<0.1	2	<0.1
Waste treatment and disposal			62	0.6
	10,374	100	10,371	100

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare

12.2 Stuart Creek Sub Basin Demographics

The 2006 Census counted 1,230 people resident within the Stuart Creek Sub Basin. Limited residential use occurs at Stuart and Roseneath.

Housing in the Stuart Creek Sub Basin is predominantly single-family dwellings with 212 separate houses out of a total 229 dwellings in the area (see Table 12.3). The Stuart detention centre is excluded from these figures.

The median age of the Stuart Creek Sub Basin population is reported at 34 years (2006 Census). Of the 162 families usually resident in the sub basin at the 2006 Census, 49 were couples without children and 76 were couples with children. 27.5% of total households in the sub basin report only one person usually resident.

Average household size at 2.7 people per household is slightly below the average occupancy of 2.8 people for the Townsville local government area. Overall, 23.7% of Stuart Creek Sub Basin households have four people, or more usually resident.[17]

Selected medians and averages from the 2006 Census for the Stuart Creek Sub Basin are presented in Table 12.2

Table 12.2 Selected Medians and Averages [18]

Description	Stuart Creek	Townsville
Median age of persons	34	33
Median individual income ($/weekly)	460	531
Median family income ($/weekly)	1,170	1,237
Median household income ($/weekly)	944	1,101
Median housing loan repayment ($/monthly)	869	1,231
Median rent ($/weekly)	141	190
Average household size	2.7	2.8

Source: ABS 2006 Census of Population and Housing

[17] All Dwelling, Household, and Median data is sourced from the 2006 Census Population and Housing Customised Basic Community Profile

[18] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

Notes: Figures are based on place of usual residence. Stuart Creek is the Stuart Creek Customised Region and Townsville is Townsville City Council local government area.

Table 12.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	212		575	
Semi-detached, row or terrace house, townhouse etc:				
Semi-detached, etc Total	0		0	
Flat, unit or apartment:				
In one or two storey block	0		3	
Flat, unit or apartment Total	0		3	
Other dwelling:				
Caravan, cabin, houseboat	9		18	
Improvised home, tent, sleepers out	8		9	
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	17		27	
Totals	**229**		**605**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Stuart Creek Customised Region.

12.3 Stuart Creek Sub Basin Land Use by Catchment

Land use summaries of the main catchments of the Stuart Creek Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA Townsville, is included in Appendix E.

12.3.1 8-1 Stuart Creek

The Stuart Creek catchment is approximately 6,700 hectares in area (~67 square kilometres) with the main land use being grazing in native pasture (61%). 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 12.4 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	10.6
	Other minimal use		514	7.6
		Defence	515	7.7
		Remnant native cover	65	1.0
Production from relatively natural environments	Grazing natural vegetation		4,130	61.4
Production from irrigated agriculture and plantations	Irrigated cropping		106	1.6
	Irrigated perennial horticulture		1	<0.1
Intensive uses	Intensive animal production	Poultry	2	<0.1
		Aquaculture	19	0.3
	Manufacturing and industrial		99	1.5

	Residential		84	1.2
		Rural residential	87	1.3
	Services		21	0.3
		Recreation and culture	10	0.2
	Utilities	Electricity generation/transmission	2	<0.1
	Transport and communication	Railways	12	0.2
	Mining		116	1.7
Water	Reservoir/dam		6	0.1
	Marsh/wetland		87	1.3
		Marsh/W Conservation	135	2.0
		Total	6,727	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

12.3.2 8-2 Sandfly Creek

The Sandfly Creek catchment is approximately 3,640 hectares in area (~36 square kilometres) with the main land use being nature conservation and other minimal use. Grazing accounts for 25% of the catchment.

Table 12.5 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	17.9
	Other minimal use		519	14.3
		Remnant native cover	90	2.5
Production from relatively natural environments	Grazing natural vegetation		923	25.3
Production from irrigated agriculture and plantations	Irrigated cropping		193	5.3
	Irrigated perennial horticulture		55	1.5
Intensive uses	Intensive animal production	Aquaculture	1	0.0
	Manufacturing and industrial		254	7.0
	Residential		7	0.2
		Rural residential	14	0.4
	Services	Commercial services	0	0.0
	Transport and communication	Railways	57	1.6
	Waste treatment and disposal	Landfill	62	1.7
Water	Reservoir/dam		7	0.2
	Marsh/wetland		628	17.2
		Marsh/W Conservation	182	5.0
		Total	3,644	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

Table 12.6 Catchments Land Use Summary

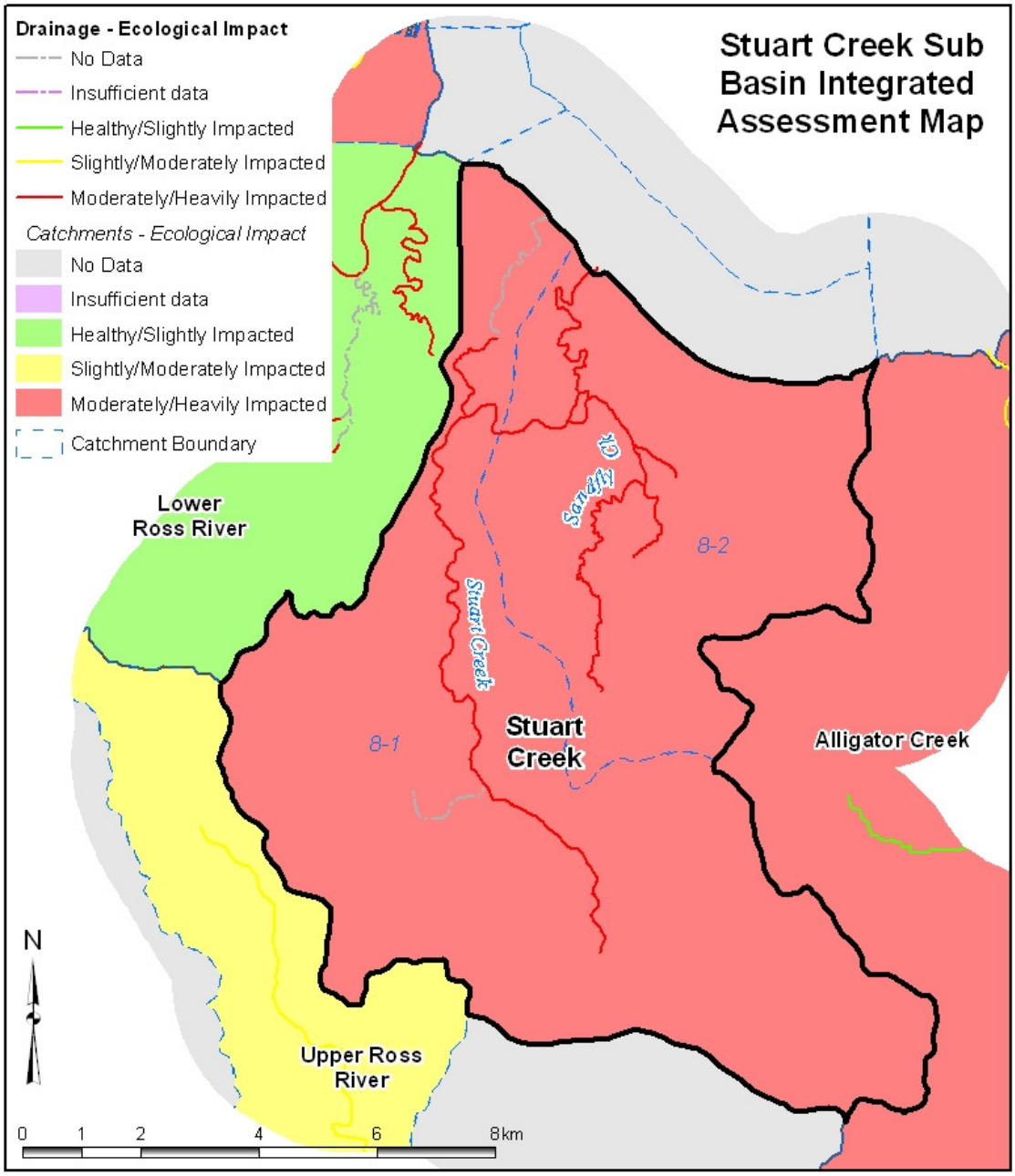
Land Use	Stuart Creek (8-1)		Sandfly Creek (8-2)	
	Ha	%	Ha	%
Conservation and natural areas	1,808	27	1,261	35
Grazing	4,130	61	923	25
Rural residential	87	1	14	0
Intensive agriculture	107	2	247	7
Urban	365	5	381	10
Water and wetlands	229	3	818	22
Totals	6,727	100	3,644	100

12.4 Stuart Creek Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (Connell Wagner 2008) indicated that the water quality of this sub basin was heavily impacted (see Figure 12.4), 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 source for this area is the water quality monitoring associated with the Cleveland Bay sewage treatment plant, at the lower end of the catchment.

Figure 12.4 Stuart Creek Sub Basin Ecological Condition



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

12.5 Water Quality and Water Quality Objectives (WQOs)

In general, the water quality condition data for the sub basin does not meet the WQOs for most of the water quality indicators (see Table 12.7). It should be noted that the water quality data for Sandfly Creek is not up to date and may not be a true reflection of current water quality condition of the catchment.

The water quality data from Stuart Creek indicates above average concentrations of all water quality indicators, with the exception of dissolved inorganic nitrogen (DIN), and shows the need for more rigorous analysis of the water quality data for this catchment.

Table 12.7 Comparing WQOs with Water Quality

Stuart Creek Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Stuart Creek 8-1	√* 50%	X 19%	X 42%	X 295%	X 160%	X 420%
[1]Sandfly Creek 8-2	X 875%	X 233%	X 308%	ND	X 820%	X 150%

Notes: Tick/cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

13. Alligator Creek Sub Basin

The Alligator Creek Sub Basin (see Figure 13.1 and Figure 13.2) includes the Alligator Creek, Crocodile Creek, Cocoa Creek and Cape Cleveland catchments (see sections 13.3.1 to 13.3.4). There are a number of tributaries and smaller waterways that have been included in these catchments.

Figure 13.1 Alligator Creek Sub Basin and Drainage

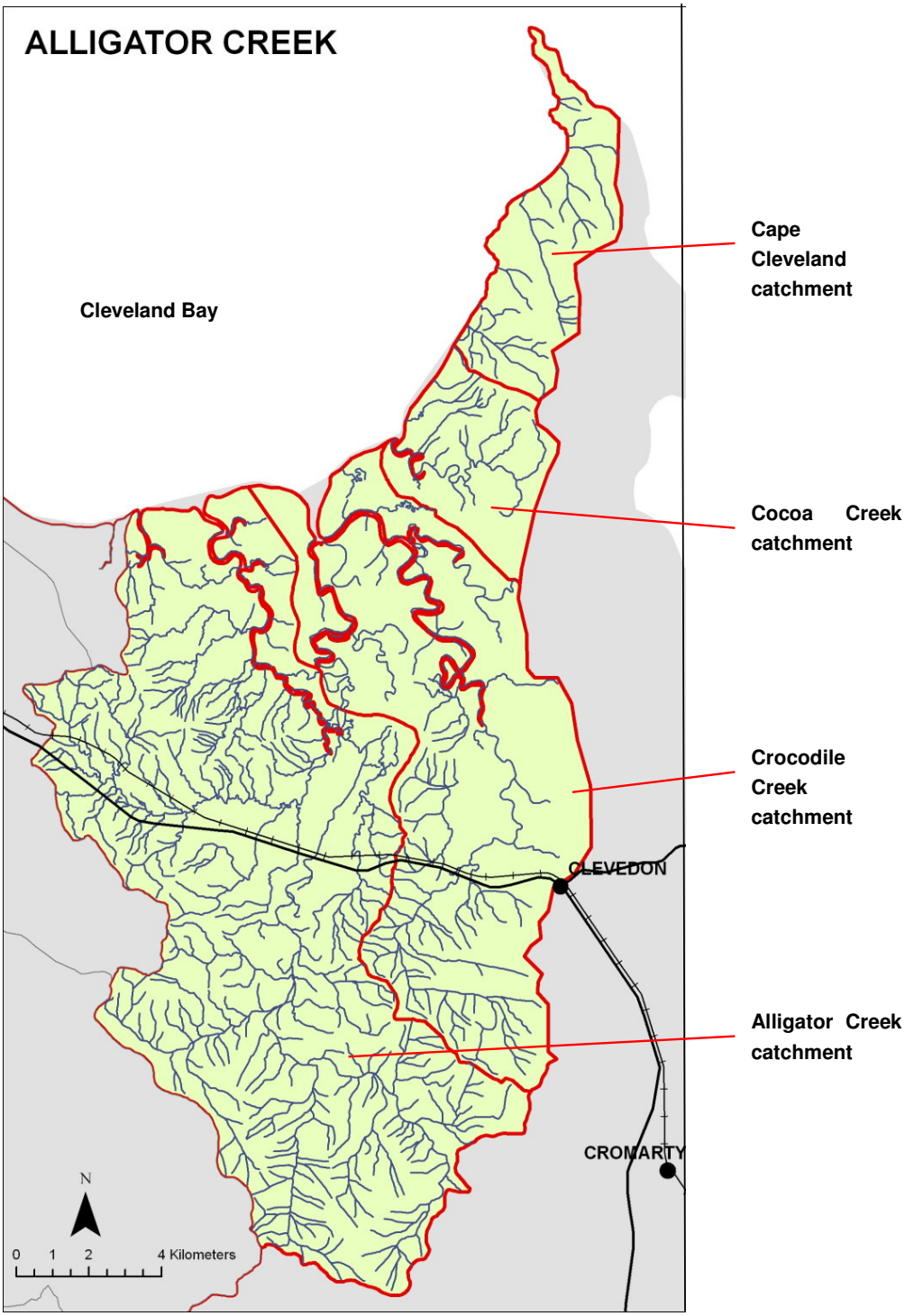
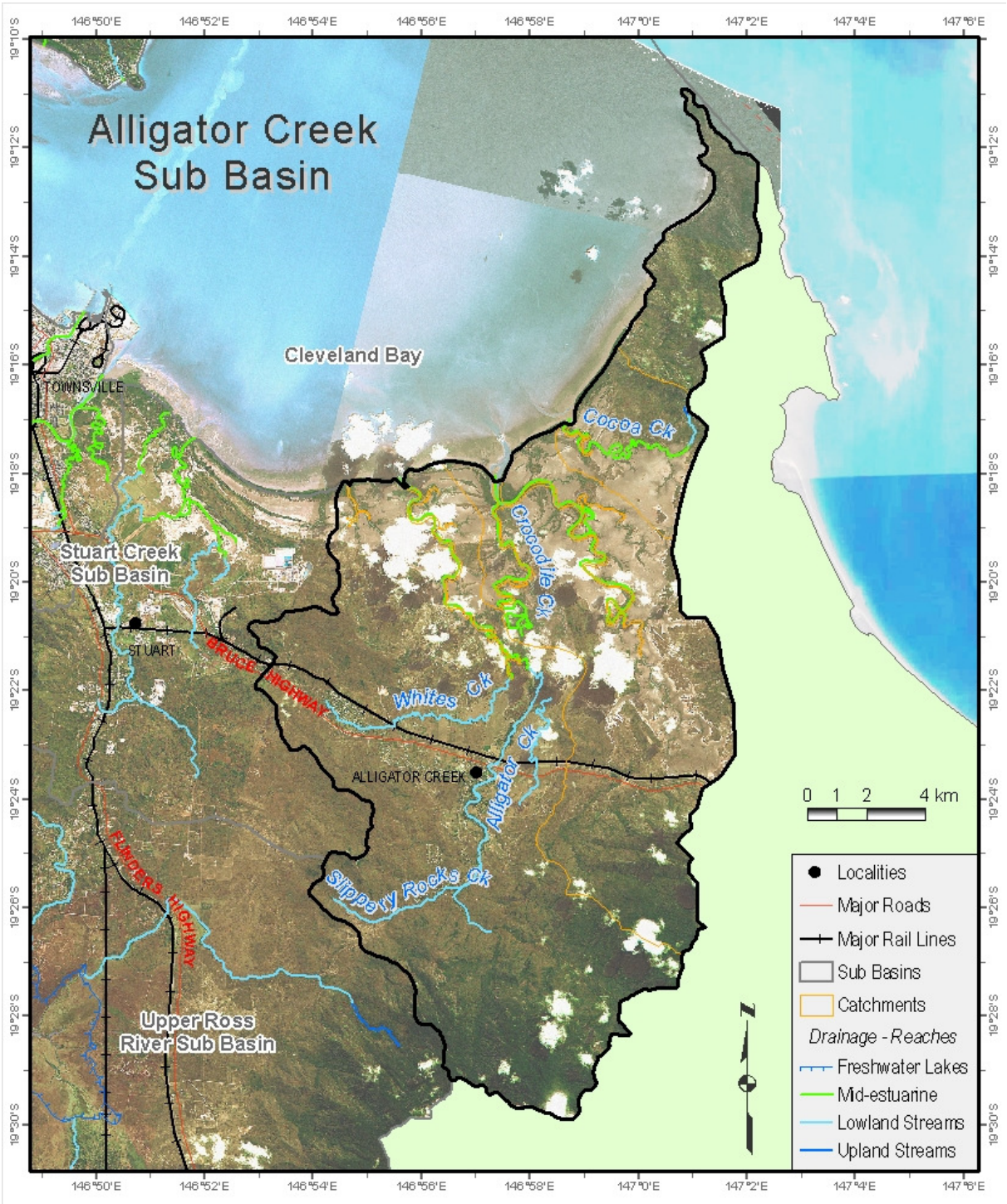


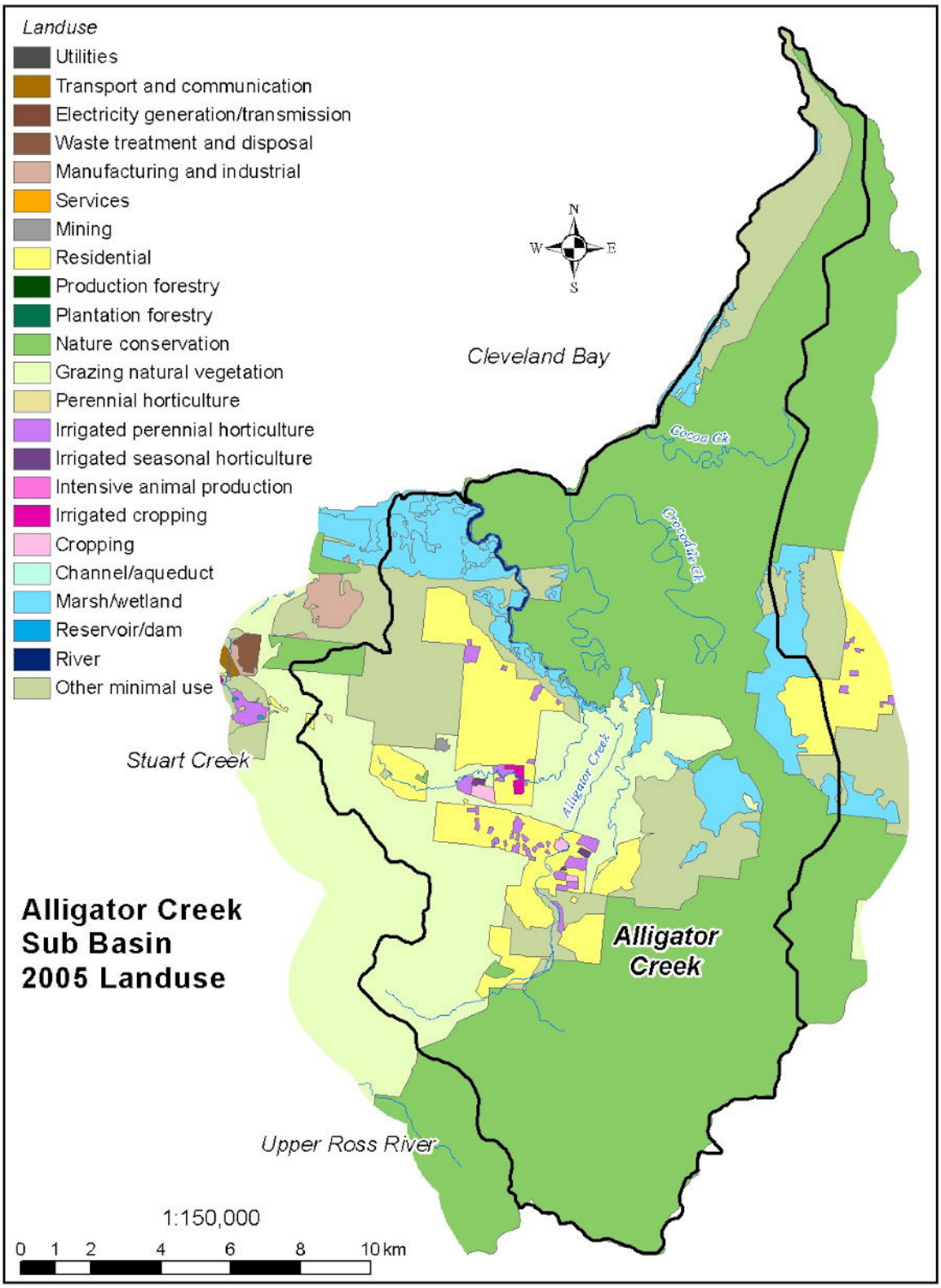
Figure 13.2 Alligator Creek Sub Basin Imagery



13.1 Alligator Creek Sub Basin Land Use

The Alligator Creek Sub Basin is approximately 265 square kilometres in size (26,500 hectares). Nature conservation and other minimal use (including wetlands) land uses dominate the Alligator Creek Sub Basin accounting for approximately 75% of the sub basin area. Grazing (natural vegetation) (15%) and residential (9%), i.e. mostly rural residential and peri-urban settlement, are also significant land uses in the Alligator Creek Sub Basin (see Figure 13.3and Table 13.1).

Figure 13.3 Alligator Creek Sub Basin Land Use



Source: 2005 land use update generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

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	4,111	15.50	4,111	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	1,755	6.62	1,755	6.62
Mining	11	0.04	11	0.04
Nature Conservation	14,229	53.65	14,194	53.59
Other Minimal Use	3,676	13.86	3,663	13.83
Perennial Horticulture	3	0.01	3	0.01
Residential	2,427	9.15	2,439	9.21
River	43	0.16	43	0.16
	26,523	100	26,489	100

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

13.2 Alligator Creek Sub Basin Demographics

The 2006 Census showed the resident population of the Alligator Creek Sub Basin to be approximately 2,100 people.

The majority of the settlement in the basin is associated with the rural residential areas of Alligator Creek and Nome, although there is dispersed settlement associated with grazing activity and other rural land uses. Settlement in the Alligator Creek Sub Basin consists predominantly of single-family dwellings (93%), reflecting the low-density nature of rural residential land use with 714 dwellings being separate houses out of a total 764 dwellings in the area.

Alligator Creek Sub Basin has a high median age of 41 years, with a high percentage of couple families without children (44.6%). The average household size at 2.8 persons is on par with the average occupancy for the Townsville local government area. 19

A small number of Alligator Creek Sub Basin residents reported that they worked from home (<1% of respondents), with a very high proportion (66%) reliant on private vehicle transport (as the driver) for their journey to work.20

Summary demographic data for the Alligator Creek Sub Basin is provided in Table 13.2 (selected medians and averages) and Table 13.3 (housing type and occupancy rates).

[19] All Dwelling, Household, and Median data is sourced from the 2006 Census Population and Housing Customised Basic Community Profile

[20] 2006 Census Population and Housing Customised Basic Community Profile (method of travel to work)

Table 13.2 Selected Medians and Averages [21]

Description	Alligator Creek	Townsville
Median age of persons	41	33
Median individual income ($/weekly)	531	531
Median family income ($/weekly)	1,324	1,237
Median household income ($/weekly)	1,154	1,101
Median housing loan repayment ($/monthly)	1,165	1,231
Median rent ($/weekly)	151	190
Average household size	2.8	2.8

Source: ABS 2006 Census of Population and Housing

Notes: Figures are based on place of usual residence. Alligator Creek is the Alligator Creek Customised Region and Townsville is Townsville City Council local government area.

Table 13.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	714	93.5	1,959	96.3
Flat, unit or apartment:				
In a one or two storey block	3	0.4	0	
In a three storey block	0		0	
In a four or more storey block	0		0	
Attached to a house	3	0.4	5	0.2
Flat, unit or apartment Total	6	0.8	5	0.2
Other dwelling:				
Caravan, cabin, houseboat	38	5.0	61	3.0
Improvised home, tent, sleepers out	6	0.8	9	0.4
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	44	5.8	70	3.4
Totals	**764**		**2,034**	

Source: ABS 2006 Census of Population and Housing

Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Alligator Creek Customised Region.

[21] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

13.3 Alligator Creek Sub Basin Land Use by Catchment

Land use summaries for the main catchments of the Alligator Creek Sub Basin are provided below. Where the 1999 and 2005 land use information is unchanged only the 2005 land use is provided. Additional catchment profile information, kindly provided by DERM/EPA, Townsville, is included in Appendix E.

13.3.1 9-1 Alligator Creek

The Alligator Creek catchment is approximately 14,800 hectares (148 square kilometres) in area with the main land use being conservation and minimal use (approximately 51% of the catchment). Grazing accounts for about 26% of the catchment and rural residential landuse about 15% of the catchment (see Table 13.4).

Table 13.4 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	5,684	38.4	5,649	38.3
	Other conserved area	133	0.9	133	0.9
Other minimal use		1,282	8.7	1,282	8.7
	Remnant native cover	493	3.3	480	3.2
Grazing natural vegetation		3,816	25.8	3,816	25.8
Cropping		43	0.3	43	0.3
Perennial horticulture		3	<0.1	3	<0.1
Irrigated cropping		26	0.2	26	0.2
Irrigated perennial horticulture	Irrigated tree fruits	184	1.2	185	1.3
Irrigated seasonal horticulture	Irrigated vegetables & herbs	15	0.1	15	0.1
Residential	Rural residential	2,196	14.8	2,208	14.9
Mining		11	0.1	11	0.1
River		43	0.3	43	0.3
Marsh/wetland		659	4.5	659	4.5
	Marsh/W Conservation	214	1.4	214	1.4
	Total	14,802		14,767	

Source: QLUMP 1999 calculations from CSIRO and 2005 update figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

13.3.2 9-2 Crocodile Creek

The Crocodile Creek catchment is approximately 8,000 hectares (80 square kilometres) in area with the main land use being conservation and minimal use (approximately 93% of the catchment). There are relatively small amounts of grazing (4%) and rural residential (3%) land use in the catchment also (see Table 13.5).

Table 13.5 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	5,794	72.5
	Other minimal use	Remnant native cover	903	11.3
Production from relatively natural environments	Grazing natural vegetation		289	3.6
Intensive uses	Residential	Rural residential	232	2.9
Water	Marsh/wetland		768	9.6
		Marsh/W conservation	10	0.1
		Total	7,995	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

13.3.3 9-3 Cocoa Creek

The Cocoa Creek catchment is approximately 1,717 hectares (17 square kilometres) in area with the predominant land use, accounting for nearly 100% of the catchment, being conservation and minimal use (see Table 13.6).

Table 13.6 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	1,597	93.0
	Other minimal use	Remnant native cover	39	2.3
Production from relatively natural environments	Grazing natural vegetation		5	0.3
Water	Marsh/wetland		20	1.1
		Marsh/W conservation	56	3.2
		Total	1,717	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

13.3.4 9-4 Cape Cleveland

The Crocodile Creek catchment is approximately 2,010 hectares (20 square kilometres) in area with the main land use being conservation and minimal use. As with the Cocoa Creek catchment this land use accounts for nearly 100% of the catchment (Table 13.7).

Table 13.7 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	1,021	50.8
	Other minimal use	Remnant native cover	959	47.7
Production from relatively natural environments	Grazing natural vegetation		2	0.1
Water	Marsh/wetland		9	0.5
		Marsh/W conservation	20	1.0
		Total	2,011	

Source: 2005 land use figures generated by Connell Wagner using QLUMP 1999 data (DNRW), 2005 aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

Table 13.8 Catchments Land Use Summary

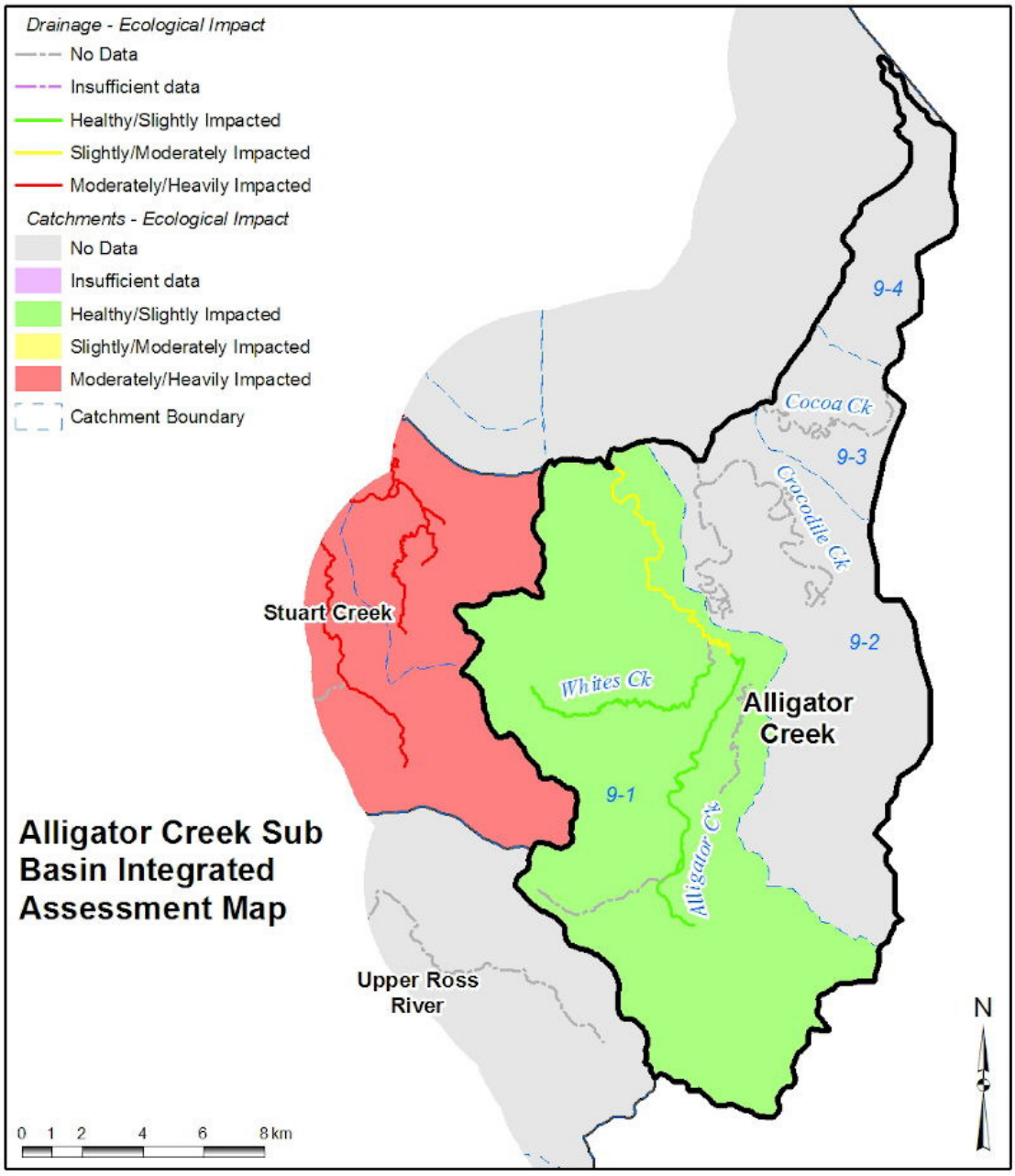
Land Use	Alligator Creek Catchment (9-1)		Crocodile Creek Catchment (9-2)		Cocoa Creek Catchment (9-3)		Cape Cleveland Catchment (9-4)	
	Ha	%	Ha	%	Ha	%	Ha	%
Conservation and natural areas	7,544	51.1	6,697	83.8	1,636	95.3	1,980	98.5
Grazing	3,816	25.8	289	3.6	5	0.3	2	0.1
Rural residential	2,208	14.9	232	2.9				
Intensive agriculture	272	1.9						
Urban	11	0.1						
Water and wetlands	916	6.2	778	9.7	76	4.3	29	1.5
Totals	14,767		7,996		1,717		2,011	

13.4 Alligator Creek Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (Connell Wagner 2008) using a range of data collected between 1972 and 2007 indicated that the water quality of this sub basin was ecologically healthy. This result is confined to the Alligator Creek catchment, as the remainder of the catchments had no water quality data to analyse (see Figure 13.4).

The most recent data from the Alligator Creek catchment indicates that there has been a significant deterioration in water quality over the last five years when compared with the previous decade. This is most likely the result of increased human activity in the peri-urban areas of the catchment.

Figure 13.4 Alligator Creek Sub Basin Ecological Impact



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams and mid estuaries)

It is assumed that water quality condition would be good, in the three unmonitored catchments in the Alligator Creek sub basin, and the streams ecologically healthy due to the limited amount of disturbance and human activity in those catchments.

13.5 Water Quality Objectives (WQOs)

The Alligator Creek catchment water quality (lowland streams) meets all the WQOs according to the available water quality monitoring data (see Table 13.9). Mid estuary water quality data only meets one of the four parameters measured based on 'old' data.

Table 13.9 Comparing WQOs with water resource condition

Alligator Creek Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Alligator Creek 9-1 (Lowland)	√ 63%	√ 46%	√ 34%	√ 25%	√ 40%	√ 20%
Alligator Creek 9-1 (Mid estuary)	X 50%	X 15%	X 10%	ND	X 17%	√ 50%

Notes: Tick / cross denotes if the WQO is met (√) or not (X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

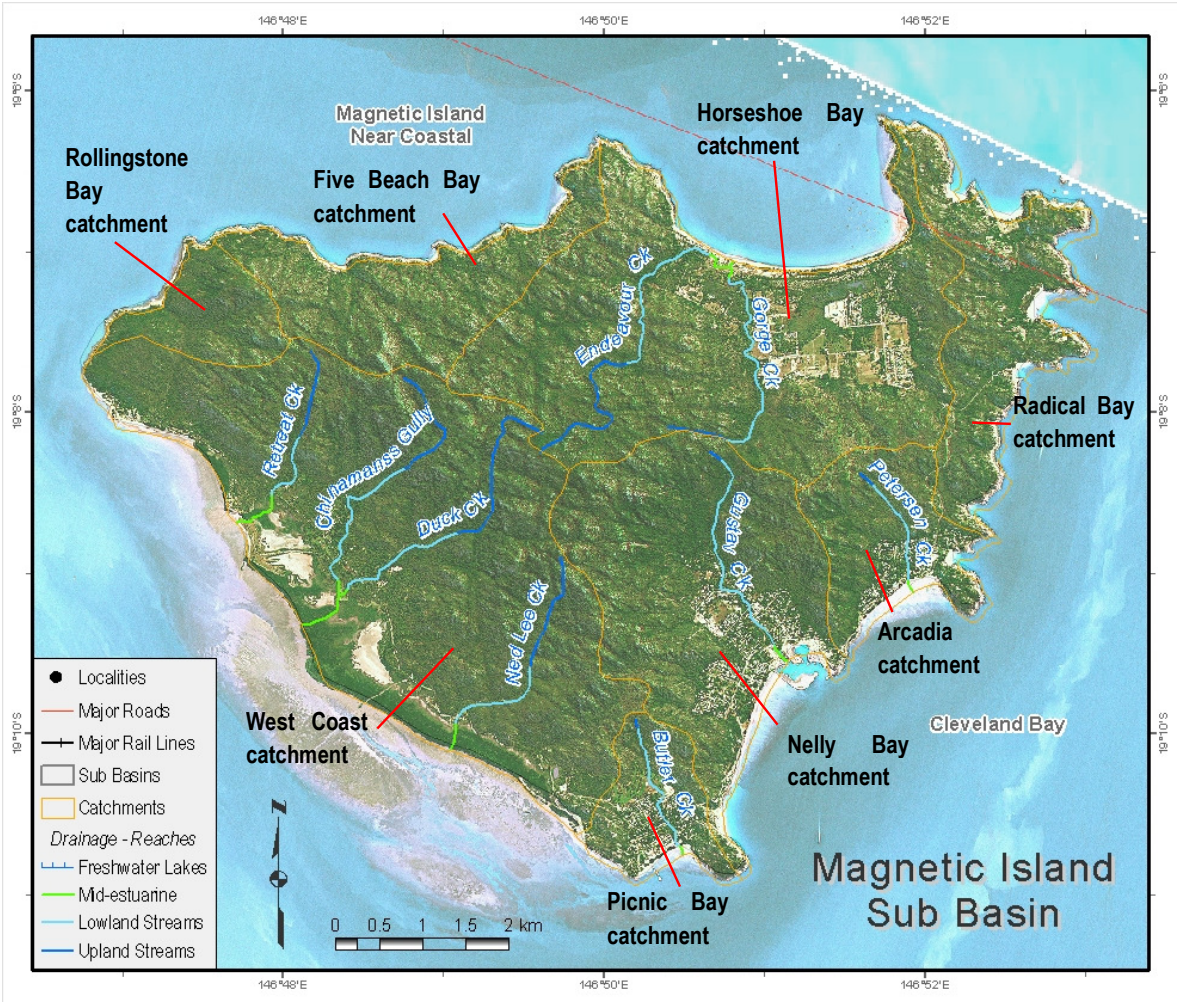
[1] indicates data is dated and may not reflect current condition.

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

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).

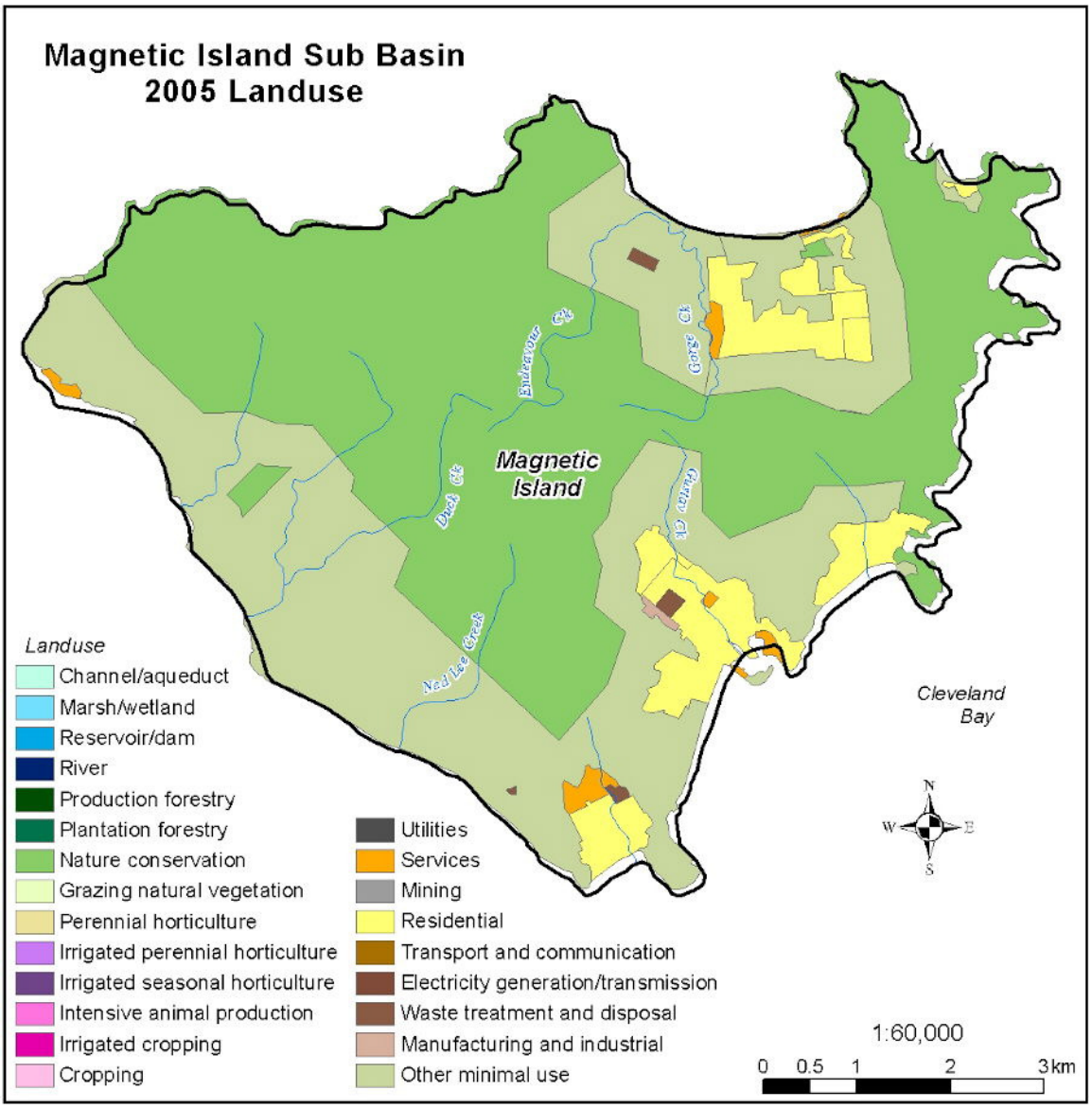
Figure 14.1 Magnetic Island Sub Basin Imagery



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 (53%) and minimal use (39%) are the main land uses of the Magnetic Island Sub Basin (see Figure 14.2 and Table 14.1).

Figure 14.2 Magnetic Island Sub Basin Land Use



Source: 2005 land use generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics).

Table 14.1 Magnetic Island Sub Basin Land Use

Land Use	Area (ha)	Area (%)
Manufacturing and industrial	5	0.1
Nature conservation	2,639	52.9
Other minimal use	1,924	38.6
Residential	383	7.7
Services	27	0.5
Waste treatment and disposal	13	0.3
	4,990	100

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.2 Magnetic Island Sub Basin Demographics

The 2006 Census counted 2,111 people resident on Magnetic Island (Sub Basin). Tourism is a key activity for Magnetic Island, and in the 2006 Census visitors swelled the total island population to 3,246[22] people.

In terms of the total population (residents and visitors), Census data indicates Magnetic Island experienced a slight population decline from 2001 to 2006, with the downturn attributed to a lower visitor count. However, 2006 Census data may not present an accurate picture for visitor numbers over an annual period, as the Census provides a 'snapshot' for a single night. Data from Tourism Queensland indicates that visitor numbers to Townsville for the year to December 2006 were slightly above 2001 figures.

The average annual residential population growth rate for Magnetic Island at 1.02% for the five years 2001-2006, is around half the average annual growth rate experienced in Townsville LGA (2.07%) during the same period.

Median age of Magnetic Island residents at 45 years is significantly higher than the Townsville median of 33 years. A significant percentage (14.4%) of Island residents are aged 65 years and above.

Average household size at 2.5 persons is significantly lower for Magnetic Island than for Townsville (2.8). Couple-only households are predominant on the Island (see Table 14.3). These statistics are fairly typical of an area that holds appeal for retirement living.

For Magnetic Island, total numbers of private dwellings increased between 2001 and 2006, however Census data shows the total number of occupied dwellings fell during the same period.

At the 2006 Census Magnetic Island housing was predominantly single-family dwellings, however, recent unit development at Nelly Bay Harbour may not have been captured at this time (714 dwellings are separate houses out of a total 845 dwellings in the area).

A number of Magnetic Island residents reported that they worked from home (84 people out of a total of 971 respondents), with a further 104 people reporting that they did not go to work.

Selected information for Magnetic Island from the 2006 Census is included in Table 14.2 and Table 14.3.

Table 14.2 Selected Medians and Averages [23]

Description	Magnetic Island	Townsville
Median age of persons	45	33
Median individual income ($/weekly)	449	531
Median family income ($/weekly)	1,024	1,237
Median household income ($/weekly)	789	1,101
Median housing loan repayment ($/monthly)	1,321	1,231
Median rent ($/weekly)	186	190
Average household size	2.5	2.8

[22] Total population, Magnetic Island SLA, Source: Australian Bureau of Statistics 2006 Census of Population and Housing

[23] **Median calculations - PLEASE NOTE -** For this customised Basic Community Profile, medians have been calculated from confidentialised and pertebated Census data. Medians have been calculated based on the assumption of a uniform distribution between ranges. Care should be taken when using these figures.
Median age of persons excludes overseas visitors.
Median individual income is applicable to persons aged 15 years and over.
Median household income is applicable to occupied private dwellings. It excludes households where at least one member aged 15 years and over did not state an income and households.
Median housing loan repayment is applicable to occupied private dwellings being purchased and includes dwellings being purchased under a rent/buy scheme. It excludes 'Visitors only' and 'Other not classifiable' households.
Median rent is applicable to occupied private dwellings being rented. It excludes 'Visitors only' and 'Other not classifiable' households.
Average number of persons per bedroom is applicable to occupied private dwellings. It excludes 'Visitors only' and 'Other not classifiable' households

Source: ABS 2006 Census of Population and Housing
Notes: Figures are based on place of usual residence. Magnetic Island is the Magnetic Island Customised Region and Townsville is Townsville City Council local government area.

Table 14.3 Count of Occupied Private Dwellings(a) and Persons in Occupied Private Dwellings

Dwelling Type	Dwellings		Resident Persons	
	Count	%	Count	%
Separate house	714		1,687	
Semi-detached, row or terrace house, townhouse etc:				
One storey	28		67	
Two or more storeys	17		35	
Semi-detached, etc Total	45		102	
Flat, unit or apartment:				
In one or two storey block	75		128	
Flat, unit or apartment Total	75		128	
Other dwelling:				
Caravan, cabin, houseboat	8		5	
Improvised home, tent, sleepers out	3		3	
House or flat attached to a shop, office, etc.	0		0	
Other dwelling Total	11		8	
Totals	**845**		**1,925**	

Source: ABS 2006 Census of Population and Housing
Notes: (a) Excludes 'Visitors only' and 'Other not classifiable' households. Figures are for the Magnetic Island Customised Region.

14.3 Magnetic Island Sub Basin Land Use by Catchment

Land use summaries of the main catchments of the Magnetic Island Sub Basin are provided below.

14.3.1 10-1 West Coast

The West Coast catchment is approximately 1,630 hectares in area (~16 square kilometres) with the main land use being conservation and minimal use (98%).

Table 14.4 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	702	43.0
		Other conserved area	17	1.0
	Other minimal use		908	55.6
Intensive uses	Residential		5	0.3
	Service	Recreation and culture	<1	<0.1
	Waste treatment and disposal	Sewage	<1	<0.1
		Total	1,633	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.3.2 10-2 Picnic Bay

The Picnic Bay catchment is approximately 180 hectares in area (~2 square kilometres) with the main land use being minimal use (62%). The catchment also has a large residential component (28%).

Table 14.5 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	<1	0.2
	Other minimal use		109	61.8
Intensive uses	Residential		49	27.6
	Service	Recreation and culture	15	8.7
	Waste treatment and disposal	Landfill	3	1.8
		Total	177	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.3.3 10-3 Nelly Bay

The Nelly Bay catchment is approximately 780 hectares in area (~8 square kilometres) with the main land uses being nature conservation (39%) and minimal use (41%). The residential component accounts for 16 per cent of the catchment area.

Table 14.6 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	303	39.09
	Other minimal use		319	41.16
Intensive uses	Manufacturing and industrial		5	0.59
	Residential		122	15.75
		Rural residential	20	2.53
	Service	Commercial services	4	0.56
		Recreation and culture	<1	0.03
	Waste treatment and disposal	Sewage	5	0.68
		Total	777	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.3.4 10-4 Arcadia

The Arcadia catchment is approximately 260 hectares in area (~3 square kilometres) with the main land use being conservation and minimal use. Residential areas account for approximately 20 per cent of the catchment.

Table 14.7 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	44.4
	Other minimal use		92	34.8
		Defence	3	1.0
Intensive uses	Residential		52	19.7
		Total	264	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.3.5 10-5 Radical Bay

The Radical Bay catchment is approximately 370 hectares in area (~4 square kilometres) with the main land use being conservation and minimal use (99%).

Table 14.8 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	95.1
	Other minimal use		15	4.0
Intensive uses	Residential	Rural residential	3	0.9
		Total	372	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.3.6 10-6 Horseshoe Bay

The Horseshoe Bay catchment is approximately 1,220 hectares in area (~12 square kilometres) with the main land use being conservation and minimal use (88%). Residential areas occupy approximately 11per cent of the catchment.

Table 14.9 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	615	50.3
		Other conserved area	5	0.4
	Other minimal use		460	37.6
Intensive uses	Residential		39	3.2
		Rural residential	98	8.0
	Service	Commercial services	2	0.1
	Waste treatment and disposal	Sewage	4	0.4
		Total	1223	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.3.7 10-7 Five Beach Bay

The Five Beach Bay catchment is approximately 385 hectares in area (~4 square kilometres) with the only land use being nature conservation (National Park).

Table 14.10 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	386	100
		Total	386	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

14.3.8 10-8 Rollingstone Bay

The Five Beach Bay catchment is approximately 160 hectares in area (~2 square kilometres) with the entire land use being a combination of conservation and minimal use (100%).

Table 14.11 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	89
	Other minimal use		18	11
		Total	159	

Source: 2005 land use figures generated by Connell Wagner using 2005 Townsville City Planning Scheme zoning, aerial photography (Townsville City Council) and SPOT imagery (NQ Dry Tropics). Figures have been rounded to the nearest hectare.

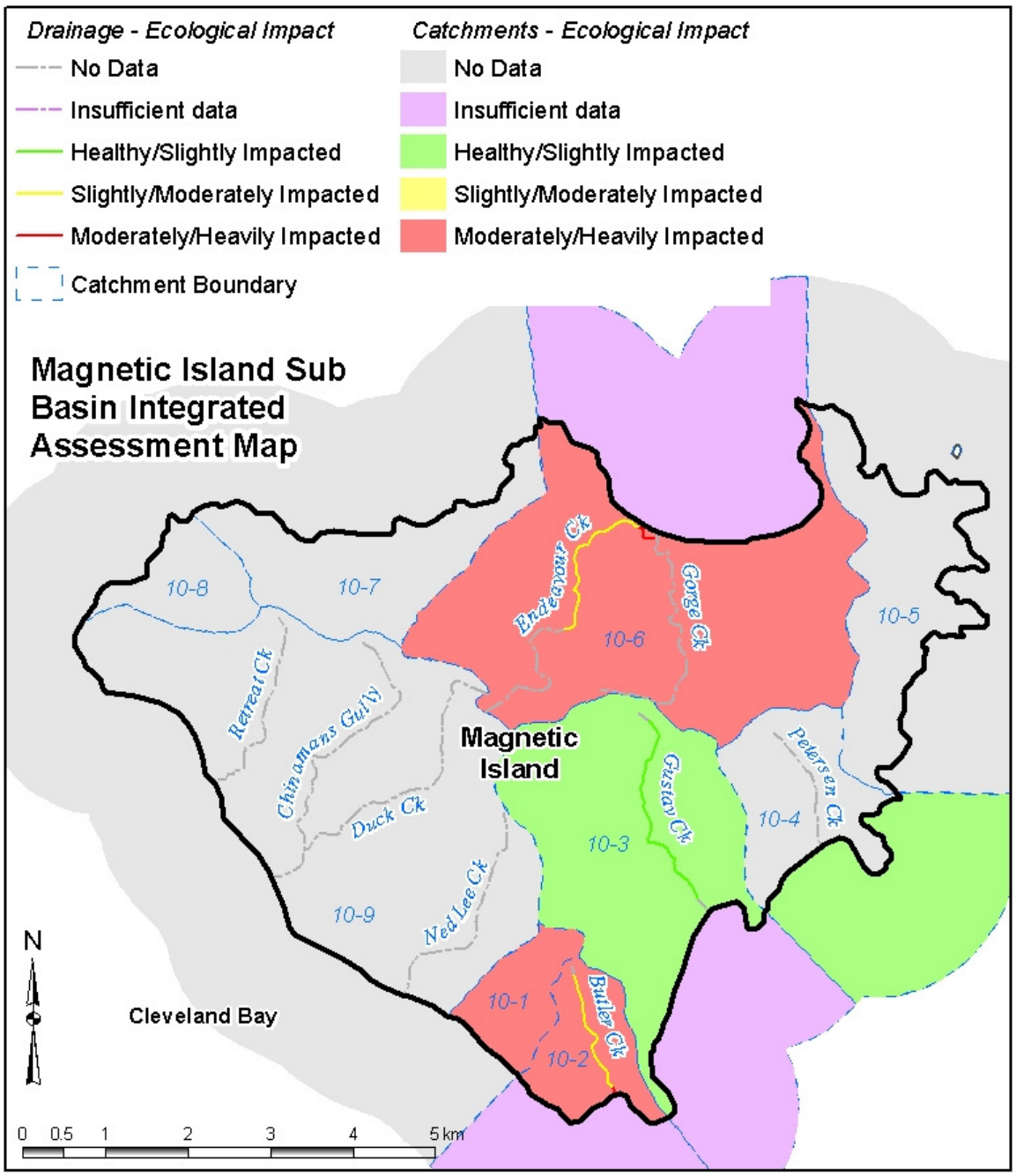
Table 14.12 Catchments Land Use Summary

Land Use	West Coast (10-1)		Picnic Bay (10-2)		Nelly Bay (10-3)		Arcadia (10-4)	
	Ha	%	Ha	%	Ha	%	Ha	%
Conservation and natural areas	1,626	99.7	109	61.8	621	80.0	212	80.3
Grazing	0		0		0		0	
Rural residential	0		0		20	2.5	0	
Intensive agriculture	0		0		0		0	
Urban	6	0.4	67	38.0	136	17.5	52	19.7
Water and wetlands	0		0		0		0	
Totals	1,632		177		777		264	
Land Use	**Radical Bay (10-5)**		**Horseshoe Bay (10-6)**		**Five Beach (10-7)**		**Rollingstone Bay (10-8)**	
	Ha	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
Conservation and natural areas	369	99.2	1,080	88.3	386	100.0	159	100.0
Grazing	0		0		0		0	
Rural residential	3	0.9	98	8.0	0		0	
Intensive agriculture	0		0		0		0	
Urban	0		45	3.7	0		0	
Water and wetlands	0		0		0		0	
Totals	372		1,223		386		159	

14.4 Magnetic Island Sub Basin Resource Condition

The Black Ross WQIP area water quality condition assessment (Connell Wagner 2008) indicated that the water quality of this sub basin is heavily impacted (see Figure 14.3). Three of the nine catchments are rated as heavily impacted with one catchment, Gustav Creek, being slightly impacted. There is insufficient data to assess the remaining five catchments.

Figure 14.3 Magnetic Island Sub Basin Ecological Impact



(Note: Water quality data was assessed against water quality objectives (WQOs) derived from the Queensland Water Quality Guidelines (EPA 2006) for the Central Coast region for lowland streams)

14.5 Water Quality and Water Quality Objectives (WQOs)

Water quality condition data for the Magnetic Island sub basin is variable and paints a mixed picture in relation to the WQOs for most of the water quality indicators (see Table 14.13).

Table 14.13 Comparing WQOs with Water Quality

Magnetic Island Sub Basin	DIN	Org N	TN	FRP	TP	TSS
Cockle Creek 10-1	ND	ND	X 26%	√* 100%	X 110%	X 70%
Butler Ck (Picnic Bay) 10-2	ND	ND	X 14%	√* 100%	X 140%	X 100%
Gustav Creek10-3	ND	ND	√* 55%	√* 50%	√* 60%	√* 30%
Endeavour Creek 10-6	X 13%	ND	X 90%	√* 100%	X 100%	X 590%

Notes: Tick / cross denotes if the WQO is met (tick) or not (cross) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.

DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.

[1] indicates data is dated and may not reflect current condition.

[More information about water quality conditions and WQOs can be found in; *Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan* (Gunn, Manning, and McHarg 2009), and *Water Quality Condition of the Black and Ross River Basins* (Connell Wagner 2008)]

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