SECTION 62 PERMIT ASSESSMENT

Guideline 7

WATER CODE OF PRACTICE

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APPROVAL

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WET TROPICS MANAGEMENT AUTHORITY

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PART 1
(of 3)

Code of Practice for Maintenance and Operation of Water Extraction Infrastructure in the Wet Tropics World Heritage Area



Koombooloomba Dam *Photo: WTMA*

Prepared by
Natural Resource Assessments Pty Ltd
For
Wet Tropics Management Authority
3 September 1999
Water CoP - Maintenance and Operation.doc

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Wet Tropics Upland Granite Stream *Photo: Mike Trenerry*
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1.1 User Guide

This document has been prepared as a guide for two target audiences:

Agencies responsible for the maintenance and operation of existing community water supply infrastructure within the Wet Tropics World Heritage Area (the Area).

Individuals operating and maintaining an existing domestic water supply in the Area.

Operators of water extraction infrastructure in operation prior to 01 September 1998 should have the following:

- Permit for maintenance of infrastructure under the *Wet Tropics Management Plan 1998*;
- Licence to extract water under the *Water Resources Act 1989*; and
- Land manager (DNR or QPWS) approval;

Whilst the Code only applies to water supply activities which occur within the Area, the Code has been developed to encourage improved practice with respect to water use within the Wet Tropics Bioregion.

Section 1: Provides an introduction and background to the Code of Practice.
Section 2: Provides **background on the biophysical values** of waterways in the Area and describes **impacts associated with flow regulation**.
Section 3: Provides Code of Practice for **operation and maintenance of existing community water supply infrastructure.**
Section 4: Provides Code of Practice for **operation and maintenance of private domestic water supplies**.
Section 5: Provides a brief overview of the WTMA permit application process.
Section 6: References.

Associated documents:
Field guide for maintenance and operation of water infrastructure
Guide for development of new water extraction infrastructure
Environmental Assessment Guide: Development and Maintenance of Water Extraction Infrastructure in the Wet Tropics World Heritage Area
Conservation Values of Waterways in the Wet Tropics World Heritage Area
Leaflet providing information for users of private domestic water supplies.

For further information contact the Wet Tropics Management Authority.

1.2 Principles

The Wet Tropics Management Authority (the Authority) is responsible for the protection of the World Heritage values of the Area. This means that the Authority must implement a rigorous approach to the protection of these values.

The maintenance and operation of water supply infrastructure in the Area may result in impacts on the biological values of the affected streams.

World Heritage Values Relevant to the Wet Tropics

- An outstanding example representing the major stages of the earth's evolutionary history.
- An outstanding example representing ongoing geological processes, biological processes, biological evolution and man's interaction with the natural environment.
- Containing superlative natural phenomena, formations or features.
- Containing the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value live.

CODE OF PRACTICE

The Code of Practice presented in this document have, therefore, been developed to provide community infrastructure operators and private landholders with guiding principles for the protection of World Heritage values whilst maintaining and operating water supply infrastructure.

The Codes of Practice have been prepared in the context of the:

Wet Tropics World Heritage Protection Management Act, 1993, and the *Wet Tropics Management Plan*, 1998, (particularly with respect to World Heritage values and integrity of the Area); and the *FNQ 2010 Regional Planning Project* (DCILGP, 1996) with respect to biodiversity, conservation and water resource management. Of particular relevance are the principles of ecologically sustainable development and inter-generational equity that underpin the FNQ 2010 planning process.

The Codes have also been prepared in the context of the:

National Principles for the Provision of Water for Ecosystems (ARMCANZ & ANZECC 1994).

Water Allocation and Management Planning (WAMP) (QDNR, 1997). WAMP is a process which involves detailed environmental and hydrological analyses and encourages ecologically sustainable use of water.

The following principles underpin these Codes of Practice.

Principles used to develop the Codes of Practice for Maintenance and Operation of Water Supply Infrastructure in the Wet Tropics World Heritage Area

- Water extraction and associated infrastructure is recognised as potentially impacting on World Heritage, ecological, cultural and social values.
- Any extraction of water should be on the basis of a best practice approach to determining the water regimes necessary to sustain the World Heritage and ecological values of the water dependent system. The approach should involve scientific, community, cultural and water management stakeholders.
- Where there is existing use, provision of water for ecosystems should go as far as possible to meet the water regime necessary to sustain the ecological values of aquatic ecosystems whilst recognising the existing uses of other water users.
- Where environmental water requirements cannot be met due to existing uses, action (including re-allocation) should be considered to meet environmental needs.
- Further allocation of water for any use should only be on the basis that natural ecological processes and biodiversity are sustained.
- Accountabilities in all aspects of management of environmental water provisions should be transparent and clearly defined.
- There should be environmental representatives on decision making groups.
- Environmental water provisions should be responsive to monitoring and improvements in understanding of environmental water requirements.
- Appropriate demand management, waste minimisation, water reuse, effective use of water and water pricing strategies should be used to assist in decision making
- All relevant environmental, social and economic stakeholders will be involved in water allocation planning and decision-making on environmental water provisions
- In the absence of system specific knowledge regarding the water regime required to sustain ecological processes additional extraction should not take place.
- Environmental issues should be considered at the earliest stages of planning and given primary consideration in the decision-making process.
- Design options should reflect protection and conservation of ecological values.

1.3 Definitions

Area: Wet Tropics World Heritage Area.

Authority: Wet Tropics Management Authority.

Community Water Supply Infrastructure: Infrastructure managed by an agency for the supply of urban, rural or industrial water resources (including hydro-electrical facilities) to the community.

Domestic Water Supply: Water extracted for domestic use by a Private Land holder, Native Title holder, or another person carrying out domestic activities on a Private Land holder's or Native Title holder's land. *Extraction for Commercial Purposes is not permitted.*

Maintenance: works taking place within the existing infrastructure formation footprint.

Native Title holder: Native Title holder with a Native Title entitlement as defined by the Native Title Act 1993.

Private Land holder: Freehold Title holder as defined under Ordinary Title holder in the Native Title Act 1993.

Permit: Permit under the *Wet Tropics Management Plan 1998*.

Plan: *Wet Tropics Management Plan 1998*.

Upgrade: -
- widening/enlarging roads or car parks
- developing existing structures
- increasing extraction regimes in excess of that lawfully permitted before the Plan commenced (1 September 1998).

1.4 Regulation of Water Supply Activities Within the World Heritage Area

1.4.1 Regulated Activities

The World Heritage Area and legislation overlies existing land tenure. WTMA functions do not involve day-to-day land management. There are more than 620 separate land parcels within the World Heritage Area, the majority of which is owned and managed by the State of Queensland. Currently, two major public land management/owner stakeholders exist, between them managing the day-to-day responsibilities of around 90 percent of the World Heritage Area. These are:

- Queensland Parks and Wildlife Service (QPWS)
- Queensland Department of Natural Resources - Resource Management (DNR)

Existing water infrastructure located on State lands requires approval from the relevant land managers who are responsible for regulating water extraction from Protected Areas.

Other agencies that issue approvals for water extraction include:

- Department of Natural Resources - Water Resources (*Water Resources Act 1989*)
  and
- Environment Australia (*EPBC Act*)

The potential for Native Title to exist within the World Heritage Area may in the future affect the make-up of prominent land management/owner stakeholders.

1.4.2 The *Wet Tropics Management Plan 1998*

The Wet Tropics Management Plan commenced operation on 1 September 1998. In general, the Plan regulates activities within the World Heritage Area that could potentially impact on World Heritage values *eg* destruction or disturbance to native vegetation, watercourses or earth. Where the installation, maintenance and operation of water supply infrastructure is associated with such disturbances, there will be a need to assess the activity under the Plan. Details of all activities regulated within the Area are given under Part 3 of the Plan.

Table 1: **WTMP Land Use Controls Relevant to Water Supplies** provides a summary guide for activities typically associated with water supply.

1.4.3 Assessment of Water Extraction Activities Under the Plan

Generally, a permit is required to undertake maintenance, operation and development of water extraction infrastructure within the Wet Tropics World Heritage Area. Water extraction infrastructure operating prior to the commencement of the Plan requires a permit for its maintenance only. Under section 27(j) of the Plan, a permit is not required to continue operation of such infrastructure (refer to the list of existing community water supply infrastructure provided below).

The development and operation of new infrastructure or upgrading of existing infrastructure requires additional approval under the Plan. In general, a permit may only be issued where the proposed development or upgrade is within Zone C or Zone D. The Plan does provide for consideration of development proposals within Zone B for essential community infrastructure. This requires a rezoning application by a Local Government in accordance with Schedule 1 of the Plan. Details can be found in the *Guide for development of new water extraction infrastructure*.

The above information also applies to land holders with domestic water supplies. A permit **must** be issued for extracting water for domestic purposes to Private Land holders or Native Title holders with land in the Area, albeit with conditions. A condition may be that the land holder must comply with the Authority's Code of Practice for water extraction. *NB: known existing domestic operations were reviewed following the commencement of the Plan in 1998/99 and at this point in time have been assessed as having a minor & consequential impact not requiring a permit. Any new development proposals are more likely to require a permit.*

Table 1: WTMP Land Use Controls Relevant to Water Supplies

Prohibited Activity	User Type	Exemptions to Prohibition	
		Allowed under Permit	**Allowed without permit**
disturbing native plants, earth and waterways • destruction • disturbance • taking of	General	**firebreaks:** building a firebreak **clearing around a structure or road:** clearing vegetation around a structure or road (only) to the extent necessary for its appropriate use **earthworks, zone C or D (refer Figure 1):** disturbing earth *eg* excavating, quarrying, grading in Zone C or D **waterworks, zone C or D (refer Figure 1):** disturbing a watercourse in Zone C or D	**firebreaks:** maintaining an existing fire break **burning:** burning vegetation other than in a rainforest **grazing animals:** but not in a rainforest
	Freehold and native title	**water for domestic use:** extracting water for domestic use (a permit must be issued) **house garden or orchard:** establishing a house garden or orchard other than for commercial purposes (a permit must be issued)	**protection, conservation or rehabilitation:** an activity for the protection, conservation or rehabilitation of world heritage values
undesirable plants • planting • cultivating • disposing of	General	**killing or disposing of**: (as listed in Schedule 2 of the Plan)	
structures, roads, walking tracks • building or maintaining	General	**walking tracks - all zones:** building or maintaining a walking track **structures and roads - permitted Zone C or D only (refer Figure 1):** building or maintaining a structure in Zone C or D **Zone B impact reduction (refer Figure 1):** an activity in Zone B that would reduce impacts on the WHA	
	Government agencies		**community services infrastructure:** the operation of community services infrastructure being lawfully operated immediately before 1 September 1998

Prohibited Activity	User Type	Exemptions to Prohibition	
		Allowed under Permit	**Allowed without permit**
waste • disposal of	General		**in a proper receptacle**
	Freehold and native title		**disposal on the land:** (refer s29 for conditions)

1.4.4 Community Water Supply Infrastructure

Community water supply infrastructure is that managed by an agency for the supply of urban or industry water resources, including hydro-electricity facilities.

A list of existing community water supply infrastructure within the Area follows:

Douglas Shire Council	Rex Creek Intake Martin Creek (Daintree) Intake Little Falls Creek (Whyanbeel) Intake
Mareeba Shire Council	Hunter Creek (Mt Molloy) Intake
Cairns City Council	Copperlode Dam Stoney Creek Intake Bessie Point Intake Freshwater Intake Behana Gorge Intake Fishery Falls Intake Bellenden Ker (Junction Creek) Intake Frenchman's Creek (Babinda) Intake Bartle Frere / Woopen Creek Intake Pugh Creek Intake Bramston Beach Minor Intake Bramston Beach Major Intake
Herberton Shire Council	Herberton Intake (Wild River)
Johnstone Shire Council	Nyletta Intake Jurs Creek Intake
Cardwell Shire Council	Meunga Creek (Cardwell) Intake Boulder Creek (rural) Intake Bulgan Creek (Tully) Intake
NQ Water	Lake Paluma Crystal Creek Intake
Stanwell Power Council	Kuranda Weir Koombooloomba Dam/Kareeya Power Station

1.5 Implementation

Implementation of the Code of Practice involves:

- dissemination of information in the form of Code of Practice and specific conditions attached to permits
- training for community infrastructure managers
- monitoring of implementation of Code of Practice or conditions attached to permits
- periodic revision of Code of Practice in light of any monitoring results and new information and experience.

The Wet Tropics Management Authority Manager, Area Conservation, will have responsibility for these aspects of implementation of the Code of Practice.

2. CONTEXT

2.1 Biophysical Values of Wet Tropics Waterways

Watercourses of the Wet Tropics region are important for a variety of reasons, many of which are the same as those that define the World Heritage status of the region as a whole, *ie* outstanding examples of biological and geological evolution and centres of high endemicity and regional biodiversity.

The riverine landscape

The streams and rivers of the Wet Tropics region are generally short and of high gradient, they have relatively short coastal plains and even shorter estuaries.

Many of the watercourses of the Wet Tropics are ancient. They show a considerable variety of landscape forming processes. One example of which is the process of river capture, where one river captures streams from another catchment and diverts them into its own channel. The Barron River appears to have captured the Clohesy River and then parts of the upper reaches of the Walsh River. River capture has resulted in drainage rearrangement and distinctive divisions in fauna distribution.



Photo: Mike Trenerry

Volcanism is another important influence in the Wet Tropics region. Volcanism affects stream flow by causing localised uplift; or by lava flows blocking streams, filling in drainage channels or rearranging drainage patterns. The Millstream Falls in the Herbert River drainage were formed by a basalt flow resulting from volcanic activity about 1.2 million years ago. Falls are significant barriers to fish movement and if they are of relatively recent formation (in geological terms) they may substantially determine upstream fish species richness.

Flow regimes

Spatial and temporal variation in rainfall, and consequently variation in discharge, are a feature of the Australian continent and Australian streams and rivers are amongst the most variable in the world (McMahon, 1986, 1989). In contrast, the amount of discharge and the pattern of its delivery in streams of the Wet Tropics is more predictable. Much of this predicability arises from the reliability of the summer wet season. Over longer periods there is a degree of variability in the intensity of wet seasons. However, high year-round groundwater inputs from the basaltic aquifers of the Atherton Tablelands ensure that flow remains elevated throughout the year in many streams. Maintenance of this type of flow regime is important for the region's aquatic biodiversity, the way in which communities are structured, and the continued success of the different life history styles employed by the region's aquatic biota. Moreover, it has consequences for the provision of different types of habitats (*ie* riffles or perennial wetlands) throughout the year and possibly for the evolution of habitat specialists.



Black Mountain Crab *Photo: Mike Trenerry*

'Perenniallity' (*ie* continuous flow, not seasonal or intermittent) over much longer time scales is another feature of the flow regimes of the region's river systems. Whereas the diversity of

terrestrial vertebrate species of the region has been strongly influenced by periodic extinction due to rainforest contractions associated with greatly reduced rainfall, there is no evidence that widespread extinction occurred in the aquatic fauna. Thus the region retains many endemic species of fish, including paleoendemic rainbowfishes, relictual paleoendemic percichthyids (the southern cods, perch and bass), and many endemic invertebrate species, some of which are stenothermic (cold loving) Gondwanan relics.

Aquatic invertebrates



Mt Lewis Cray *Photo: Mike Trenerry*

Streams of the Wet Tropics region contain a very high diversity of aquatic invertebrates and this diversity is greater than that seen in similar streams elsewhere in Australia and globally (Pearson *et al*, 1986).

Some species are endemic to the region, for example, the small freshwater crayfish *Cherax wasselli* is found only in streams of the Wet Tropics region. Highly localised populations of the different species of crayfish within this genus *Euastacus* are located throughout the Wet Tropics region. Endemic shrimps are also known and some of these show very restricted habitat requirements. *Caradina zebra* and *C. confusa* may occur in the same stream but never together, the first is found only where the riparian zone is intact whereas the second occurs where the riparian zone is degraded. Therefore, the situation may arise where the presence of each species alternates as you move along the stream if there are alternating riparian conditions. *S*ubstantial genetic differentiation exists between different populations of *C. zebra* as the result of drainage rearrangement (Hughes *et al*, 1996). Patchy riparian clearing may also reduce gene flow between populations.

Freshwater fishes



Kuranda Red Rainbowfish *Photo: Mike Trenerry*

The fresh water fish fauna of the Wet Tropics region is fairly well known and is highly distinctive. Forty percent of all of Australia's freshwater fishes and well over half of the freshwater fish fauna of northern Australia are found in the Wet Tropics (Pusey and Kennard, 1996). This high diversity is also evident at the scale of individual river basins; the Mulgrave River is believed to contain, for its size, more species than any other river in Australia (Pusey *et al*, 1995). The Johnstone River contains the highest diversity of rainbowfishes of any river in Australia (Pusey *et al*, 1997).

Frogs



Stoney Creek Frog *Photo: Mike Trenerry*

Williams *et al*, 1996, list fifty-four species of frogs as occurring in the Wet Tropics region; 21 of these are listed as Very Important Species either because of regional endemism or listing as a rare or endangered species.

Population sizes of several species of endemic frogs have undergone severe declines in the last decade. This is reflected in 7 species being officially listed as 'Endangered' in the schedules to the *Nature Conservation (Wildlife) Regulation* 1994. The cause or causes of these declines remains uncertain but occurred after similar declines were also observed elsewhere. Declines in certain populations have been observed to coincide with structural changes in invertebrate populations following large changes in stream flow (Pusey and Pearson, *in prep*). Interestingly, all frogs that have disappeared or significantly declined have been species that are obligate in-stream reproducers.

Reptiles



Keelback Snake *Photo: Mike Trenerry*

The reptile fauna of the Wet Tropics region is composed of a mixture of Gondwanan endemics and recent invaders from New Guinea. The region contains 131 species. Few are rainforest specialists (29) and even fewer are endemic (20) to the region. The best known is the Estuarine Crocodile. Crocodiles are extremely common, even in rainforest sections of the Daintree River up to 100 km inland. In fact, their upstream penetration appears limited only by the presence of a large waterfall.



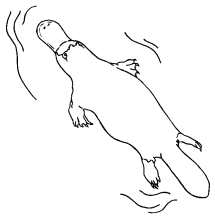
Several lizard species of the Wet Tropics region are closely associated with stream systems. Such species include the Eastern water skink and the Eastern water dragon. Aquatic snakes are also present. Their diets comprise both fish and amphibia. Many other snakes also forage extensively along watercourses preying upon frogs. Such species include the well-known taipan and red bellied black snakes.



Eastern Sawshell Turtle *Photo: Mike Trenerry*

Several species of freshwater turtle are found in the Wet Tropics region. With the exception of the crocodile, turtles are the most water dependent of the region's reptiles and probably the species most at risk from alterations to flow regimes.

Aquatic mammals



The platypus is entirely dependent upon the freshwater habitat. Its diet consists predominantly of aquatic insect larvae, shrimps and crayfish. The platypus spends about 50% of its day in the water foraging for food. Flow regulation that impacts on these food sources is likely to severely impact upon platypus populations.



The other aquatic mammal of the Wet Tropics region is the common water rat. This species is found throughout Australia and spends much of its time foraging along stream banks. Its diet is catholic but aquatic invertebrates, especially crayfish, are important. Like the platypus, it is most likely to be affected by flow regulation via changes in available food resources.

Aquatic vegetation

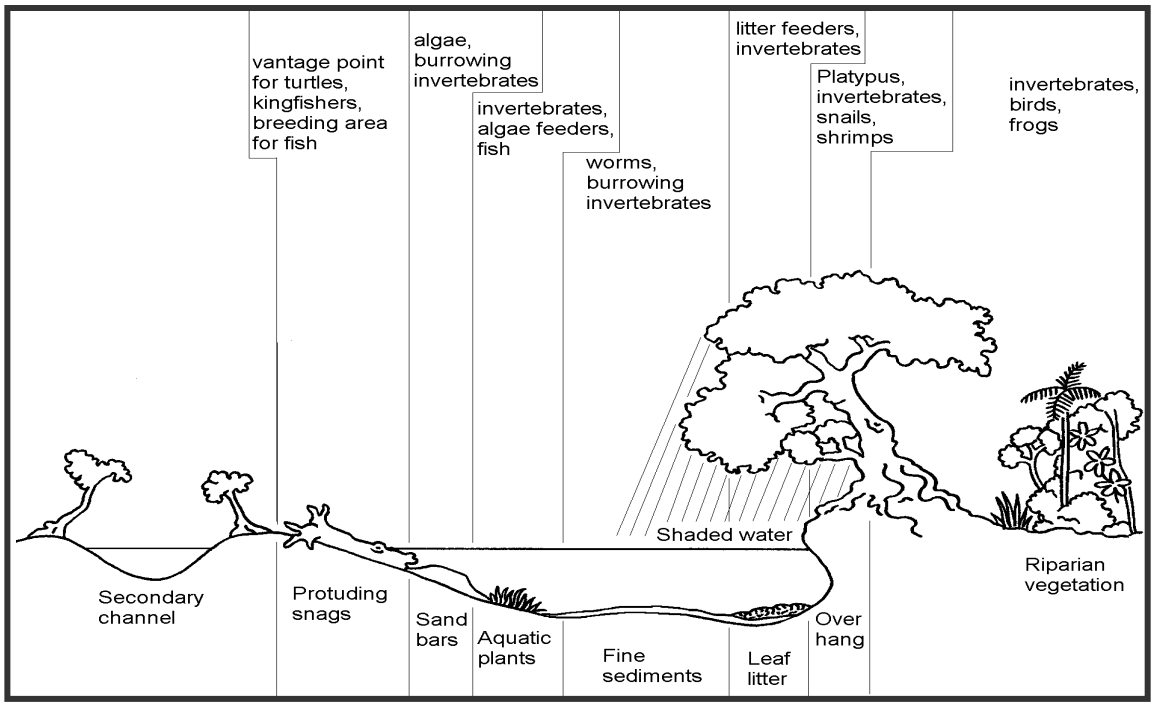
Aquatic plants are a conspicuous feature of the streams of the lowland areas of the Wet Tropics region. A number of important species are endemic to the region, they are restricted to riffle run habitats with fast flowing water; a pattern essentially paralleling that observed for the freshwater fishes. It is unknown to what extent these plants contribute directly to aquatic food webs but they may offer important diversity to aquatic habitats. Beds of the ribbon weed *Aponogeton bulosus* are an important habitat for juvenile catfish after they have left the comparative safety of the parental nest.

The riparian zone

The riparian zone is a powerful influence on stream ecosystems. Streamside vegetation shades streams, prevents rapid temperature changes, and reduces the range of water temperature experienced. Diurnal temperature fluctuations in unshaded streams may be up to 2.5 times greater than in shaded streams and seasonal fluctuations are also greater in unshaded streams (Quinn *et al*, 1993). Water temperature is critical for stream organisms such as fish and insect larvae.

The riparian zone is also important for consolidating the structure of the bank and reducing erodibility. In addition the riparian zone is the source of woody debris for streams (an important habitat element).

The riparian zone is also an extremely important source of carbon (=energy) in many streams because of the transport of leaf litter and dissolved and particulate organic matter derived from terrestrial plants. Riparian fruits are an important food source for many species of turtles and fish, and insects from the riparian zone are of great importance to animals ranging from juvenile crocodiles to fish.



Resource Use of Stream Zones

The interception and retention of sediment and nutrients originating from disturbed land is another function of the riparian zone that has achieved substantial prominence in recent years.

The integrity and diversity of the riparian zone is directly linked to the flow regime and any alteration to the flow regime which affects the riparian zone may therefore adversely impact on the stream environment in a variety of direct and indirect ways.

Stream processes and their relationship to flow

Geomorphological processes within streams and rivers are intimately linked to flow regimes. For example, when large volumes of water are removed from a stream to the extent that wet season flows are greatly reduced, the water channel contracts in size over time.

Biological processes are also linked to the flow regime. For example, some species of stream fishes of the Wet Tropics region spawn during stable, low-flow periods and the survival of their larvae is greatly affected by the occurrence of spates (a sudden rise in water level). In contrast, fishes in lowland rivers are often stimulated to spawn by rising floodwaters. In both cases, reproduction is timed to coincide with conditions most conducive to larval survival.

The downstream movement of water is of fundamental importance in the movement of carbon and energy within and between aquatic and terrestrial ecosystems. Many organisms are dependent on upstream terrestrial ecosystems. Similarly, floodplain systems are thought to be important sources of carbon for the aquatic organisms of large lowland rivers. If rivers are denied access to their floodplains through regulation and impoundment, then floodplain carbon is no longer available. Major changes in biomass and trophic structure of fish communities in estuaries following reductions in discharge have been reported due to reductions in the delivery of nutrients and energy. The magnitude of commercial fish catches in Queensland has been correlated with discharge. In the years following wet seasons with higher than average rainfall, commercial fish catches are significantly enhanced (Bunn and Loneragan, 1998). In addition, sediment transported out of river mouths is important for the replenishment of coastal beaches.

Cultural and Social Values

Waterways are often key elements in Aboriginal landscape and culture and may have spiritual or other meaning important to the local people, for example be story places or clan boundaries.

Evidence of European occupation is often found in proximity to waterways and may include old settlement sites, mining camps (water races and weirs) and logging camps.

Aesthetic and Recreational Values

The region's watercourses have high scenic and recreational values. The Wet Tropics region contains the largest waterfalls in Australia and many visitors are drawn to the natural splendour of sites such as the Barron Falls during flood flows or the crystal clear rainforest waters of Mossman River. Recreational activities on and around the freshwater rivers and streams take the form of white water rafting, swimming, canoeing and bush walking.

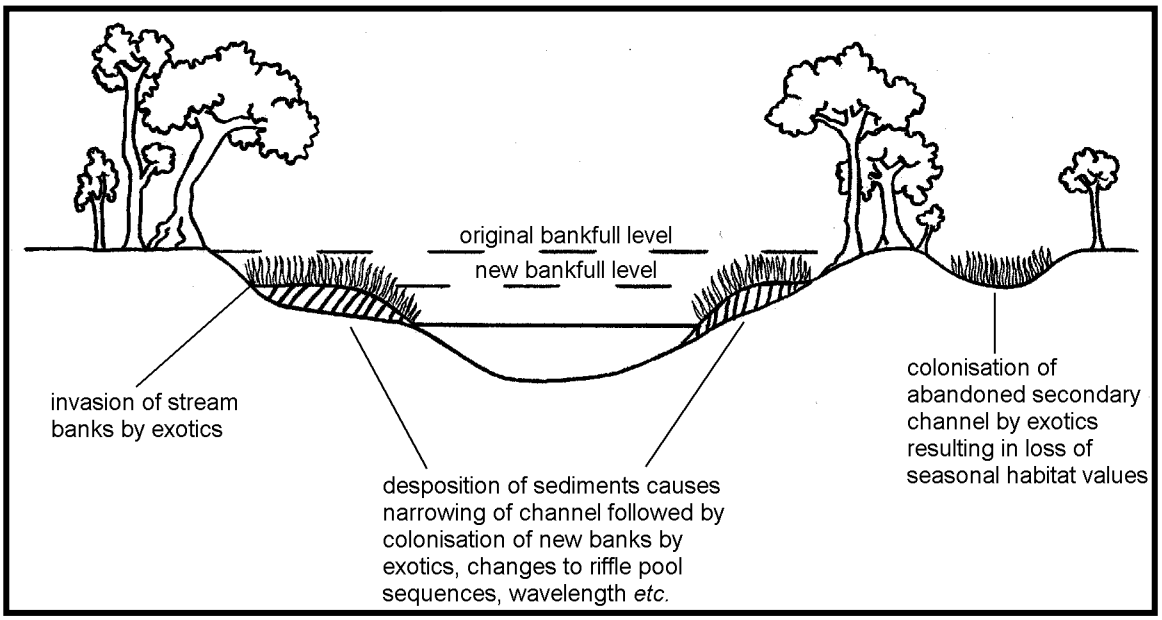


Rafting on the Tully River *Photo: WTMA*

2.2 Impacts Associated with Water Extraction

The single most important factor influencing the ecological, physical (geomorphological) and chemical attributes of rivers and streams is flow regime (Leopold *et al.* 1964, Sparks 1992, Poff and Ward 1989). Changes in flow regime therefore greatly impact upon stream ecosystems.

2.2.1 Physical responses to altered flow regimes



Stream Response to a Reduced Flow Regime

Physical responses by rivers and streams to changing flow regime are reasonably well understood and are likely to include the following:

Channel formation and maintenance

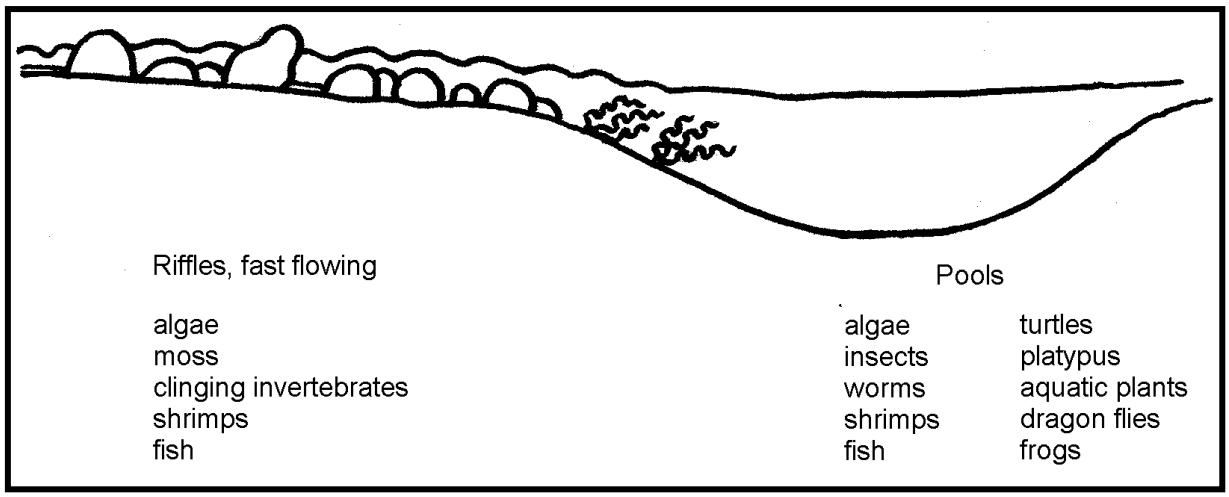
The flow that fills a waterway to its banks (the bankfull flow) is the most important flow for maintaining the waterway's channel. In tropical regions bankfull flows may occur every year. Failure to ensure that channel forming flows occur at the appropriate frequency will result in changes to channel morphology and in-stream habitat. If frequencies are reduced then deposition of sediment along the stream margin causes the stream to contract. This may result in an increase in deleterious secondary impacts such as reductions in habitat area for fishes and invertebrates, provision of greater habitat within the channel for weed species and isolation of important instream habitat elements such as undercut banks and root masses. Invasion of the stream margin by invasive plants such as paragrass may then occur, leading to further capture of fine sediments resulting in consolidation of the new banks. The new channel is no longer competent to convey larger floods and this may result in increased flooding in some circumstances, and in the failure of rehabilitation works on stream banks.

Interbasin transfer of discharge from one stream system into another (for example, by constructed diversions) may impact in different ways. The receiving stream will seek to accommodate the new discharge regime and this can only be achieved by increases in stream width (increasing depth as a mechanism of accommodating increased flows does not usually occur in nature). Increased stream width is achieved by bank erosion. Bank scour will result in the loss of riparian vegetation and, in extreme cases, enough woody debris may enter the stream to cause a reduction in the ability of the stream to discharge its flow.

Channel contraction is usually a slow process (as opposed to channel enlargement). Changes in width may occur first by abandonment of formerly seasonally inundated channel bar surfaces (areas of sediment deposition which may form additional aquatic habitat when inundated *ie* braiding) and abandonment of secondary channels (which are very important habitat for many species of fish), and then later by sediment accretion. In addition, the rivers may shorten due to the abandonment of the braided structure, resulting in a change in gradient. Such adjustments are likely to lead to greatly increased flooding during very large flow events.

Riffle/pool sequences - formation and maintenance

Riffles and pools occur in a graded sequence down the length of a river and the variation in habitat structure that they generate is important for the maintenance of biodiversity. Riffles are important as sources of high secondary production and as recharge areas for dissolved oxygen. The size of individual riffles or pools is dependent on channel width (length = six channel widths, on average) (Leopold *et al*, 1964). Therefore, changes in discharge which impact upon channel width will also, in time, impact upon the size and spatial arrangement of riffles and pools within a river. Such changes take time, and the interim result (until equilibrium conditions are re-established) tends to cause drowning-out of riffles and a reduction in the diversity of flow conditions with subsequent declines in abundance of aquatic organisms.



Resource Use of Riffle and Pool Zones

Meander formation

As with the spacing of riffles and pools, the physical dimensions of meanders (*ie* wavelength and radius of curvature) are associated with the magnitude of the bankfull discharge and can be expressed as functions of stream width. For example, there are relationships between radius of curvature and wavelength and bankfull widths (Leopold *et al*, 1964). Increased flows (such as in interbasin transfers or augmented irrigation flows) will increase scour and, over time, cause meander wavelengths and radius of curvature to increase. The result is increased erosion of banks, loss of riparian vegetation and loss of productive lands. Reduced flows tend to have less effect on meanders in the short term, particularly if the stream channel is deeply incised.

Sediment composition

In general, substrate particle size varies with stream size and gradient. High-gradient streams tend to have large particles whereas larger, low-gradient streams tend to be dominated by finer particle sizes such as fine gravels, sands and muds. Reductions in discharge (water volume), and hence reduced water velocities, tend to result in the deposition of finer sediments, as the stream is no longer competent to transport larger particles. It is generally accepted that reduced discharge results in increasing sedimentation, but this is not always the case. Dams and weirs interrupt inflowing water causing sediment to settle out of the water column, and in this way act as large sediment traps. Any water leaving such a reservoir will be sediment deficient and, if the discharge is still competent, will cause pronounced localised scour immediately downstream of the outlet point. Scour of this nature can occur very quickly proceeding to bedrock within a few decades, and be evident for many tens of kilometres downstream.

Floodplain systems

Changes in the physical nature of floodplains are to be expected only if the frequency of overbank flows and resultant inundation is reduced. In such cases, the reduction in sediment delivery to floodplain areas is expected to have impacts only in the very long-term. Substantial deleterious biological effects are to be expected in the short term.

End of system effects

The volume of water discharged from a river mouth is an important determinant of sand bar formation and estuary closure. Sediment derived from upstream erosion and delivered to the mouth of a river is an important source of sediment for near-shore environments and beaches. Sand transport offshore is particularly important for the maintenance of beaches in the Wet Tropics region. The transport of fine sediments and nutrients is important for many aspects of near-shore marine and estuarine ecology.

2.2.2 Impacts of altered flow regimes on water chemistry and quality

Water temperature

Water temperature may vary considerably over the length of a watercourse. The longer that water remains in a river or stream the greater its potential to absorb heat. Thus changes in flow regime that slow the water discharge down can increase water temperature. Increase in temperature can cause biological impacts *eg* by disrupting the reproductive cycles of aquatic organisms.

Several aspects of water regulation may result in "thermal pollution", including:

- discharge of heated industrial waters,
- returning irrigation waters (differential of between 10-20^{o} C),
- interbasin transfer of water (*eg* transfer of cooler waters from the upstream areas of one river into the warmer lowland reaches of another), and
- impoundment

Dissolved oxygen

Nearly all aquatic organisms are dependent on dissolved oxygen. As a consequence dissolved oxygen is constantly being depleted by respiring organisms and is often in short supply. Turbulence is the major mechanism ensuring that oxygen is transferred from the gaseous to dissolved state and occurs predominantly in riffle zones. Riffles have been termed the stream's "lungs". Changes in flow regime that reduce turbulence or the extent of riffle habitats will impact upon a wide variety of organisms by reducing oxygen supply.

Dissolved solids, conductivity and salinity

A variety of substances is transported in stream waters in a dissolved state. Reductions in flow have the potential to result in elevated concentrations of dissolved ions. This is most significant when groundwater contributions to discharge are significant and carry high concentrations of dissolved ions.

Saline pools may form in streams draining areas with high surface irrigation demand and in streams in which groundwater inputs are significant. Anderson and Morison (1989) investigated the size of freshwater releases necessary to prevent the formation of saline pools. They found that a moderate flood was inadequate and that a major flood was needed. Unfortunately, saline pools quickly re-established following return to normal regulated flow conditions. Moreover, the slug of saline water flushed from such pools caused fish mortality as it passed down the river. Presently, this is only known to be a problem in the Upper Walsh region of the Area.

Reductions in flow may also cause the encroachment of saline estuarine waters upstream into previously exclusively freshwater reaches (tidal migration).

Nutrients, carbon and energy

Nutrients are generally in limited supply. The export of nutrients from head water areas to downstream riverine reaches, estuaries and near-shore environments is of fundamental importance to the functioning of those receiving ecosystems. However, large inputs of nutrients (especially nitrogen and phosphorous) from farm run-off and sewage, can result in algal blooms and are detrimental to stream health.

Carbon is an important nutrient as it is the fundamental building block of living tissue. Flow regulation will impact on the process of organic carbon transfer downstream and therefore impact upon ecosystem integrity.

2.2.3 Biological impacts of altered flow regimes

Changes in recruitment patterns.

Many stream-dwelling fishes of the Wet Tropics region spawn during the dry season period of stable low flows. Larvae produced during this period have sufficient time to develop without the risk of being swept away by floods. Alterations to flow regimes that result in an increased frequency of spates during this low flow period are likely to severely impact on fish populations.

There is also evidence to suggest that different flow conditions may be required at different stages in invertebrate life histories. For example, some invertebrates may be dependent on good water quality during larval stages and on intact riparian vegetation when adults. A reduction in flow variability may directly influence completion of life history stages and therefore long-term population viability.

Barriers to movement

Reservoirs and weirs may act as barriers to the upstream or downstream movement of fishes and macroinvertebrates and interfere with successful reproduction or recruitment of juveniles into adult habitats. Such barriers may also reduce gene flow between populations.

Siltation

Increased sediment loads may have significant impacts on stream fauna by blanketing algae and thereby decreasing primary productivity. Such an impact will be reflected throughout the food chain. In addition, different species of aquatic invertebrates prefer different sediment particle size and an increase in fine silts and mud may cause a shift in the number and type of invertebrate species existing in a stream.

The absence of disturbance

Disturbance due to floods and droughts is a natural component of the stream ecosystem and its absence due to regulation may decrease local biodiversity.

Primary production

Several recent environmental flow studies have found that important sources of primary production such as benthic algal mats on fine-grained substrates are particularly susceptible to impact by changing flow conditions.

Transfer of organic carbon

Flow related changes in the amount and size of particulate organic matter have the potential to impact upon downstream ecosystems resulting in changes in biomass, trophic complexity and assemblage structure.

Alterations in total habitat availability

Changes in channel formation ultimately result in a reduction in the amount of available habitat and will probably lead to a reduction in the number of species. Channel responses to altered flow may also result in a reduction in the diversity of available habitats and consequently result in a reduction in biodiversity.

Maintenance of evolutionary processes

High levels of genetic differentiation exist between geographically close populations of organisms including Crustacea, frogs and fish. Interbasin transfer of water has the potential to disrupt this genetic separation within a very short time and effectively obliterate thousands to millions of years of evolutionary process.

Many other ecological effects of altered flow regime exist, some of which, such as changes in in-stream light environment, are extremely subtle. It has been suggested that every aspect of the riverine environment, whether physical, chemical or biological, is determined and maintained by the flow regime. Therefore, to alter any aspect of the flow regime is to invite impact.

2.2.4 Social impacts of Altered Flow Regime

Water extraction can impact on other users in the catchment through:

a decline in water supplies downstream
interference with existing uses of the waterway
development of access infrastructure
changes to condition of recreational sites
waste water disposal
modification of cultural heritage sites
major economic impacts through stabilisation of erosion, loss of land, increased flooding, damage to crops etc

2.3 Impacts Associated with the Installation, Operation and Maintenance of Domestic Water Supplies

- Installation of infrastructure requires access to the site via roads and tracks; this leads to increases in runoff and sediment transport into streams.
- Clearing of riparian vegetation in order to site off-takes, pipes and pumps disrupts soil integrity and leads to increased erosion.

- Loss of riparian vegetation directly affects stream and bank stability.
- Pump lines may, if poorly sited, act to channel overland flow into narrow paths, thus increasing erosion and sediment mobilisation.
- Loosely tethered pump lines and fixed structures may also increase instream erosion through scour, particularly at times of high flow.
- Fuels and lubricants used in the day to day operating and maintenance of pumps may enter streams. An important consequence may be disruption of local surface water tension and loss of suitability as habitat for surface dwelling invertebrates such as gerrid and microvellid bugs, interference with surface aerial respiration for a range of aquatic insects and disruption to reproduction by aquatic plants such as Valisneria which rely on surface tension to cause localised changes in water surface level in order to deliver pollen to downstream flowering structures.
- Many small fishes of the Wet Tropics region reproduce during the dry season low flow period and the survival of larvae is dependent on the provision of suitable low flow environments and protection from even small-scale changes in discharge. Backwaters and pool margins provide such an environment. Moreover, such habitats are rarely located evenly within streams and the location of larval fish assemblages tends to be very contiguous with the distribution of these habitats. Early larval stages are poor swimmers and are easily entrained in pump streams. Poor location of pump inlets has the potential to reduce recruitment in stream reaches.
- Noisy pumps have the potential to disrupt foraging, nesting and feeding of a range of aquatic organisms (such as platypus) and terrestrial organisms (such as birds) reliant on aquatic systems.
- Small riparian pumps, especially when numerous, poorly located and poorly maintained, may impact on stream ecosystems by simple changes in discharge regime.
- The use of inappropriate materials (such as sheets of iron and fertiliser bags) to create weirs is not acceptable practice and can have detrimental effects on stream flow and/or nutrient balance.

3. Code of Practice for Operation and Maintenance of Existing Community Infrastructure

Goals

To manage maintenance of water extraction in a way which:

- maintains and enhances World Heritage integrity
- conserves World Heritage values of the Area and
- protects the water regime required to sustain ecological values and systems.

3.1 General Codes of Practice

The following Codes of Practice relate to the general issues which apply to works carried out in the Wet Tropics World Heritage Area.

3.1.1 Vegetation Management

The desired outcome is to prevent impacts on World Heritage integrity, loss of significant species and unnecessary impacts associated with vegetation clearing.

Under the Plan, clearing around a structure or road (only) to the extent necessary for its appropriate use may be authorised.

Code of Practice

- Only trim/remove vegetation that poses a risk to safety or infrastructure.
- Determine whether any trees or plants have conservation values prior to trimming/removal. This may be necessary to determine the practicality or most suitable method of clearing. For example if a plant of conservation value needs to be removed to maintain the integrity of infrastructure it may be a requirement to transplant it or collect seed from it prior to removal.
- Where possible, maintain a continuous canopy across the site, and retain as much of the existing vegetation as possible. It is best to undertake minor vegetation management regularly (for example once per year) rather than leave the trimming for a longer period and then have to undertake major and potentially destructive works.
- Vegetation management should be carried out during the early dry season. Any bare earth should be revegetated with native grasses/low growing shrubs which will minimise growth of weeds.
- Prunings should be placed to the side of the working area and left.
- Epiphytes should be left on site.
- Use the minimum appropriate size of machinery required to carry out the works.
- Minimise disturbance to the canopy as connectivity is important for tree dwelling animals (*eg* possums).
- Pruning should be achieved using clean cuts which minimise risk of infection and subsequent tree death.

3.1.2 Herbicide Use

The desired outcome is to prevent uncontrolled use of herbicides in the Wet Tropics World Heritage Area.

Code of Practice

- Only use herbicide control when mechanical controls are non-economical or impracticable.
- Herbicide use should be undertaken by personnel accredited in the handling and application of herbicide.
- Only non-residual herbicides specifically registered for the purpose should be used. Suitable additives should be used to prevent mobilisation by rain, runoff or wind.
- Record herbicide use (type, location, amount. date).
- Store concentrates in a bunded covered area. Where possible, mixing should be carried out in the store in accordance with manufacturer's guidelines.
- Take care to avoid spillage.
- Try to avoid using herbicides during windy or wet weather.

3.1.3 Weed Control

The desired outcome is to prevent new outbreaks and control existing weed infestations in the Wet Tropics World Heritage Area.

A list of weed species found, or potentially occurring, in the Area and which are of particular concern to World Heritage management is provided in Appendix A. Of particular relevance to waterways are the aquatic and semi-aquatic weeds (highlighted in the table in Appendix A). Other species are known for their ability to invade riparian vegetation and therefore indirectly affect in-stream habitat. *Thunbergia grandiflora* is well known in this respect.

Any introduction or spreading of weeds listed in Appendix A is prohibited. Weed control also requires a permit because of the potential of weeds to spread if not disposed of properly, and the potential non-target impacts of control measures.

Code of Practice

- Determine extent and type of weeds occurring around infrastructure sites. Seek training in the identification of weeds occurring within the district.
- Report any weed outbreaks to the Environmental Officer or Wet Tropics Management Authority. Seek advice for environmental management for control/eradication procedures
- Treat weeds using specifically registered herbicides.

3.1.4 Hygiene

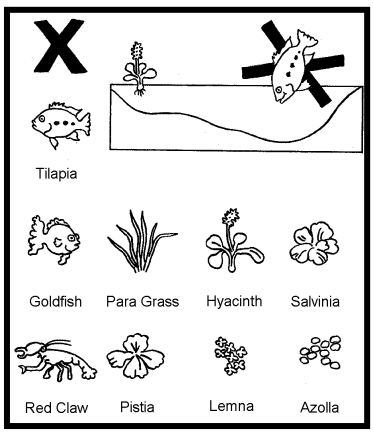
The desired outcome is to prevent the introduction of non-endemic pathogens or other species.

The introduction of non-endemic species of flora, fauna or pathogens to the Area could significantly compromise its integrity. Exotic aquatic plants (*eg* Salvinia, water hyacinth) or

fish (*eg* Tilapia) can rapidly dominate a waterway decreasing species diversity and thus habitat values. Pathogens (*eg Phytophthora* sp), once introduced to an area, are virtually impossible to eradicate.

Code of Practice

Ensure shoes, clothes and equipment (including vehicles and tyres) are free of any soil or seed before entering the Area.



- Wash-down vehicles prior to entering the Area.
- Do not introduce fish, crayfish *etc* into **any** waterways.
- Do not introduce **any** plants into **any** waterways.
- Ensure any plant species used for erosion control (*eg* cover crop) is approved by the Authority prior to use.
- When carrying out equipment checks or routine maintenance, check the area for weeds or dieback.
- Where the presence of harmful pathogens (*ie* dieback) or declared weeds is suspected contact the Authority and the Department of Natural Resources.
- Ensure any materials (particularly fill material, topsoil or organic mulches) used in erosion control are checked and treated for weed contamination prior to importing to the Area.
- Ensure construction materials and equipment are free of exotic animals (*ie* spiders, toads, mice and house geckos) before transport into the Area.

3.1.5 Erosion and Sedimentation Control

The desired outcome is to ensure that surface stability is maintained and that erosion and sedimentation of waterways is not caused by maintenance activities.

Erosion and sedimentation can become issues where surfaces are exposed (for example, clearing of vegetation or weeds) or flows channelised during maintenance.

Code of Practice

- Control erosion and sedimentation using suitable techniques outlined in Appendix B.

3.1.6 Recreational and Scenic Amenity

The desired outcome is to maintain and enhance existing recreational and scenic amenity associated with infrastructure sites.

Rivers and streams are focuses for recreational activities which are often concentrated in areas where good vehicle access exists (such as water supply infrastructure sites). Where access is permitted visitors may come to these areas for passive recreation *ie* simply to gain a close-up view of the forest and streams. Other visitors may engage in bushwalking, swimming or canoeing.

Code of Practice

- Encourage rehabilitation of natural vegetation as visual 'buffers' to infrastructure.
- Appropriate selection of colour for exterior cladding/structures (refer Design and Siting Guidelines being developed by the Authority).

- Signage sympathetic with natural aesthetics.
- Public access to waterways, *eg* walking track design, entry points, maintenance.
- Consider cooperative presentation opportunities.
- Prevent graffiti through use of anti-graffiti treatments.

3.1.7 Cultural Values

The desired outcome is to ensure Cultural Heritage sites are not disturbed by maintenance activities.

Waterways are often key elements in Aboriginal landscape and culture and may have spiritual or other meaning important to the local people, for example be story places or clan boundaries.

Evidence of European occupation is often found in proximity to waterways and may include old settlement sites, mining camps (water races and weirs) and logging camps.

Code of Practice

If a site of possible cultural heritage value is found:

- Do not disturb the site. The relationship of artefacts to each other and to elements of the natural landscape are important in interpreting the significance of the site.
- Mark the area and advise others that the area should not be disturbed.
- Immediately report the site to the Environment Protection Agency (Cultural Heritage), if possible with photographs and/or a sketch map of the site.
- Advise the Authority of the location and nature of the site.

3.1.8 Waste Management

The desired outcome is to reduce the generation of wastes and prevent environmental pollution.

Failure to correctly dispose of waste can cause contamination of the land, creeks, rivers and groundwater of the Area.

Code of Practice

- Consider options to reduce waste volume (particularly waste products of high environmental risk) and facilitate waste recycling.
- Partition wastes to facilitate appropriate handling and ultimate safe removal from the Area.
- Contain wastes in a defined area and manage to minimise pollution (for example store above flood level). This is particularly important in the case of liquid wastes which have the potential to cause severe and immediate impacts on streams. Such wastes include oils and fuels, solvents and paints, herbicides and pesticides, biodegradable wastes and liquid inorganic wastes. These should be decanted into marked, purpose provided containers and stored under shelter in a bunded area until removal from the Area is arranged.
- Maintenance contracts should include provision for contractor responsibility for management and removal of all waste materials generated.

3.1.9 Vibration, Noise and Air Quality

The desired outcome is to prevent impacts on fauna caused by maintenance and operation activities.

Machinery noise and vibration can cause disorientation and changes in faunal behaviour thereby increasing the risk of predation.

Code of Practice

- Select maintenance techniques and equipment which minimise noise and vibration generation and air pollution.
- Restrict operation of noise and vibration producing machinery to daylight hours.
- Consider use of temporary noise barriers during maintenance work.

3.1.10 Training

The desired outcome is to ensure personnel carrying out maintenance works in the Wet Tropics World Heritage Area are given suitable training to assist them to work in an environmentally aware and positive manner in areas of high ecological and cultural value.

Code of Practice

- Personnel carrying out maintenance works, or contractors engaged to undertake maintenance works, should have appropriate training in environmental awareness and the impacts that inappropriate activities can have on the environment.
- Training should be structured with reference to appropriate nationally endorsed training packages. For example, the Civil Construction Training Package, Forest Products Training Package and the Environmental and Cultural Management Training Package (in preparation).

3.1.11 Monitoring, Performance Indicators and Reporting

The desired outcome is to identify any impacts of water extraction on key ecological values so that appropriate remedial actions can be taken.

The establishment and implementation of a monitoring program is an essential step in determining the success of the Code of Practice detailed in this document and the effectiveness of any conditions attached to a permit for maintenance of community water supply infrastructure. The choice of performance indicators will include consideration of current knowledge of the key values of waterways as described in the document *Conservation Values of Waterways in the Wet Tropics World Heritage Area* (WTMA, 1999). Permit conditions will also provide reporting requirements.

It should be noted that the Plan does not require permits for community water supply infrastructure, operations and extraction regimes lawfully in operation before the Plan commenced (1 September 1998). In general, it can be expected there will be limited monitoring requirements for such existing operations. Exceptions might be where key

conservation values are likely to be subject to significant ongoing impacts. In these instances the Authority will seek to negotiate changes to current practices to mitigate such impacts.

Code of Practice

- Adhere to permit conditions including any requirement for monitoring of impacts of activities on key indicators.
- Report on the results of monitoring in relation to performance indicators. Instigate appropriate actions to mitigate impacts identified. This may entail modification to extraction regimes.

3.2 Operation and Maintenance of Specific Infrastructure

The following Codes of Practice refer to specific items of infrastructure found within the Area and should be considered in addition to the general Codes of Practice in Section 3.1.

> The desired outcome is to ensure maintenance of specific items of infrastructure is conducted so that impacts on ecological values, particularly in-stream biota, are minimised and if possible avoided.

3.2.1 Water Intakes

Water intakes comprise gravity fed or pump intakes. An obvious potential impact associated with this equipment is the uptake of in-stream fauna. This may entail more than occasional entrainment of individuals. Some species may aggregate in particular areas of a stream during certain stages of their lifecycle (notably the water surface and near bank areas) and if this corresponds to the intake location annual recruitment of that species and the species which depend on it can be significantly curtailed.

Currents around structures vary with stream levels and flow rates. Erosion and sedimentation characteristics may vary in response to these, as will subsequent impacts on in stream habitats.

Continued extraction during extreme low flow situations (for example, by construction of temporary weirs) can impact upon in-stream fauna that depend on low flow environments to complete their lifecycle.

Code of Practice

The following Codes are in addition to those outlined in Section 3.1.

- If intake is flexible maintain it at least 30 cm below water surface and 1 m from bank.
- Do not prolong extraction during dry periods by construction of temporary weirs, excavation of stream bed or other forms of interference with the watercourse.

3.2.2 Sand Traps, Screens, Screen Chambers

These are primary filtration structures designed to remove leaves, detritus and sand from the water column. Maintenance comprises manual removal of captured materials and periodic washing of screens. Transport of this sediment and organic matter from upstream areas to downstream reaches, estuaries and near-shore environments is of fundamental importance to the functioning of those environments.

Code of Practice

The following Codes are in addition to those outlined in Section 3.1

- Organic material and sand removed from screens and traps should be returned to the stream. Reintroducing sand to a stream should be timed so that it:
  - is regular and thus only small volumes of material are involved
  - coincides with high flow periods when energy levels are sufficient to disperse the material (*ie* smothering of habitats immediately downstream does not occur).
- The most appropriate time for reintroduction is immediately after a flood event, as soon as access to screen and trap structures is possible.
- Larger material (rock and rubble) should be removed from the Area or integrated into local stabilisation works.
- Bent or damaged screens should be removed to an off-site workshop for repairs.

3.2.3 Off-stream Storages

Reservoirs are currently utilised for off-stream storage at some sites in the Area. Associated maintenance comprises periodic cleaning out of sediments and algae. Potential impacts associated with off-stream storage are erosion from overflows, weed growth around reservoirs and the visual impact of associated earthworks (benching) and the structure itself.

Code of Practice

The following Codes are in addition to those outlined in Section 3.1.

- Where possible the visual impact of the storages should be softened by painting to blend with surrounding areas or revegetating to screen the structure and associated earthworks.
- Provide defined and controlled drainage from overflow points to natural drainage pathways. Elements should include hardened outlet splash areas, lined (vegetated) drains and lined chutes to convey water down steep slopes.
- Revegetate earthworks to control erosion, provide competition for weeds and improve visual amenity.

3.2.4 Access Tracks

Vehicular access is required to all community water supply infrastructure. The level of maintenance required varies depending on the scale and importance of the infrastructure involved. Tracks can be unsealed, gravel, or sealed. In some instances control and maintenance of the tracks is undertaken by other agencies (Department of Natural Resources). Maintenance works entail erosion repairs and vegetation control at margins. The potential impacts relate to the integrity of the Area; loss of vegetation (and associated habitat), associated clearing methods (for example the use of herbicides near waterways), increased erosion and weed and feral animal ingress.

Code of Practice

The following Codes are in addition to those outlined in Section 3.1.

- Maintenance of access tracks and roads should conform to the *Roads in the Wet Tropics Best Practice Manual* (Main Roads, 1997*)*.

3.2.5 Water Mains, Pipelines

Pipelines require little maintenance. Above ground structures require periodic rust treatment (sand blasting) and painting. Potential impacts are related to the nature of the treatment products used (for example lead based primer), the handling and disposal of the slag material produced during sand blasting, and the use, handling and storage of paint products applied to the pipe-work.

Code of Practice

The following Codes are in addition to those outlined in Section 3.1.

- Select products to minimise the potential for environmental harm.
- Collect and dispose of slag material generated during sand blasting in a licensed disposal facility.
- Store painting materials in a covered and bunded area.
- Mix and clean painting materials in a bunded area and according to manufacturers directions.
- Where possible the visual impact of pipe-work should be softened by painting to blend with surrounding areas.

3.2.6 Concrete Dams and Weirs

Concrete weirs are stable, low maintenance structures. However, they interrupt the flow regime of the stream creating barriers to movement of fishes and macroinvertebrates, interfering with reproduction or recruitment of juveniles into adult habitats and reducing gene transfer between populations. In-stream structures also interrupt the transport of sand and organic matter from upstream areas to downstream reaches, estuaries and near-shore environments. Maintenance activities involve:

- periodic desilting using suction hose, sluice gates or scour valves, usually during flood events. Potential impacts include: extensive sedimentation in downstream habitats and scour of sections of bed and banks immediately downstream
- cleaning walls, weep holes and operational areas with high pressure hoses. Potential impacts are turbidity downstream of weirs during cleaning operations.

Code of Practice

The following Codes are in addition to those outlined in Section 3.1.

- Maintain in-stream sediment transport by regular removal of sand from weirs. Removal should be timed so that it:
- is regular and thus only small volumes of material are involved
- coincides with high flow periods when energy levels are sufficient to disperse the material (ie smothering of habitats immediately downstream does not occur).
- Investigate mechanisms for improving transparency of weirs to the natural flow regime of the stream. This may be achieved by flow bypass at times of low flow, fish-way devices or other specific techniques defined by identified conservation values for the particular sub-catchment.

3.2.7 Earth Dams

Associated infrastructure includes spillways, spillway bridges, outlet towers and scour tunnels. As with weirs dams interrupt the flow regime of the stream creating barriers to movement of fishes and macroinvertebrates, interfering with reproduction or recruitment of juveniles into adult habitats and gene transfer between populations. In-stream structures

also interrupt the transport of sand and organic matter from upstream areas to downstream reaches, estuaries and near-shore environments. Deep water storages can develop zones of varying temperature and oxygen levels and release of these waters can have a variety of impacts on downstream habitats. For example, altering the water temperature downstream can desynchronise the reproductive cycle of aquatic organisms. Similarly, release of poorly oxygenated water can have direct and immediate impacts on survival of downstream aquatic life.

Releases of water also have the potential to cause scouring and channel modification (and subsequent modification of habitat) downstream.

Maintenance activities involve:

- periodic settling surveys
- tree and weed clearing on walls and survey lines
- tree and weed clearing at dam margins
- periodic releases of water
- equipment and infrastructure repairs

Code of Practice

The following Codes are in addition to those outlined in Section 3.1.

- In areas within 30m of a water body or near drainage lines vegetation control should be achieved by mechanical means. Techniques to suppress regrowth (whilst protecting the surface from erosion) such as mulching or application of hydraulically applied organic fibres should be investigated to reduce future maintenance requirements. If organic fibres are used they should be weed free.
- Investigate release regimes that model natural flow regimes for the waterways. If possible, adjust release strategies to reinstate elements of natural flow and /or prevent impacts on downstream water quality (*ie* temperature and dissolved oxygen levels).

3.2.8 Treatment and Associated Small Volume Water Storage

Treatment facilities within the Area are generally on a small scale, supplying only site needs. Potential impacts relate to the handling and use of treatment chemicals (for example chlorine, potassium, soda ash) and disposal of precipitate, which can have direct impacts on aquatic organisms if discharged to a waterway through spillage or inappropriate disposal.

Code of Practice

- As per Section 3.1.

3.2.9 Minor infrastructure items (sheds, residences, walkways, stairways, generator sheds) and visitor facilities (picnic tables, BBQs, walking paths, scenic lookouts, gardens, toilets)

Given the nature of the structures involved and the low level of risk associated with maintenance of these the greatest potential impacts are related to the presentation of World Heritage values. Since structures are in areas accessed by the public they are prominent visual features. Inappropriate design, shape, style, building material, colour or landscaping associated with a structure can negatively impact on an area's visual amenity.

Code of Practice

- As per Section 3.1.

4. Code of Practice for Operation and Maintenance of Existing Domestic Water Supplies

Goal

To ensure any development, maintenance or operation of domestic water supply facilities occurs in a way which maintains the World Heritage Values of the Area and protects the water regime required to sustain ecological values.

This section deals with existing domestic water extraction activities. The Plan provides for the provision of a domestic water supply for Private Land holders or Native Title holders (Refer to Section 1.4).

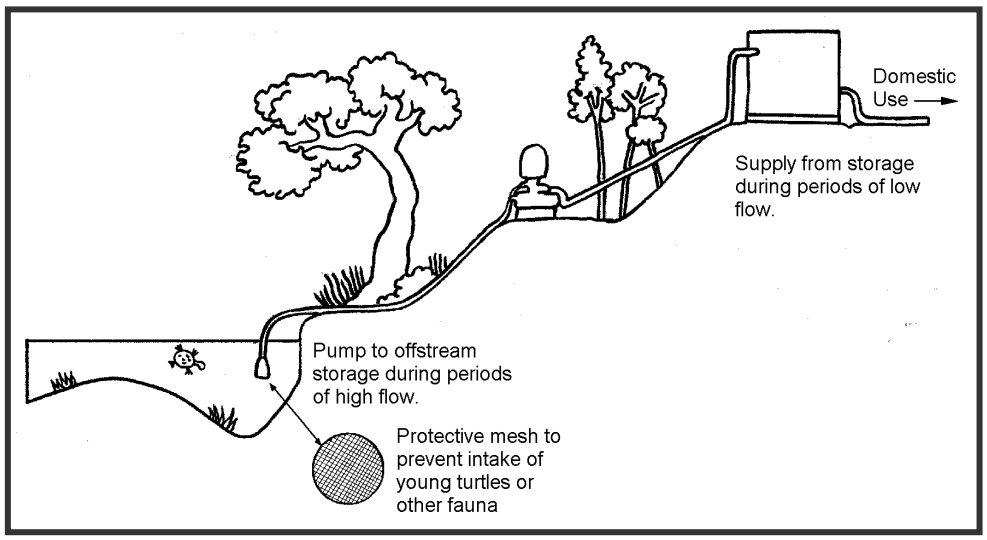
Section 4 outlines the Permit assessment process for any new domestic extraction infrastructure. The significance of the waterway and existing and potential cumulative impacts will be considered in the assessment process.

The potential impacts on ecological values from inappropriate maintenance and operation include:

- loss of vegetation, leading to increased erosion and in stream effects such as smothering of benthic fauna.
- extraction in no flow or low flow situations leading to drying up of pools and subsequent localised loss of flora/fauna.
- disturbance to bottom substrates (and subsequent dislodgment and/or death of bottom-dwelling fauna/flora) through pipe movement.
- entrainment of, or disturbance to, fish and other organisms.
- downstream erosion due to redirection of stream flow resulting from installation of the pump inlet.

Code of Practice

- Where practical locate pumps above the bank full level of the waterway.
- Pump inlets should be positioned at least 30 cm below the low flow water surface and at least 1m from the bank to avoid uptake of juvenile native fishes.
- Removal of aquatic vegetation and submerged woody debris from the vicinity of the pipe inlet should be limited in extent (for example, no more than a 1m radius of the inlet mouth) and sufficient only to result in efficient abstraction of water.
- If a fuel driven pump is being used install engine mufflers to reduce noise levels and conduct frequent maintenance checks to ensure that noise reduction is effective.
- Fuel driven pumps should generally only be used during daylight hours (depending on location). If the pump is to be used for extended periods in close proximity to residences it should be housed in a sound-proofed structure.
- The pump intake should be meshed to prevent intake of young turtles, juvenile fish or other fauna.



- Use flexible pipes with compression or screw fittings which can be quickly dismantled so that the pump can be removed in flood situations.
- The pump should be fixed (using quick release fastenings) to concrete footings.
- If electric power has been brought to the site, then power poles must be made possum-proof.
- Consider options for minimising water demand. For example:
  - rainwater collection tanks
  - composting toilets
  - reuse of shower, bath and/or laundry water
  - the use of water saving devices such as mist shower roses and dual flush toilets.
- Do not locate pipes where they may cause overland flow to channelise and cause erosion.
- Where possible located and support pipe above the ground surface to allow for the movement of ground dwelling fauna.
- Road and track access to a pump site should be kept to a minimum and should preferably be walking access only.
- Vehicle tracks are not to continue into the stream channel.
- Maintain roads and tracks in accordance with Section 3.2.4 and should conform to the *Roads in the Wet Tropics Best Practice Manual* (Main Roads, 1997).
- In instances where the area of disturbance is small, cover disturbed areas with leaf litter or weed free mulch immediately after completion of earthworks.
- Where larger areas need to be revegetated seek information regarding appropriate species and techniques from the Authority.
- Manage weeds in accordance with Section 3.1.3 above.
- Do not store fuels or maintenance materials (*eg* lubricants) with extraction equipment.
- Servicing equipment should include a drop sheet to prevent spills, solvents, or lubricants contacting the ground or drainage pathway. Empty sealable containers should be available to contain and remove spilt or residual lubricants or fuel.
- Manage equipment in accordance with hygiene Section 3.1.4 above.
- Conduct monitoring in accordance with Section 3.1.1 above.

5. PERMIT APPLICATION PROCESS

5.1 Permit Application Process

Note that this Section only applies to WTMA permits. The applicant must also seek approval to conduct water extraction from the relevant land managers (DNR or QPWS), DNR - Water Resources and Environment Australia.

Process

A permit application[1] for maintenance of water extraction infrastructure will need to include the following information. These may be included in a plan of maintenance (PoM) or environmental management plan (EMP) which includes reference to:

- location
- other approvals
- duration of permit
- a description of proposed works and/or operations
- character of the environment
- impact considerations (World Heritage integrity, World Heritage values)
- community implications
- precautions to prevent, minimise and monitor impacts.

The PoM/EMP should draw on the General Codes of Practice outlined above as well as the more specific Codes of Practice provided for the operation and maintenance of various forms of infrastructure as described in Section 3.2.

The Authority will assess the permit application by:

a) Initial assessment to determine whether further information is required *eg*:
   - an environmental impact statement conducted to stated terms of reference (given the potential for impacts associated with new development it is likely that an environmental impact statement prepared subject to other relevant legislation may meet this requirement although additional information may be required)
   - information about the nature, scale, duration and extent of the proposed activity
   - information about whether there is a prudent and feasible alternative to the activity
   - information about the effects that a proposed decision on the application may have for the community, or for a section of the community (particularly Private Land holders, Native Title holders and any other Aboriginal person concerned with the land).

b) Request for further information

c) Permit Assessment against standard criteria set out in the Plan

d) Issue or Refuse the permit

Note: The permit may be issued with conditions considered necessary to prevent, minimise or monitor any adverse impact, or to rehabilitate the area. There are review/appeal provisions if the applicant is not satisfied with Permit Conditions or the Application has been refused.

An Environmental Management Plan may provide the detail required to obtain a permit with the advantage of meeting obligations under the *Environmental Protection Act* (1994) and any Environmental Management System a local Authority is operating under.

[1] Refer 1.4.3 regarding "maintenance and operations" of community water supply infrastructure.

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APPENDIX A

Undesirable Plants of the Wet Tropics World Heritage Area

Note: Species able to invade and establish in Wet Tropics waterways are highlighted. These plants are recognised as existing or potential weeds which can invade native vegetation in the Area.

Species	Common Name
all non-native species	
Allamanda cathartica	allamanda
Annona glabra	pond apple
Azolla spp	
Bambusa spp	bamboo
Brachiaria mutica	para grass (ponded pasture)
Cabomba caroliniana	cabomba (aquatic weed)
Calopogonium mucunoides	calopo (pasture legume)
Centrosema pubescens	centro (pasture Legume)
Chuckrasia velutina	East Indian mahogany
Cinnamonum camphora	camphor laurel
Clitoria laurifolia	clitoria
Coffea arabica	coffee
Duranta repens	golden dewdrops or sky flower
Eichhornia crassipes	*water hyacinth*
Glycine spp	glycine
Harungana madagascariensis	harungana
Hemigraphis colorata	
Eipomoea spp	morning glory
Lantana camara	lantana
Lemna spp	duck weed
Ligustrum spp	privet
Ludwigia spp	water primrose
Melinis munutiflora	molasses grass
Miconia calvescens	miconia
Momordica charantia	balsam pear
Montanoa hibiscifolia	anzac flower
Panicum maximum	guinea grass
Passiflora spp (exotics)	passion fruits or flowers
Pennisetum purpureum	elephant grass
Perilepta dyeriana	
Pinus caribaea	caribbean pine
Pistia stratiotes	water lettuce
Psidium guajava	guava
Pueraria phaseoloides	puero (pasture legume)
Salvinia molesta	salvinia or water fern
Saman samonea	raintree
Sanchezia parvibracteata	sanchezia
Sansevieria spp	mother-in-law's tongue
Selaginella willdenovii	peacock fern
Spathodea campanulata	African tulip tree

Species	Common Name
Stephanophysum longifolium	
Thaumastochloa danielii	prayer plant
Thunbergia alata	black-eyed susan
Thunbergia grandiflora	blue thunbergia
Thunbergia laurifolia	laurel clock vine
Tithonia diversifolia	Japanese sunflower
Tradescantia spp	wandering jew
Turbina corymbosa	turbina
Wedelia tricomuta	Singapore daisy
Zebrina spp	wandering jew

APPENDIX B

Erosion Control Techniques
(selected and adapted from Roads in Wet Tropics- Main Roads 1997)

Erosion Control Technique	Purpose	Limitations	Advantages	Disadvantages
Chemical Surface Stabilisers	Generally effective for dust control of erosion caused by raindrop impact. Also used for tacking organic mulches.	Products have a limited life and consideration should be given to the use of geotextiles if the exposed surfaces need to be protected for extended periods or during the wet season.	Provides instant protection. Suitable for temporary stabilisation.	Usually less effective than mulches. The established surface crust must remain intact to be effective. Bitumen products can break down and release phosphorous and oils to receiving waters. Vegetation may also root through cracks causing crumbling of the surface. Some products can reduce water infiltration.
3 Dimensional Synthetic Infill Matting	Provides reinforcing to slopes or channels likely to receive erosive flows.	Non-biodegradable mats and nets have limited use in bushland areas. Lizards, snakes and birds have been known to entangle themselves in the netting.	Effective in concentrated flow situations.	Some products may have a very limited working life.
Organic Mats	Protection of exposed surfaces against the erosive effects of wind, raindrop impact and stormwater run off. Selective control of vegetation growth. Often used when revegetating slopes steeper than 4(H):1(V). Can control soil temperature and moisture loss. Some products may be used as mulch.	Few totally biodegradable products can withstand the erosive effects of concentrated flow.	Can be used to protect dispersive soils. May be reusable. Quick to install and provides instant protection.	Fabrics have a very limited working life.

Erosion Control Technique	Purpose	Limitations	Advantages	Disadvantages
Mulching	Applied to clay soil surfaces to limit run off and turbidity caused by raindrop impact. Applied to mild slopes to control raindrop impact as well as erosion caused by sheet flow. Used to control soil temperature and moisture loss. Mulch can be used to aid or inhibit seed germination and to control weed growth.	Some mulches are not suitable in bushland areas due to possible introduction of unwanted seeds. Not suitable for areas subjected to concentrated flow unless a suitably sized gravel mulch is used. Mulch should cover 70-75% (minimum) of the soil surface to give adequate protection against erosion. Not suitable for steep slopes (>20%).	Most effective and practical means of controlling erosion prior to vegetation establishment. Can be applied on irregular terrain. Particularly useful in higher rainfall areas to protect against raindrop impact. Also restricts moisture loss, increases infiltration rates and minimises temperature fluctuations.	Decomposition of some wood products can tie up significant amounts of soil nitrogen, thus requiring modification to fertiliser application rates. Associated bitumen-based fixers can release phosphorus to receiving waters. May be displaced if subjected to flooding or concentrated overland flow.
Revegetation	Soil surface protection and soil reinforcement. Stabilisation of shallow land slips. Interception and retention of stormwater run-off. Reduce rainfall impact energy. Increase soil permeability and evaporation, thus reducing the volume of total annual runoff.	There are limits to the role vegetation alone can play in controlling erosion before it becomes established. Both soil strength and vegetation cover (including root system) can take years to develop the required characteristics. Usually not suitable in heavy traffic areas or for long slopes greater than 2(H):1(V).	In terms of soil surface protection vegetation is the best long-term defence that can be used. Environmentally sound and inexpensive long-term erosion control measure. Self regenerating properties reduces the long-term loss of topsoil.	Long establishment time, subject to damage in heavy traffic areas.
Soil Cement Treatment	Used to increase the strength of on-site soils. Soil cement has been used in the construction of levees, channel bank protection, drop structures and merits consideration as a substitute for rock protection in areas where rock is not economically available.	Limited design information available. Limited interaction with vegetation. Not suitable for all soil types.	Its primary advantages are low cost, durability and permeability. Soil cement requires a cheaper aggregate mix than concrete because more fines are acceptable.	Can limit vegetation cover. Some soil cement mixtures break readily if subjected to traffic or high volume flows. May result in localised soil or water alkalinity or pH problems.

Erosion Control Technique	Purpose	Limitations	Advantages	Disadvantages
Surface Roughening	On recently seeded or exposed earth surfaces, erosion protection can be improved by roughening the soil surface to increase infiltration.	Surface roughening or ripping is not effective during major rainfall events where concentrated runoff will break through the furrows and cause rill erosion. Tracking is generally not as effective as other surface roughening methods as it can compact heavier soils.	Increases infiltration and reduces run-off. Inexpensive. Can improve the stabilisation of topsoil when surface roughening has been applied to subsoil. Aids the establishment of vegetation.	Of only limited advantage during periods of heavy rainfall.
Brushwood Barriers	Brushwood barriers can be used as check dams to provide temporary channel stabilisation during revegetation. In areas of concentrated flow, they can be used as a support for sediment fences. Brushwood barriers can also be used to stabilise and slowly backfill large gullies with trapped sediment.	Limited control over the finer sediments depending on the type and placement of the geotextile filter. Usually only suitable in areas where upstream flooding is not a concern. Used with caution in high flow watercourses.	Has a natural appearance. May be left to naturally degrade with time when used in rural or bushland areas. Inexpensive to install and maintain. Can be a source of seeds native to the locality.	The brushwood can contribute to stream debris. The strength of the barrier may be questionable and will deteriorate with time. Can divert run off and cause increased erosion, not suitable for high volume flows.
Buffer Zones	Used to control sediment run off from access roads, or construction sites and protect adjacent wetlands, streams, rivers and bushland areas	Buffer zones generally only trap coarse sediments. Clays and fine silt particles will generally pass through buffer zones during periods of heavy rain. Suitable for slopes between 1% and 10% grade.	Buffer zones can reduce the need for on-site erosion and sediment control measures during any earthworks. Particularly useful on low to medium slopes.	Ineffective during periods of very heavy rain. Buffer zones can be easily disturbed or destroyed by poor site management. Can require large areas of land.
Grassed Filter Strips	Grassed filter strips are placed around impervious surfaces to filter sediment run-off before it leaves the site. Strips of vegetation retained or laid (turf) down slope of disturbed land can provide a simple method for trapping sediment. They can also be used to control flow and sediment run-off on small step embankments.	Grassed filter strips generally only trap coarse sediments. Clay and fine silt particles will pass through a buffer zone during periods of heavy rain. Cover crops can give surface stability for 3-6 months.	Efficient during regular storm events (*ie* <<Q1). Reduces on-site and off-site clean up work after storms.	Ineffective during periods of heavy rain. Can be disturbed by construction vehicles.

Erosion Control Technique	Purpose	Limitations	Advantages	Disadvantages
Sediment Fences	Temporarily reduce the velocity of contaminated sheet flow to induce gravitational settlement of the entrained sediment. Control of sediment run-off from exposed land, unsealed roads and stockpiles.	Often called 'silt fences' these structures have little impact on fine silts (<0.02mm). Design flows limited to around 40 litres per second in areas of concentrated flow. Drainage area limited to 0.6 ha per 100 m of fence, or a max. slope length of 60m. Service life of around 6 months.	Easy to install, controls sediment run off close to the source of the erosion. Highly visible sediment control measure. Generally more efficient than straw bales.	Easily damaged by construction equipment and stockpiles. Can cause concentration of sheet flow if poorly located, installed or maintained. Limited service life of around 6 months or less during the wet season. Often incorrectly installed and maintained.

APPENDIX C

Best Practice Environmental Flow Determination

1. Best Practice Framework

1.1 Introduction

The literature on environmental flow assessments is voluminous and replete with methods, models, holistic methodologies, guidelines, decision support systems, hybrids of all of these, and the obligatory acronyms. Which to apply in a given set of circumstances is a decision for the individual or group conducting an environmental flow assessment. However, all of the available methodologies could be improved, either individually, or by accommodating the most useful features of them within the broader context of a 'best practice framework'. The purpose of such a best practice framework is to establish a logical sequence of activities which should be undertaken in a systematic fashion irrespective of the particular methodology and technical methods applied to address the water requirements of the study system.

A best practice framework proposed for Australian environmental flow assessments is outlined in Figure 1 (from Brizga 1998b and Arthington *et al.* 1998). It represents a more structured and comprehensive version of the Flow Restoration Methodology (see Arthington and Zalucki 1998) with several additional elements proposed largely by Brizga (1998b). This framework offers a systematic and structured sequence of background data collation, field studies and workshops ending with an evaluation of alternative environmental flow options and their implications for other water users in a catchment.

1.2 Structure

The framework set out in Figure 1 has 10 main stages, including five multidisciplinary workshops. Square boxes indicate work carried out by individual team members, rounded boxes indicate workshops involving all members of the environmental team. Disciplines which should be included in the environmental team include hydrology, hydraulics, geomorphology, water quality and ecology (aquatic, riparian and terrestrial vegetation, aquatic invertebrates, freshwater and estuarine fish, and other water dependent vertebrates). Close interaction between the disciplines is considered necessary because of interdependencies between physical and ecological processes. Workshops are seen as an efficient means of fostering such interaction. There will often need to be some individual follow-up work and consultation amongst the team members after the workshops to finalise outcomes at each stage.

The following amplification of the best practice framework is intended to indicate sources of literature on each major activity, step and process.

The steps and activities envisaged in the best practice framework are as follows:

1. Preliminary Desk Studies

The first step in the process of assessing environmental flow requirements is the compilation and overview of existing relevant information about the study area, and identification of critical information gaps. This is done by individual team members assigned particular disciplinary areas which would generally include geomorphology, water quality and ecology (aquatic, riparian and terrestrial vegetation, aquatic invertebrates, freshwater and estuarine fish, and other water dependent vertebrates).

It is not possible to be absolutely prescriptive about these background data collation activities; they will vary from study to study. However, examples of the types of data collation activities required are provided in the Background Papers from the Logan River Trial of the Building Block Methodology (Arthington and Long 1997) and in the Brisbane River study report (Arthington and Zalucki 1998). Note that the various chapters of the Logan background papers and Brisbane River report also summarise the results of field and other commissioned studies so they effectively encompass steps 1-5 of the best practice framework.

Figure 1

A calibrated hydrological simulation model of the catchment or sub-catchment with a daily time step and environmental flow node should be available at this stage of the project. The model is used to describe the unregulated and existing flow regime and to assess the hydrological impacts of past and existing flow regulation and/or modification (whichever is relevant). This provides a fundamental starting point for development of flow-ecology relationships and the construction of environmental flow regimes. Procedures involved in development of hydrological models are well-established and too complex to describe here. An example of the development of such a model can be found in the final report from the Brisbane River environmental flows study, in which the Integrated Quality Quantity Model (IQQM) developed in New South Wales provided the modelling platform (Ruffini *et al*. 1998).

Assessment of the hydrological impacts of existing flow regulation (or modification of the flow regime in unregulated rivers) can involve many different statistical analyses and there is no set prescription for such work. In fact there is a plethora of statistical analyses and indices and little agreement around Australia as to the most appropriate methods to use. To some extent, this flexibility is commendable but there does need to be some agreement on a fundamental set of analyses that will capture the likely range of changes to key features of the flow regime including changes made to the full range of flows from zero to maximum flood levels. The approach used in the Brisbane River study is recommended as a background reference (Brizga 1998a). Analyses should be based on a set length of simulated daily flows to capture extended historical sequences of flow patterns; 100 years is becoming the accepted length of the simulation period for such models.

2. Workshop 1

This is essentially a field inspection of the stream(s) in question, carried out together by the whole study team. It is a familiarisation exercise which also underpins identification of geomorphological river zones and selection of river reaches for further study. The

importance of bringing the full study team together for this exercise cannot be over emphasised as it is the first stage of the complex process of building a study team with a common vision of the scope and intentions of the flow assessment. A smaller team comprised of the geomorphologist, hydrologist and leading ecologist will usually undertake a preliminary overview of the catchment to decide on the best vantage points for the full team to visit. Inaccessible areas may require helicopter surveys. It is customary in the Building Block Methodology to make a video of these inaccessible areas to ensure that the full study team has a grasp of their location, extent, characteristics and significance in relation to the geomorphological analysis of river zones.

The identification of geomorphological river zones and selection of river reaches for further study is a highly technical process and crucial to the whole program of study. It has to take account of both the natural variation in flow and physical conditions throughout the basin and also the location and extent of the major water supply infrastructure which regulates the flow regime. The basic approach to the analysis of a river is to divide it into a series of longitudinal River Management Zones each with different geomorphological, hydrological and ecological characteristics, also taking into consideration the management possibilities in different reaches and zones. The work of Brizga (1997) in the Logan catchment is a good example of the basic approach required.

Selection of appropriate river reaches for further detailed study by the whole team is central to the process of constructing the environmental flow recommendations. This step involves a spatial disaggregation of the riverine environment using the lateral zones of in-stream, riparian, near floodplain and far floodplain. This longitudinal and lateral spatial disaggregation is intended to provide relatively homogeneous types of riverine environment within which representative study reaches are identified. Criteria for selection of "representative" study reaches within each geomorphological river zone are described in Brizga *et al*. (1997). If a study reach is selected on some basis other than its representativeness of the range of geomorphological conditions which characterise that part of the river, the reasons for its selection must be clearly understood. A prime objective from the perspective of river biota is to represent the full range of in-stream hydraulic and floodplain habitats within each geomorphological river zone that are likely to be of importance to the river's aquatic flora and fauna. Some care is required to ensure that the reaches and study sites selected for detailed surveys will encompass all of these potential habitats and also enable their connectance under different discharges to be assessed.

3. Completion of Background Studies

Completion of the geomorphological and ecological background studies is carried out on the basis of the compilation of existing information, the group field inspections (Workshop 1), and the results of the assessment of hydrological impacts of existing regulation and/or flow modification. By this stage, relatively homogenous river zones and reaches have been identified that encompass the full range of geomorphological, hydraulic and hydrological variation in the catchment or sub-catchment. Then, for each reach, assessments are undertaken by each team member of existing conditions, significant features, flow-related natural processes, impacts of existing flow regulation and other human activities, and likely sensitivity of the stream to potential future flow-related development.

Methods for assessment (*eg* expert opinion *versus* detailed studies) will depend on whether the study is a rapid basin wide assessment of development opportunities or a more detailed assessment of a smaller number of development and flow management options. These decisions influence the timeframe and the level of resources. At this stage a background report is prepared by the full study team and subjected to peer review (see Figure 1).

4. Workshop 2

Held after the completion of the background studies and circulation of the background report prepared by the team members. Several tasks are undertaken at this workshop:

Task 1

The first task in the workshop is to develop a vision of the desired future geomorphological and ecological conditions for the river system and for particular river reaches. The vision should take into account inputs from stakeholders, give realistic consideration to human use constraints, and specify what those constraints are. For example, "to protect specified ecological, geomorphological benefits, without exacerbating bank erosion and providing of x ML". At this stage, objectives relating to the biota should be established (*eg* maintenance of fish and invertebrate diversity and the recruitment of all species/or some key species, plus protection of values, and objectives related to any rare and endangered species). The geomorphological and ecological objectives which need to be met to achieve the vision should be outlined in detail, so as to assist in identifying optional management strategies.

Task 2

The purpose of this task is to identify management measures which could be used to achieve the specified environmental objectives. Flow related measures (*eg* minimum flow, flushing flow) and other measures not related to flow regime (*eg* revegetation, structural works, catchment management measures) should be identified. Critical dependencies should be determined, *eg* the need to establish indigenous vegetation communities along cleared streams before an environmental flow provision can be expected to provide significant benefits in terms of riparian vegetation. Specific issues (*eg* management of exotic weeds and fire) should be referred formally to other river management programs or to the relevant management agencies for action.

Task 3

Once the relevant issues have been scoped and agreed on in qualitative terms, decisions can then be made about the level of quantification that is required. These decisions should be related to the objective of the assessment (rapid basin wide assessment, holistic assessment at catchment or sub-catchment scale, or more detailed assessment of particular issues via targeted research).

Priorities for quantification and suitable methods should be determined taking into account cost, time, knowledge about the processes in question, data availability, and the feasibility of implementation of a specific recommendation. As recent literature reviews have shown (see chapters in Arthington and Zalucki 1998), methods are available to

quantify only a limited number of the factors which may be relevant to an environmental flow assessment, and suitable data may only be available for a subset of these. The specific techniques to be used (*eg* 'rule of thumb', hydraulic habitat assessments, trial release) must be decided by the whole study team. A decision also needs to be made as to whether the environmental flow will be determined using a bottom-up or top-down approach, or a combination of both.

One example of the feasibility of implementation is provided by considering a reach controlled by a large ungated dam, in which instance there may be no point in making detailed calculations of a flushing flow unless there is a possibility of retrofitting of the structure to make it capable of passing a significant flood pulse. Under these circumstances it would probably suffice for the study team to flag that this as an issue and to give a 'ballpark' estimate of the required flow.

5. Detailed Studies

This step consists of detailed field and desktop studies to quantify flow requirements, using the procedures and methods agreed at Workshop 2. Work would be carried out individually or collaboratively as appropriate. The recommendations of the various disciplinary experts are then combined and integrated in Workshop 3, and the quantitative flow and any other recommendations (*eg* need for further investigation of particular issues, or long-term research) are written up in a technical report.

Note that assessment of the flow requirements of biota requires many types of information that would not be collected by relevant ecologists, who would need to advise other participants of any particular data requirements, the spatial and temporal resolution of the data and the necessary formats of the data. For example, essential data on the food resources available to fish might include invertebrate data from stream surveys, information on aquatic macrophytes and/or algae or benthic algal mats, presence/seasonality of riparian fruits, *etc* Similarly, fish may have certain requirements for spawning habitat involving the need to quantify the flows that inundate aquatic and riparian vegetation or areas with particular substrate characteristics. Ecologists may in turn be required to provide data to another aspect of the study (*eg* data on numbers or biomass of a significant species, or data relevant to the dietary requirements of waterbirds). Establishing a common understanding of these linkages and data requirements is an important part of best practice.

6. Workshop 3

A set of optional flow management strategies is outlined, with indications of their ecological and water resource management implications, so as to provide a basis for the social and economic evaluations. These might commence with the most water hungry environmental scenarios and descend to the most parsimonious alternatives, with the environmental consequences at each level specified as precisely as possible. This is the point at which a benchmarking process should be designed to evaluate alternative scenarios. Optional management scenarios for hydrological modelling and assessment of ecological implications are selected at this workshop.

7. Modelling of Optional Scenarios

The modelling of alternative environmental flow scenarios would be carried out after Workshop 3, and the results presented and evaluated by the environmental team in Workshop 4. The procedures used for modelling environmental flow scenarios vary from one methodology to another and are too technical to describe here. Examples of approaches to modelling of scenarios can be found in documents arising from the Brisbane River flows study (Arthington and Zalucki 1998), the Fitzroy basin WAMP (DNRQ 1998, Vanderbyl 1998) and the Condamine-Balonne WAMP (Burgess and Thoms 1997).

8. Workshop 4

This workshop evaluates the optional scenarios, and identifies potential environmental risks associated with alternative scenarios, based on a suitable process such as benchmarking or some other form of risk analysis. Monitoring requirements would also be specified at this stage. Following Workshop 4, an Options and Impacts Report is prepared, which will form the basis of social and economic evaluations. The other three reports shown in Figure 4 (*ie* Background Report, Scoping Report and Technical Report) can be appended to the Options and Impacts report to provide a complete record of the process.

Evaluation of the optional management and environmental flow scenarios, and identification of the potential environmental risks of each scenario is a crucial part of the best practice framework. Several Australian environmental flow methodologies have employed a process for evaluating environmental risks, of which the most quantitative is the benchmarking process developed as part of the Fitzroy basin WAMP (DNRQ 1998, Vanderbyl 1998).

9. Social and Economic Evaluations

The next step is an evaluation of social and economic implications of optional management scenarios. The bulk of this is undertaken by relevant analysts but there should be interaction with the study team to receive their input into final consideration of environmental flow options once the social and economic implications are understood. This phase also involves consideration of alternative ways to deliver environmental flows, or to improve environmental conditions by other mechanisms (*eg* alternative infrastructure arrangements, adjustments to channel morphology to accommodate the modified flow regime, creation of habitat refugia or installation of a fish ladder, *etc*). Ecologists and geomorphologists should be involved as they can make a significant contribution to the work of engineers and planners by suggesting alternative ways to deliver environmental flows or strategies for improving environmental conditions by other mechanisms. Engineers and planners working independently of ecologists may not foresee all of the options.

The best practice framework includes an evaluation of the social and economic implications of alternative flow management scenarios.

The final outcomes at this point is the selection of one environmental flow scenario for implementation and monitoring.

10. Review Workshops

The best practice framework suggests that regular workshops should be held to evaluate the outcomes of routine monitoring and discuss the results in relation to the ecological

outcomes predicted from environmental flow allocations. These workshops should consider the need for adjustments to the environmental flow allocations and recommend any necessary changes. The timing of the first workshop would be related to the expected timing of delivery of the first monitoring results (suggested timeframe of 1-2 years). At this time, the results of some special investigations should also be available for input into the revised environmental flow regime.

The process of monitoring, special investigations, review of outcomes and adjustment of environmental flow regimes should continue for a lengthy period after implementation of environmental flows. Monitoring and investigations/research should be undertaken by key members of the original study team, to ensure continuity and to standardise monitoring methods.

This process of hypothesis generation and testing through monitoring and research is essential to strengthen the particular flow assessment, and to improve understanding of river ecology and processes driven by the flow regime. Without it, environmental flow strategies will continue to be based on simplistic or surrogate measures of biological requirements and ecological processes. A carefully designed program of monitoring and research linked to environmental flow assessments represents a major opportunity to increase and broaden our understanding of riverine ecology and effects of flow regulation in Australia.

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WET TROPICS MANAGEMENT AUTHORITY

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PART 2
(of 3)

Environmental Assessment Guide: Development and Maintenance of Water Extraction Infrastructure In the Wet Tropics World Heritage Area

Prepared by
Natural Resource Assessments Pty Ltd
For
Wet Tropics Management Authority
2 September 1999



Koombooloomba Dam *Photo: WTMA*

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1. INTRODUCTION

1.1 Aims

This Environmental Assessment Guide aims to provide officers of the Wet Tropics Management Authority (the Authority) with direction and assistance in assessing and determining permit applications for water infrastructure maintenance, operation and development in the World Heritage Area. Specifically it aims to:

- provide generic Terms of Reference for permit applications for maintenance works associated with infrastructure
- provide generic Terms of Reference for Environmental Impact Assessments associated with water infrastructure development and operation
- develop guidelines for assessment and setting of conditions in relation to permit applications associated with water infrastructure development, maintenance and operation
- specify practical measures (including performance indicators) for ongoing environmental monitoring of waterways subject to significant disturbance through water extraction.

It is envisaged that the Environmental Assessment Guide will be adopted by the Authority under Section 62 of the *Wet Tropics Management Plan* 1998. Section 62 states the Authority may prepare guidelines containing information relevant to the principles and criteria for deciding permit applications and that the Authority "must have regard to the information in the guidelines" when assessing a permit application.

1.2 Structure of Document

Section 2 details the **permit requirements** for various activities related to water extraction. Appropriate **Terms of Reference** for activities are outlined in **Section 3.**

Guidelines for assessing applications are provided in **Section 4** whilst **guidelines for setting permit conditions and monitoring requirements** are outlined in **Sections 5 and 6** respectively.

1.3 Definitions

The following definitions apply to these Codes of Practice.

Area: Wet Tropics World Heritage Area.

Authority: Wet Tropics Management Authority.

Community Water Supply Infrastructure: Infrastructure managed by an agency for the supply of urban, rural or industrial water resources (including hydro-electrical facilities) to the community.

Domestic Water Supply: Water extracted for domestic use by a Private Land holder, Native Title holder, or another person carrying out domestic activities on a Private Land holder's or Native Title holder's land. *Extraction for Commercial Purposes is not permitted.*

Maintenance: works taking place within the existing infrastructure formation footprint.

Native Title holder: Native Title holder with a Native Title entitlement as defined by the Native Title Act 1993.

Private Land holder: Freehold Title holder as defined under Ordinary Title holder in the Native Title Act 1993.

Permit: Permit under the *Wet Tropics Management Plan 1998*.

Plan: *Wet Tropics Management Plan 1998*.

Upgrade: - widening/enlarging roads or car parks
- developing existing structures
- increasing extraction regimes in excess of that lawfully permitted before the Plan commenced (1 September 1998).

2. PERMIT REQUIREMENTS

2.1 Regulation of Water Supply Activities within the World Heritage Area

2.1.1 Regulated Activities

The World Heritage Area and legislation overlies existing land tenure. WTMA functions do not involve day-to-day land management. There are more than 620 separate land parcels within the World Heritage Area, the majority of which is owned and managed by the State of Queensland. Currently, two major public land management/owner stakeholders exist, between them managing the day-to-day responsibilities of around 90 percent of the World Heritage Area. These are:

- Queensland Parks and Wildlife Service (QPWS)
- Queensland Department of Natural Resources - Resource Management (DNR)

Existing water infrastructure located on State lands requires approval from the relevant land managers who are responsible for regulating water extraction from Protected Areas.

Other agencies that issue approvals for water extraction include:

- Department of Natural Resources - Water Resources (*Water Resources Act 1989*)
- Environment Australia (*EPBC Act*)

The potential for Native Title to exist within the World Heritage Area may in the future affect the make-up of prominent land management/owner stakeholders.

2.1.2 The *Wet Tropics Management Plan 1998*

The Wet Tropics Management Plan commenced operation on 1 September 1998. In general, the Plan regulates activities within the World Heritage Area that could potentially impact on World Heritage values *eg* destruction or disturbance to native vegetation, watercourses or earth. Where the installation, maintenance and operation of water supply infrastructure is associated with such disturbances, there will be a need to assess the activity under the Plan. Details of all activities regulated within the Area are given under Part 3 of the Plan. **Table 1: WTMP Land Use Controls Relevant to Water Supplies** provides a summary guide for activities typically associated with water supply.

2.1.3 Assessment of water extraction activities under the plan

Generally, a permit is required to undertake maintenance, operation and development of water extraction infrastructure within the Wet Tropics World Heritage Area. Water extraction infrastructure operating prior to the commencement of the Plan requires a permit for its maintenance only. Under section 27(j) of the Plan, a permit is not required to continue operation of such infrastructure (refer to the list of existing community water supply infrastructure provided below).

The development and operation of new infrastructure or upgrading of existing infrastructure requires additional approval under the Plan. In general, a permit may only be issued where the proposed development or upgrade is within Zone C or Zone D. The Plan does provide for consideration of development proposals within Zone B for essential community infrastructure. This requires a rezoning application by a Local Government in accordance

with Schedule 1 of the Plan. Details can be found in the *Guide for development of new water extraction infrastructure*.

The above information also applies to land holders with domestic water supplies. A permit **must** be issued for extracting water for domestic purposes to Private Land holders or Native Title holders with land in the Area, albeit with conditions. A condition may be that the land holder must comply with the Authority's Code of Practice for water extraction.
NB: known existing domestic operations were reviewed following the commencement of the Plan in 1998/99 and at this point in time have been assessed as having a minor & consequential impact not requiring a permit. Any new development proposals are more likely to require a permit.

Table 1: WTMP Land Use Controls Relevant to Water Supplies

Prohibited Activity	**User Type**	**Exemptions to Prohibition**	
		Allowed under Permit	**Allowed without permit**
disturbing native plants, earth and waterways • destruction • disturbance • taking of	General	**firebreaks:** building a firebreak **clearing around a structure or road:** clearing vegetation around a structure or road (only) to the extent necessary for its appropriate use **earthworks, zone C or D (refer Figure 1):** disturbing earth *eg* excavating, quarrying, grading in Zone C or D **waterworks, zone C or D (refer Figure 1):** disturbing a watercourse in Zone C or D	**firebreaks:** maintaining an existing fire break **burning:** burning vegetation other than in a rainforest **grazing animals:** but not in a rainforest
	Freehold and native title	**water for domestic use:** extracting water for domestic use (a permit must be issued) **house garden or orchard:** establishing a house garden or orchard other than for commercial purposes (a permit must be issued)	**protection, conservation or rehabilitation:** an activity for the protection, conservation or rehabilitation of world heritage values
undesirable plants • planting • cultivating • disposing of	General	**killing or disposing of**: (as listed in Schedule 2 of the Plan)	
structures, roads, walking tracks • building or maintaining	General	**walking tracks - all zones:** building or maintaining a walking track **structures and roads - permitted Zone C or D only (refer Figure 1):** building or maintaining a structure in Zone C or D **Zone B impact reduction (refer Figure 1):** an activity in Zone B that would reduce impacts on the WHA	

Prohibited Activity	User Type	Exemptions to Prohibition	
		Allowed under Permit	**Allowed without permit**
	Government agencies		**community services infrastructure:** the operation of community services infrastructure being lawfully operated immediately before 1 September 1998
waste • disposal of	General		**in a proper receptacle**
	Freehold and native title		**disposal on the land:** (refer s29 for conditions)

2.2 Community Water Supply Infrastructure

Community water supply infrastructure is that managed by an agency for the supply of urban or industry water resources, including hydro-electricity facilities.

Infrastructure Developments and Upgrades:

Developments and upgrades include:

- all infrastructure, not just that associated with the immediate water supply facility *eg* access roads to the facility, energy supplies to operate the facility
- upgrades to existing structures *ie* changes to extraction regimes in excess of that lawfully permitted before the Wet Tropics Plan commenced (1 September 1998).

In general, a permit may only be issued where the proposed development is within Zone C or Zone D. The plan does provide for consideration of development proposals within Zone B for essential community infrastructure, obviously the demonstration of "community need" would be a primary consideration in deciding such applications. Given the potential for impacts associated with any new development it is likely that an Environmental Impact Assessment would be required.

Douglas Shire Council	Rex Creek Intake Martin Creek (Daintree) Intake Little Falls Creek (Whyanbeel) Intake
Mareeba Shire Council	Hunter Creek (Mt Molloy) Intake
Cairns City Council	Copperlode Dam Stoney Creek Intake Bessie Point Intake Freshwater Intake Behana Gorge Intake Fishery Falls Intake Bellenden Ker (Junction Creek) Intake Frenchman's Creek (Babinda) Intake Bartle Frere / Woopen Creek Intake Bramston Beach Minor Intake Bramston Beach Major Intake

Herberton Shire Council	Herberton Intake (Wild River)
Johnstone Shire Council	Nyletta Intake Jurs Creek Intake
Cardwell Shire Council	Meunga Creek (Cardwell) Intake Boulder Creek (rural) Intake Bulgan Creek (Tully) Intake
Thuringowa Shire Council	Paluma - Crystal Creek
Stanwell Power Council	Kuranda Weir Koombooloomba Dam/Kareeya Power Station

Maintenance and Operations

Maintenance of infrastructure will require a permit where the maintenance involves more than minor and inconsequential impacts. The document *Codes of Practice for Water Extraction in the Wet Tropics World Heritage Area* (WTMA, 1999) will be the basis for development of conditions associated with such maintenance.

Operation of community water supply infrastructure is the actual operation of equipment to abstract water. Under section 27(j) of the Plan, a permit is not required to continue such operations where they were being undertaken prior to commencement of the Plan on 1 September 1998 (the box above provides a list of existing community water supply infrastructure in the Area). Any changes to these operations (for example a new abstraction regime) would, however, require a permit application.

2.3 Domestic water supplies

The above information also applies to land holders with domestic water supplies. A permit **must** be issued for extracting water for domestic purposes to Private Land holders or Native Title holders with land in the Area, albeit with conditions. A condition may be that the land holder must comply with the Authority's Code of Practice for water extraction. *NB: known existing domestic operations were reviewed following the commencement of the Plan in 1998/99 and at this point in time have been assessed as having a minor & consequential impact not requiring a permit. Any new development proposals are more likely to require a permit.*

3. TERMS OF REFERENCE

3.1 Introduction

Terms of Reference define the information requirements needed by the Authority in order to determine a permit application.

The generic Terms of Reference presented here have been developed to assist in the identification of the types of activities which may potentially impact on the environment, rather than setting terms for specific activities which may relate to a particular development proposal.

The Terms of Reference have been prepared with reference to:

- Principals and criteria for deciding permit applications under Part 4 Division 2 of the Plan
- *Protection through Partnerships* (WTMA, 1997), the Authority's policy guidelines for management of the Area
- *ANZECC Guidelines and Criteria for Determining the Need for and Level of Environmental Impact Assessment in Australia* (ANZECC, 1996)
- other environmental considerations particularly characteristic of the Wet Tropics biogeographic region.

3.2 Community Water Supply Infrastructure

Infrastructure Development and Upgrades

Proposals for new infrastructure shall demonstrate the "need" for the development. It is likely that a detailed and comprehensive Environmental Impact Assessment (EIA) will be required for such proposals. The minimum Terms of Reference required to be fulfilled in the preparation of an EIA are provided in Appendix A. Terms of Reference address biophysical, ecological, cultural and social issues associated with the development.

The Terms of Reference for an upgrade to infrastructure will be commensurate with the scale and potential impact of the proposal.

Maintenance and Operations

The following generic Terms of Reference apply:

1. **Location:** Site where works will be carried out (location and extent of works indicated on map). Zone under the *Wet Tropics Management Plan* 1998.
2. **Other Approvals Held/Required/Applied For**: for example licenses under the *Environmental Protection Act* 1994, *Water Resources Act* 1959, *Forestry Act* 1989.
3. **Duration of Permit**: What is the requested duration of the permit? The Authority encourages applications to cover planned maintenance for a 3 year period.
4. **A Description of the Proposed Works and/or Operations:**
    - **Proposed Activities:** describe the proposed maintenance and operational activities. These may include:
        - extraction regimes: existing regime, any proposed changes (note that any changes to extraction regimes in excess of that lawfully permitted before the Plan commenced are considered upgrades to infrastructure)
        - earthworks, including road and track maintenance
        - vegetation clearing
        - painting and cleansing
        - cleaning of screens and intakes
        - desilting

- maintenance of water treatment facilities
- maintenance and use of hazardous chemical storages including generator facilities
- maintenance of visitor facilities (including toilet facilities).

- **Prudent and Feasible Alternatives:** describe prudent and feasible alternatives which might have less impact on integrity of the Area. For example consider:
  - the need for the works
  - alternative methods of carrying out the activity
  - alternative products
  - alternative timing for the activity
  - increasing the life cycle of the activity (that is, carrying out a higher level of maintenance to decrease the maintenance frequency).
- **Conformance with Established Practices:** are techniques in conformance with established practices (for example the *Codes of Practice for Water Extraction in the Wet Tropics World Heritage Area*, WTMA, 1999)? Are any new techniques proposed and are these proven?

5. Character of the Environment: provide a broad description of the environment:

- river/stream affected
- ecological values of the riverine system and level of knowledge of these
- any known areas, sites or values of high natural, heritage significance (*eg* refer to *Conservation Values of Waterways in the Wet Tropics World Heritage Area,* WTMA, 1999)
- level of existing impacts or degradation *eg* extent of weeds
- cultural values
- community use values.

6. Impact Considerations:

NB Short-term and long-term impacts, upstream and downstream impacts, and cumulative impacts should be considered.

- **World Heritage Integrity:** consider the likely impact of the proposed activity on the Area's integrity including:
  - altered extraction regimes (possible impacts include changes in hydrological regime, altered stream geomorphology, loss of habitat, deterioration in water quality)
  - earthworks including road and track maintenance (possible impacts include erosion and sedimentation, loss of habitat, turbidity, bank destabilisation)
  - vegetation clearing (possible impacts include fauna barriers, weed ingress, feral animal ingress, introduction of disease)
  - painting and cleaning (possible impacts include soil contamination, water pollution)
  - cleaning of screens and intakes (possible impacts include turbidity, sedimentation)
  - desilting (possible impacts include sedimentation, loss of habitat)
  - maintenance of water treatment facilities (possible impacts include soil contamination and water pollution)
  - maintenance and use of hazardous chemical storage including generator facilities (possible impacts include soil contamination and water pollution)
  - maintenance of visitor facilities including toilet facilities (possible impacts include erosion and sedimentation, bank destabilisation, decreased visual amenity).
- **World Heritage Values:** consider the likely impacts on World Heritage values including:

- presumed extinct, endangered, vulnerable or rare wildlife under the *Nature Conservation Act* 1992
- habitat of the above
- other threatened plant or animal communities
- natural ecological processes (particularly instream processes)
- cumulative impacts of the activity and any other activities being carried out or planned in the same catchment
- scenic amenity.

7. **Community Implications:** the social, economic and cultural effects of the activity on:
   - Land holders, Native Title holders and other Aboriginal persons.
   - amenity (*eg* noise, visual, traffic), including experiences currently enjoyed by visitors
   - the community's ability to participate in management, protection, presentation, enjoyment and ecologically sustainable use of the area (catchment).
8. **Precautions to Prevent, Minimise and Monitor Impacts:** for example, an Environmental Management Plan which has been developed for the activity.

3.3 Domestic Water Supplies

As stated earlier, all known existing domestic operations were reviewed after commencement of the Plan in 1998/99 and, at this point in time, have been assessed as not requiring a permit. Any new development proposals however are more likely to require a permit. Generic Terms of Reference for any new domestic water supplies include the following:

1. **Identity of Applicant:**
   - name and address of applicant
   - contact details
2. **Location:**
   - name of watercourse (location indicated on 1:50,000 topographic map)
   - address of property
   - Real Property Description
3. **Land holder status:**
   - Private Land holder
   - Native Title holder
   - permission of above land holder to carry out proposed activity
4. **Duration of Permit**: what is the requested duration of the permit? The Authority encourages applications to be for a 3 year period.
5. **A Description of the Proposed Works:**
   - location of water supply equipment and associated structures
   - the "need" for the water extraction
   - a description of the extraction method and equipment to be used, *eg*:
     - pump (type of pump, make, model number, capacity)
     - storage equipment (for water supply and/or fuel)
     - pipework (diameter and type of pipe)
     - instream works (*eg* weirs, anchor points)
     - near stream works (*eg* clearing of access for pipeways)
     - access requirements

- volume of water required per annum
- does the proposed extraction method conform to the Authority's codes of practice for private domestic water supplies (in *Codes of Practice for Water Extraction in the Wet Tropics World Heritage Area,* WTMA, 1999)?

6. **Character of the Environment:** provide a broad description of the environment:
   - any known ecological values of the riverine system (the Authority may provide information and assistance if values are unknown)
   - level of existing impacts or degradation (*eg* extent of weeds, extent of clearing, existing bank erosion)
   - any known cultural values
   - any known community use (*eg* recreational).

4. PERMIT APPLICATION ASSESSMENT GUIDE

The Plan provides a listing of broad criteria for assessing the suitability of an application for a potentially impacting activity within the Wet Tropics region. Relevant sections include:

Part 4 (Division 2):
Principles and criteria for deciding permit applications

s56
The most important consideration for deciding the application is the likely impact of the proposed activity on the Area's integrity.

s57
The Authority must decide the application under the principle that, if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

s58
The Authority must consider whether there is any prudent and feasible alternative to a proposed activity. In deciding whether an alternative is prudent, the Authority must consider the likely impacts of the alternative on the Area's integrity compared to that of the proposed activity.

s59
The Authority must decide the application in a way that minimises the likely impact of the proposed activity on the Area's World Heritage values.

s60
The Authority must have regard to the effects of the decision on the Private Land holder, any Native Title holder, and Aboriginal persons particularly concerned with the land, or the amenity. It must also consider continued involvement within the Area and other relevant social, economic and cultural effects.

s61
The Authority must have regard for the carrying capacity of the land.\

Part 5 (Division 4):
Permit applications for particular activities

s63
The Authority must issue a permit for an activity necessary to extract water for domestic use. This does not limit the Authority's power to issue the permit with conditions.

4.1 Assessing a Permit Application

In assessing the Permit Application consideration must be given to:

- impacts normally associated with the type of activities proposed
- impacts normally associated with the type of site under consideration
- whether all potential impacts are manageable within acceptable limits
- whether the level of certainty or prediction of any impact is sufficiently high to be confident about not encountering unforeseen problems
- whether the potential impacts are likely to have cumulative, long or short-term, or irreversible implications.

The information provided in the Permit Application must also be considered in the light of current knowledge of the conservation values of the affected sub-catchment. This information is documented in the Authority's *Conservation Values of Waterways in the Wet Tropics World Heritage Area* (WTMA, 1999).

Conservation values were assessed in terms of ten key attributes:

- ecosystem function values
- presence of taxa of rheophytic plants of conservation interest
- presence of taxa of aquatic plants of conservation interest
- diversity of freshwater invertebrates
- presence of taxa of crustacea of conservation interest
- presence of taxa of freshwater fish (including important fish habitat and areas of high fish diversity) of conservation interest
- presence of taxa of frogs of conservation interest
- presence of taxa of freshwater turtles of conservation interest
- regional ecosystems of specific conservation interest
- distinctive flow regime types and/or flow needs.

Based on the assessment of these attributes each sub-catchment has been classified as:

1. **Very High Conservation and Ecological Value**. No extraction will be permitted (*ie* precautionary principle exercised).
2. **High Conservation and Ecological Value**. Extraction may proceed following direct assessment only if impacts deemed acceptable; or
3. **Moderate Conservation Value**. Extraction can occur with conditions.

It should be noted that the scheme above does not include a category in which streams or sub-catchments of poor or low conservation value might be included as it was considered that sub-catchments of such low quality would not occur within the boundaries of the WTWHA.

The checklist in the following table should be used to assist in the assessment of a Permit Application. The Assessment Summary (at the end of the table) provides a mechanism for confirming that the principles and criteria for deciding a permit application as defined in the Plan (Part 4, Division 2) have been addressed.

Checklist for Water Infrastructure Development, Operation and Maintenance	Has this been considered in permit application? Yes/No/NA	Implications	Action/Condition Required
• Is proposed activity located within the WHA?			
• Will the proposed activity occur within Zone A or Zone B			
Will the proposed activity occur on land subject to special protection, status or Native Title determination?			
• National park			
• Conservation area			
• Resources refuge			
• Nature refuge			
• Co-ordinated conservation area			
• Wilderness area			
• Land subject to Native Title determination			
• Cooperative management agreement area			
The application should demonstrate consideration of environmentally significant areas: ***Physical Attributes***			
• geological formations of local, regional or other significance			
• waterways of local, regional or other significance			
• areas adjacent to geological or hydrological features of significance			
Ecological Attributes			
• areas providing or potentially providing habitat for other threatened/ rare/restricted or otherwise significant fauna or flora species (terrestrial and avifaunal)			
• recognised/postulated area of endemism			
• threatened regional community/ecosystems contained in or connected to the area			
• unlogged or undisturbed forests contained in or connected to the area			
• remnant vegetation contained in or connected to the area			
• wildlife corridor or refuge			
• culturally significant areas			

Checklist for Water Infrastructure Development, Operation and Maintenance	Has this been considered in permit application? Yes/No/NA	Implications	Action/Condition Required
The application should demonstrate consideration of potential impacts of the proposed activity on: ***Physical Factors***			
• possible alterations to wetland/swamp/mangrove/lake or estuarine ecosystems			
• the area of land disturbance			
• possible erosion, subsidence or instability, or soil contamination			
• use of the area for a special purpose (eg defence/communication)			
Water			
• the volume of water or the frequency and variation in water flow within waterways likely to be altered by the activity			
• any impacts of the activity likely to be evident in the estuarine areas of the river			
• likely effects on water quality			
• increases in erosion and sediment input into waterways			
• any likely contamination of waterways			
• alteration of drainage patterns, including water table disruption			
• likely effects on surface and ground water supplies in the area			
Biological Factors			
• likely impacts on significant flora or fauna species (aquatic, terrestrial and avifaunal) through extinctions, reduced reproductive viability, changes in community structure, increased susceptibility to rapid change (and hence higher probability of extinction), changes in genetic composition etc			
• likely increases in weed or pest species (aquatic and terrestrial)			
• likely effects on inter-relationships between fauna & vegetation (both instream & riparian)			
• risk of creation of barriers to instream fauna movement (either upstream or downstream)			
• alteration of instream and/or riparian habitat distribution *eg* through inundation			
• likely inter-basin transfer of species			

Checklist for Water Infrastructure Development, Operation and Maintenance	Has this been considered in permit application? Yes/No/NA	Implications	Action/Condition Required
• impact on important aquatic or riparian habitats (*eg* low flow areas in the breeding season)			
• likely impacts of noise on fauna			
• likely increases in unnatural night-time illumination			
• likely impacts on biodiversity			

Checklist for Water Infrastructure Development, Operation and Maintenance	Has this been considered in permit application? Yes/No/NA	Implications	Action/Condition Required
Infrastructure			
• any likely increased demand on services/infrastructure			
• impact on existing infrastructure *eg* roads, telecommunication cables, power lines			
Aesthetics/Amenity			
• impact on any aesthetic or scenic values of the area			
• is it in an area, or within the viewshed of an area, of high visitor use?			
• possible obstruction of views			
Air and Noise			
• likely impacts on air quality			
• likely impacts of noise on neighbours			
Social			
• possible decline in water supplies downstream			
• interference with existing uses of the waterway			
• any need for the development of access infrastructure and associated impacts such as land resumption			
• likely changes in the condition of recreational sites			
• how waste will be handled and disposed of			
• possible curtailment of alternative beneficial uses of the area			
• increased demands on natural resources in local short supply			
• any significant effects on the livelihood of existing users			
• impacts on the regional and state economy			
Cultural Heritage			
• likely impacts on cultural heritage (indigenous and non-indigenous)			
• likely extent to which native title rights and interests may be affected			

Assessment Summary	Yes	No	Qualification
Have impacts on World Heritage values and integrity been identified and adequately considered?			
Have prudent and feasible alternatives (including demand management) been adequately considered.			
Is the level of cumulative impacts likely to be acceptable?			
If any potentially serious and irreversible impacts have been identified, have they been addressed using proven or valid techniques which will prevent environmental degradation?			
Are the proposed techniques, practices, equipment and scheduling the most appropriate given the values of, and potential impacts on the area?			
Will Private Land holders be negatively impacted?			
Will Native Title holders or other Aboriginal people concerned with the land be negatively impacted?			
Are there any unacceptable impacts on the community's sustainable use and involvement in the area?			
Is there a system in place to ensure that the activity can be carried out in accordance with the permit application and any conditions on the permit?			

NB: If a shaded box is ticked the application should be refused, or granted with conditions.

5. SETTING CONDITIONS

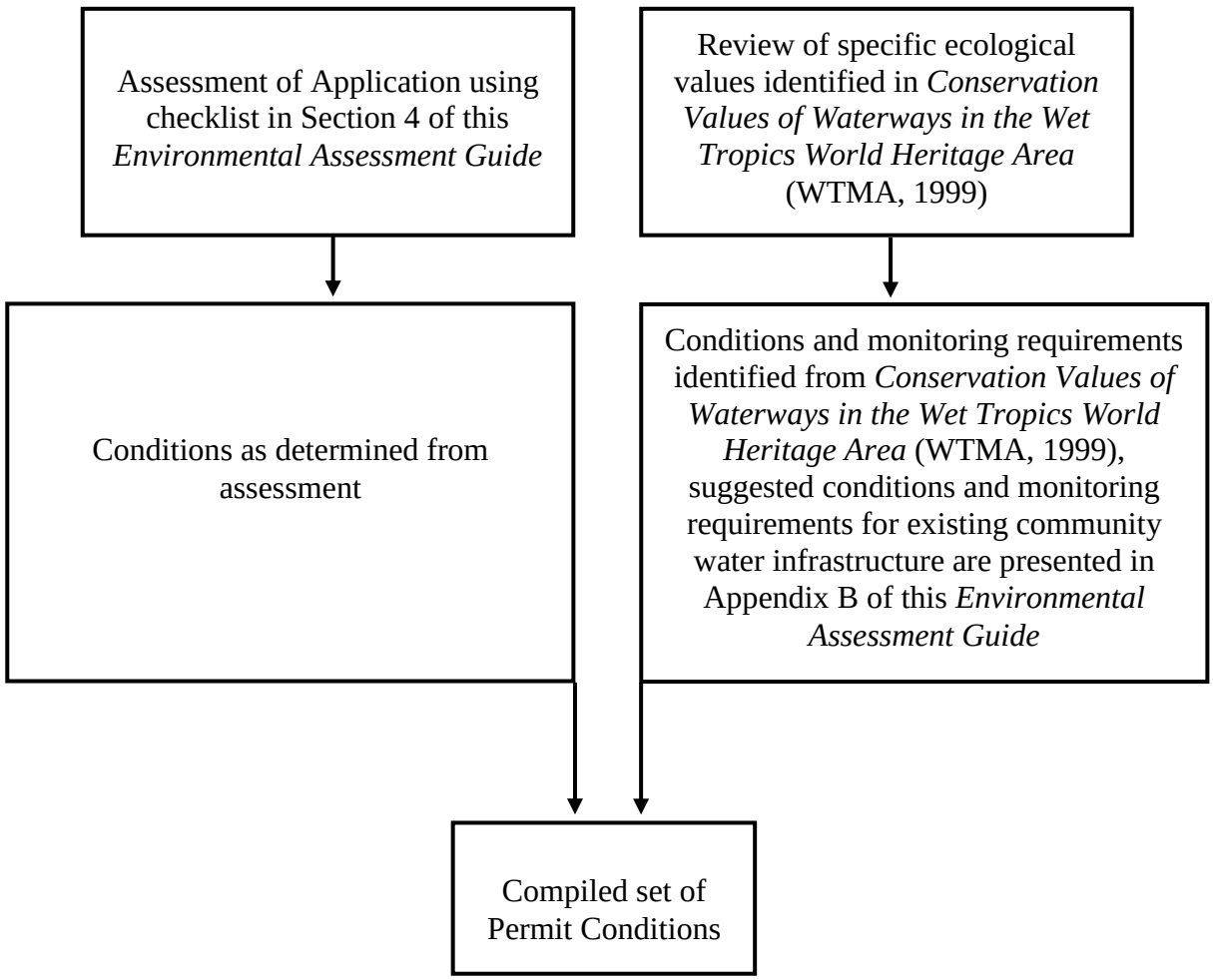
5.1 Setting Conditions for Permits

Conditions to accompany approved permits are required to ensure protection of World Heritage values and in particular specific ecological values identified for a sub-catchment.

Conditions are determined by the process illustrated below. Conditions may include monitoring requirements.

Suggested initial operation and maintenance conditions for existing community infrastructure are provided in Appendix B.

Flow Chart to illustrate how conditions accompanying approved permits are derived



6. MONITORING

6.1 Performance Indicators

A performance indicator defines the attribute which will be measured to indicate the level of impact. The indicator must be practical and easily measured given the nature of the activity.

6.2 Intervention Thresholds

An intervention threshold defines the point at which action will be taken by the Authority to prevent/reduce impacts. This is established by reference to performance indicators.

6.3 Response Mechanisms

A response mechanism nominates the process by which corrective action will be taken. This will involve referral to a Reference Panel. The Reference Panel will establish possible corrective action. Stakeholder negotiations will then be required to arrive at agreed actions and timeframes.

6.4 Reference Panel

The composition of the Reference Panel is dependent on the issues to be addressed. A core group should consist of:

- the Authority
- a freshwater ecologist
- a community representative
- an Aboriginal liaison representative.

The core group will need to be able to draw on specialists in the following areas as required: geomorphologist, hydrologist, invertebrate ecologist, aquatic botanist, botanist, limnologist, water chemist, zoologist (amphibians), freshwater fish ecologist.

7. REFERENCES

ANZECC (Australia and New Zealand Environment and Conservation Council) 1996, *Guidelines and Criteria for Determining the Need for and Level of Environmental Impact Assessment in Australia.* Australia and New Zealand Environment and Conservation Council. http://www.environment.gov.au/portfolio/epg/eianet/eia/anzecc_criteria.html.

WTMA (Wet Tropics Management Authority) 1999, *Codes of Practice for Water Extraction in the Wet Tropics World Heritage Area*, 1999.

WTMA, 1999, *Conservation Values of Waterways in the Wet Tropics World Heritage Area,* 1999.

WTMA, 1997, *Protection through Partnerships. Policies for Implementation of the Wet Tropics Plan*. WTMA, Cairns.

APPENDIX A

TERMS OF REFERENCE

Terms of Reference for Environmental Impact Assessment (EIA)

1. Introduction and purpose of the EIA.

2. The need for the development including the:
   - feasibility of the proposal and alternatives
   - demand management initiatives considered for implementation

3. Description of existing physical environment:
   - Flora (terrestrial and riparian) - describe the vegetation communities, including:
     - extent and location of native vegetation communities and their bioregional significance, both in the area of the primary impact and any subsequent impact areas (*eg* inundation areas)
     - existence of any rare, threatened or otherwise noteworthy species or communities, both in the area of the primary impact and any subsequent impact areas
     - existence of any species of declared plants and any weed management methods recommended by local agencies
     - significance of vegetation to native wildlife
     - World Heritage values of terrestrial and riparian flora of the area and related ecological processes.
   - Flora (aquatic) - describe the aquatic vegetation in the study area, including:
     - extent and location of aquatic vegetation communities
     - presence of rare, threatened or otherwise noteworthy aquatic species or communities downstream of the site, or within upstream watercourses which may be impacted
     - presence of any species of declared plants, and any weed management methods recommended by local agencies
     - significance of vegetation to native wildlife
     - World Heritage values of aquatic flora of the area and related ecological processes.
     - Fauna (terrestrial and riparian) - describe the fauna present or likely to be present in the study area, including:
     - species habitats on and about the area of primary impact and any subsequent areas of impact (riparian, terrestrial and avifaunal)
     - presence of rare, threatened or otherwise noteworthy aquatic species or communities downstream of the site, or within upstream watercourses which may be impacted
     - provide comment on movement corridors and barriers to movement of any species affected by construction and operation.
     - the existence of any species of feral animal and any suitable eradication/management programme
     - World Heritage values of the terrestrial and riparian fauna of the Area and related ecological processes.

- Fauna (vertebrate and invertebrate aquatic) - describe the aquatic fauna present in the study area including:
  - the extent and location of aquatic fauna species habitat upstream and downstream of the site
  - presence of rare, threatened or otherwise noteworthy aquatic species or communities downstream of the site, or within upstream watercourses which may be impacted
  - provide comment on ecological processes and movement corridors and barriers to movement of any species affected by construction and operation. Discuss options for mitigating such impacts, *ie* fish transfer devices
  - the presence of any fish species of importance for recreation or commercial fisheries both upstream and downstream of the site
  - World Heritage values of the aquatic fauna of the area and related ecological processes.
- Soils/Geology/Terrain - provide details of the soils, geology and terrain of the study area including:
  - bioregional ecosystems
  - extent of any inundation based on terrain
  - potential sources of gravel, rock, sand and other suitable materials for use in the construction
  - any geological formations, or areas, of known medium to high porosity within any inundation area, or any water storage site
  - the presence of any acid sulphate soils within any inundation area or any water storage site
  - any mining leases or areas of known geological or mineral value
  - any geological monuments or terrain of particular scientific or aesthetic value should be noted
  - World Heritage values of geological, geomorphic or physiographic processes evidenced in the area.
- Air - provide details of the air quality of the study area and surrounding environs including:
  - prevailing wind conditions within the catchment and surrounding areas
  - sources of air pollution and contamination within the catchment area and sources outside the catchment which affect air quality within the catchment
  - potential impacts on air quality as a result of construction.
  - Water - provide details of:
  - water quality within the study area, as well as upstream and downstream of this point, and the potential impacts of the proposed development on water quality (in physio-chemical and biological terms)
  - historical flow rates within the river and the potential impacts of the proposed development on flow
  - the potential likelihood of blue-green algae blooms and infestation by other aquatic weeds as a consequence of construction and operation of the infrastructure.

4. Description of the Social Environment
   - Socio-Economic Environment - describe the existing socio-economic characteristics of existing communities likely to be affected by the infrastructure development including:
     - existing and changing population characteristics of the area such as growth and distribution

- existing and changing residential and agricultural/pastoral nature of the wider area
- existing and required social infrastructure such as community support services, emergency services, leisure and recreation opportunities
- existing economic characteristics of local businesses and primary industry in the wider area
- describe the socio-economic impacts on the regional and state economy.

- Cultural Heritage
  - liaise with and establish a consultation framework with key indigenous groups and individuals
  - undertake research and consultation to identify the probable and known location of sites of indigenous and non-indigenous heritage value
  - include details of any cultural heritage studies, negotiations and outcomes to date
  - detail any buildings, structures or other facilities of particular cultural, historical, architectural, technological, spiritual or social importance
  - make reference to Native Title claims and claimants
  - develop a cultural heritage management plan.
- Aesthetic values
  - describe the broad aesthetic and landscape values of the proposed development site and any inundation areas, including a description of any significant views, focal points, ridgelines and any special features
  - describe those visual features of the landscape which meet World Heritage values
  - describe the disturbance to the existing and future landscape.
- Recreation
  - describe the broad recreation values of the proposed development and any inundation areas including a description of any significant areas and facilities
  - describe the types and intensities of recreation undertaken in the area
  - describe the disturbance to the existing and future recreation potential of the area.

5. Description of the Existing Resources and Infrastructure
   - Infrastructure - the proposed development may have the potential to impact upon items of existing infrastructure. To investigate the potential impacts the following should be addressed:
     - the nature and extent of impacts upon existing or gazetted roads
     - the nature and extent of any impacts upon access to private property *ie* through inundation of public or private roads
     - the nature and extent of impacts upon existing or gazetted rail lines and corridors
     - the nature and extent of any impacts upon private or government owned gas/water pipelines
     - the nature and extent of impacts upon any mode of public power transmission, particularly high voltage lines
     - the nature and extent of impacts upon any telecommunications cables.
   - Land Use:
     - describe the existing land use, land tenures, encumbrances, town planning provisions, Wet Tropics zoning, Native Title claims, Conservation Agreements, State Forest *etc*

    - determine if there are any contaminated sites or sources of contamination that could affect water quality if impacted upon by the development.
- Water Use and Environmental Flow:
    - discuss any existing or future Water Management Plans or Water Allocation Management Plan for the area including the mechanisms for determining environmental flow requirements of the system
    - describe the potential impacts of the development on water users within the catchment.
- Industry and Manufacturing:
    - describe the local and regional industrial and manufacturing water users and current average volume requirements for water. Outline the purposes for which the water is used.
- Primary Industries:
    - describe the primary industries undertaken within the catchment of the proposed development. Outline the extent and intensity of the primary industries undertaken
    - describe the extent and type of impacts on primary industries from the proposed development.

6. Analysis of Environmental and Social Impacts:
    - Describe the impacts on the environment, and particularly World Heritage values and integrity, which may occur as a consequence of the proposed infrastructure development, including direct and indirect, short and long-term impacts, as well as irreversible, adverse, beneficial and cumulative impacts.
    - Provide details of controls, safeguards, planning conditions and design features included in the project to minimise environmental impacts during construction, operation, maintenance and decommissioning phases of development.
    - Any potentially significant adverse impacts which cannot be satisfactorily mitigated shall be clearly described.
    - Amenity - describe impacts associated with:
        - development during the construction and operation phases of the project
        - community loss of amenity
    - Noise and Vibration:
        - detail the potential noise and vibration sources, the hours the noise source will be present and describe particular tonal, cyclic or impulsive characteristics pertaining to individual noise sources where relevant.
    - Public Utility Services:
        - detail possible disruptions or impacts, *ie* road location, on existing services. Provide details of planning for provision of future services and safety aspects of above ground services and structures where relevant.
    - Cultural Heritage:
        - provide an assessment of any likely effects on sites of cultural value (indigenous and non-indigenous).
    - Soils and geology - describe:
        - effects of soil erosion and sedimentation
        - stability of stream banks affected by the project

    - natural resources in relation to mineral and gravel deposits *etc*
    - effect on agricultural/pastoral land
    - control of acid sulphate soils (if present).
- Water quality - describe:
    - quality of water leaving the construction sites on the project
    - effects on surface and ground water supplies in the area, including downstream requirements for environmental flows
    - alteration to drainage patterns including water table disruption
    - effects on the quality of water downstream of the infrastructure, within the impoundment and within creeks and gullies upstream.
- Flora - describe:
    - the impact of clearing on any rare, threatened or otherwise noteworthy species
    - the impact of clearing on species diversity and movement corridors for wildlife
    - the impact on aquatic flora
    - the impact on riparian vegetation, especially downstream
    - significance of any clearing of vegetation to the vegetation remaining in the area, local amenity, landscape and visual effects
    - the significance and impact of any declared plants on the development and subsequent ecological impacts.
- Fauna - describe:
    - the effect of development on the native wildlife
    - impact of development on downstream and upstream aquatic fauna
    - impact on rare or threatened species
    - impacts on wildlife corridors
    - noise, vibration and inundation impacts on fauna
    - significance and impact of any feral animals on the local ecosystems affected by the development.
- Air - assess the:
    - potential air emission sources during construction and operation
    - dust nuisance during construction and operation.
- Climate - include:
    - impact of clearing vegetation
    - effect on construction
    - present and future impact of prevailing winds
    - possible climate change from greenhouse gases.
- Social - include:
    - investigation of the potential social stress and personal hardship resulting from a decision to undertake the development
    - potential for changes to land holders use of their land due to the development
    - potential impacts on areas or links of social value to the local community
    - impact on the values and aspirations of individuals and groups with an interest in the proposed development area
    - the social consequences of safety hazards during the construction and operation of the development

    - access to social services and emergency services during construction and operation.
- Land Use Planning - describe the:
    - land tenure directly and indirectly impacted upon by the proposal and, where possible, provide land requirements in terms of size and reason for requirement
    - Native Title claims affected.
- Economic - discuss the:
    - potential for adverse and beneficial impacts on existing and future business and agricultural/pastoral properties within, around, and downstream of any proposed inundation areas
    - potential impacts on property values
    - potential for loss of primary production and the follow-on impacts such as income loss in the immediate area and in the supporting industries
    - impact on the regional and state economy.
- Visual - describe the:
    - impacts of the proposal on landscaping and recreational proposals
    - the effects on the rural character of the landscape (where appropriate).
- Public consultation:
    - consultative process shall be established to identify issues of concern to individuals and community groups and measures and/or strategies to be incorporated into the proposal which could avoid or minimise potential issues of concern.
- Consultation with stakeholders should include:
    - Local Government interests
    - all relevant State Government Departments and agencies
    - Traditional Owners
    - relevant interest groups (*eg* Aboriginal groups, progress associations, farming or agriculture organisations, Chamber of Commerce, conservation groups)
    - directly affected property owners
    - elected representatives
    - other community-based groups identified as being important in relation to the project.
- Other:
    - potential impacts to residents not directly affected by any inundation zone and resumptions
    - treatment of any surplus land acquired for the proposal
    - public safety during the construction and operation of the proposed development.

7. Discussion and Conclusions - provide:
    - measures to mitigate any adverse impacts of the proposed development and enhance any positive impacts
    - a balanced overview of the environmental and social impacts of the proposed development

8. Recommendations:
    - recommendations for final design including (where applicable) fishways, environmental flows, submerged fish habitat and other relevant environmental issues to the proposed development.

9. Environmental Management Plan (EMP). The EMP should clearly define and separately list all activities which will potentially cause impacts and provide details of commitments to mitigate such impacts. Such commitments should define:
   - who will do the work, what the work is, when the work will be carried out and to whose satisfaction the work will be carried out
   - the means by which monitoring of any adverse impacts is to be undertaken
   - threshold levels to be applied to define any unacceptable impacts
   - procedures for reporting monitoring programmes
   - responsibility for monitoring and reporting arrangements
   - how to ensure safeguards are being effectively applied
   - how any unpredicted impacts requiring remedial measures are to be managed.

APPENDIX B

Suggested Initial Operation and Maintenance Conditions for Existing Community Water Supply Infrastructure

Based on reference to the Authority's
***Conservation Values of Waterways in the Wet Tropics World Heritage Area* (1999)**

Infrastructure: Behana Gorge Intake							
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for maintenance of flow regime and delivery of organic carbon to downstream reaches and in maintaining connectivity	3	Maintain existing flow regime	No alteration to extraction level. Disturbance to terrestrial vegetation to be preceded by baseline botanical survey Desilting of weir to occur when no water is flowing over the weir; or, desilting of weir to occur during high flow events during the wet season. Downstream turbidity to remain within 10% of upstream values during desilting. Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Rare and threatened species retained Turbidity measurements (at 1 hr intervals) at a point nominated by appropriate experts upstream and downstream during desilting (refer to *Queensland Water Quality Monitoring Manual,1995*)	<10% increase in extraction for wet and dry seasons over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction for wet and dry seasons over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	Habitat for *Waterhousea mulgraveana* and *Acacia hylanoma*	3	Maintain integrity of watercourse				
Aquatic plants	Habitat of *Torrenticola queenslandica*	1	Maintain existing flow regime				
Freshwater invertebrates	Several waterfalls (specialised habitat)	4	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	Sole geographic range of *Euastacus balanensis*	5					
Freshwater fish	High habitat value, habitat for species of conservation interest. Downstream reaches contain small populations of *Pseudomugil gertrudae* and *Melanotaenia maccullochi*	5					

Infrastructure: Behana Gorge Intake							
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Frogs	Full complement of highland rare and threatened species	5					
Freshwater turtles	Probable presence of morphological variant of *E aff dentata.*	3					
Regional ecosystems	Sustains endangered complex mesophyll riparian rainforest and melaleuca open forest	4	Maintain existing flow regimes				
Flow regime types	Constancy and magnitude of dry season flows need to be maintained. Stream flow within this catchment is the most predictable and constant in Queensland, if not Australia	4	Maintain flows in dry season				

Infrastructure: Rex Creek Intake							
Major Catchment: Newell, Mossman & Cook			**Subcatchment : Platypus**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Probably a major source of water and carbon for the Mossman River given subcatchment size	3	Maintain existing flows	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by baseline botanical survey Desilting of weir to occur when no water is flowing over the weir; or, Desilting of weir to occur during high flow events during the wet season Downstream turbidity to remain within 10% of upstream values during desilting. Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Rare and threatened species retained Turbidity measurements (at 1 hr intervals) at a point nominated by appropriate experts upstream and downstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction for wet and dry seasons over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction for wet and dry seasons over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	Records of *Buckinghamia, Waterhousea hedraiophylla* & stronghold of *Peripentadenia phelpsii*	5	Maintain integrity of watercourse and flow regime				
Aquatic plants			Maintain existing flows				
Freshwater invertebrates	Large waterfalls present which provide a specialised habitat (including Mossman falls)	4	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	*Euastacus fleckeri* recorded	5					
Freshwater fish	Contains *K. marginata* and good populations of *K. rupestris*	5					
Frogs	Highland areas contain 6 spp. of R&T frogs. Only species absent is *Litoria lorica*	5					
Freshwater turtles		?					
Regional ecosystems	Contributes to sustaining RE 7.3.5	1					

Infrastructure: Rex Creek Intake							
Major Catchment: Newell, Mossman & Cook			**Subcatchment : Platypus**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Flow regime types	Maintenance of habitat integrity during the dry season must be given high priority. Management of low flows must be given careful consideration	2	Maintain constancy and magnitude of dry season flows. Regulation should not alter flow pattern towards a greater difference between wet and dry season flows				

Infrastructure: Hunter Creek (Mt Molloy) Intake							
Major Catchment: Mitchell			**Subcatchment : Bushy**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for maintenance of flow regime and delivery of organic carbon to downstream reaches and in maintaining connectivity	3	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by baseline botanical survey Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse Desilting of weir to occur when no water is flowing over the weir; or, Desilting of weir to occur during high flow events during the wet season Downstream turbidity to remain within 10% of upstream values during desilting.	Monthly extraction levels Rare and threatened species retained Turbidity measurements (at 1 hr intervals) at a point nominated by appropriate experts upstream and downstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction for wet and dry seasons over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction for wet and dry seasons over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	Records of *Ostrearia* & likely provides habitat for *R. gralata*	3	Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high.	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	*Euastacus fleckeri* recorded for area	5		When performance indicators are breached a Reference Panel will establish possible corrective action.			

Infrastructure: Hunter Creek (Mt Molloy) Intake							
Major Catchment: Mitchell			**Subcatchment : Bushy**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Freshwater fish	Streams within subcatchments have perennial stream flow in contrast to similarly sized streams elsewhere within drainage. Fish fauna of distinctively different zoogeography to those fishes occurring in easterly flowing rivers of the WT region.	2					
Frogs	Contains all of the R&T Wet Tropics endemic frog species	5					
Freshwater turtles	Only subcatchments of the Mitchell River contained within the WTWHA likely to contain *Emydura tanybaraga* which is endemic to the Mitchell and Daly rivers	2					
Regional ecosystems	Contributes to sustenance of variants of RE 7.3.22	2	Maintain existing flow regimes				
Flow regime types	Perennial flow regimes more typical of systems east of the Great Dividing Range and essential for the continued survival of R&T frogs.	3	Maintain flows in dry season				

Infrastructure: Little Falls Creek (Whyanbeel) Intake							
Major Catchment: Newell, Mossman & Cook			**Subcatchment : Whyanbeel**		Conservation Value: High		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for maintenance of flow regime and delivery of organic carbon to downstream reaches and in maintaining connectivity	2	Maintain existing flow regime	No alteration to extraction level. Disturbance to terrestrial vegetation to be preceded by baseline botanical survey Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse Desilting of weir to occur when no water is flowing over the weir; or, Desilting of weir to occur during high flow events during the wet season Downstream turbidity to remain within 10% of upstream values during desilting.	Monthly extraction levels Rare and threatened species retained Turbidity measurements (at 1 hr intervals) at a point nominated by appropriate experts upstream and downstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction for wet and dry seasons over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction for wet and dry seasons over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	Records for *Neostrearia fleckeri*	2	Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high. Includes large waterfall (specialised habitat).	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish		2		When performance indicators are breached a Reference Panel will establish possible corrective action.			
Frogs	Highland areas contain R&T species typical of Mt Carbine region	3					
Freshwater turtles							
Regional ecosystems	Sustains endangered RE 7.3.7 & of concern RE 7.3.5	3	Maintain existing flow regimes				

Infrastructure: Little Falls Creek (Whyanbeel) Intake							
Major Catchment: Newell, Mossman & Cook			**Subcatchment : Whyanbeel**		Conservation Value: High		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Flow regime types	Maintenance of flow regime typical off the catchment must occur to ensure the diversity of flow regime types and associated natural processes within the WTWHA	2	Maintain constancy and magnitude of dry season flows. Regulation should not alter flow pattern towards a greater difference between wet and dry season flows				

Infrastructure: Fishery Falls Intake							
Major Catchment: Mulgrave			**Subcatchment : Fishery Falls**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for maintenance of flow regime and delivery of organic carbon to downstream reaches and in maintaining connectivity	3	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by baseline botanical survey Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse. Desilting of weir to occur when no water is flowing over the weir; or, Desilting of weir to occur during high flow events during the wet season Downstream turbidity to remain within 10% of upstream values during desilting.	Monthly extraction levels Rare and threatened species retained Turbidity measurements (at 1 hr intervals) at a point nominated by appropriate experts upstream and downstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction for wet and dry seasons over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction for wet and dry seasons over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	Habitat for *Syzygium boonjee*	2	Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Several water falls present (specialised habitat)	4	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	Potential habitat for *Euastacus balanensis*	4					
Freshwater fish	Rich in goby and Eleotrid species plus endemic species and WT endemic species. Important lowland tributary habitat	4		When performance indicators are breached a Reference Panel will establish possible corrective action.			
Frogs							
Freshwater turtles	Highly probable that it contains a morphological variant of *E.* aff. d*entata* given the distinctiveness of its fish fauna and the distributional pattern	3					

Infrastructure: Fishery Falls Intake							
Major Catchment: Mulgrave			**Subcatchment : Fishery Falls**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Regional ecosystems	Assists in the sustenance of RE 7.3.22 & significant lagoonal wetlands including endangered 7.3.6	5	Maintain existing flow regimes				
Flow regime types	Maintenance of the diversity of flow regimes within catchments is important to maintain diversity of community types within the WTWHA	4	Maintain constancy and magnitude of dry season flows. Regulation should not alter flow pattern towards a greater difference between wet and dry season flows				

Infrastructure: Frenchmans Ck (Babinda) Intake							
Major Catchment: Russell			**Subcatchment : Harvey**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Maintenance of high flows for maintenance of habitat integrity and connectivity with estuarine areas	3	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by baseline botanical survey Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse Desilting of weir to occur when no water is flowing over the weir; or, Desilting of weir to occur during high flow events during the wet season Downstream turbidity to remain within 10% of upstream values during desilting.	Monthly extraction levels Rare and threatened species retained Turbidity measurements (at 1 hr intervals) at a point nominated by appropriate experts upstream and downstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction for wet and dry seasons over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction for wet and dry seasons over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	Records for *Syzygium boonjee* and *Waterhousia hedraiophylla*	3	Maintain integrity of watercourse				
Aquatic plants	Likely that *Torrenticola* occurs	1					
Freshwater invertebrates	Invertebrate diversity high.	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	*Euastacus balanensis* recorded	5					
Freshwater fish	Very important fish habitat, contains morphologically distinctive population of *Pseudomulgil signifer* and is the only known location for the rare recently described goby *Stiphodon allen*	5		When performance indicators are breached a Reference Panel will establish possible corrective action.			
Frogs	Contains full complement of R&T species	5					

Infrastructure: Frenchmans Ck (Babinda) Intake							
Major Catchment: Russell			**Subcatchment : Harvey**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Freshwater turtles	Highly probable that this system would contain it's own morphological variant of *E. aff. dentata* given the distinctiveness of its fish fauna and the distributional pattern	3					
Regional ecosystems	Major feeders of Russell River wetlands containing endangered RE 7.3.3, 7.3.6 and RE of concern 7.3.5 (also type locality of Tracey type 3a)	5	Maintain existing flow regimes				
Flow regime types	Ephemeral nature of system should be maintained	4	Maintain constancy and magnitude of dry season flows. Regulation should not alter flow pattern towards a greater difference between wet and dry season flows				

Infrastructure: Stony Ck Intake							
Major Catchment: Barron			**Subcatchment : Stony**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	2	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by baseline botanical survey Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse Desilting of weir to occur when no water is flowing over the weir; or, Desilting of weir to occur during high flow events during the wet season Downstream turbidity to remain within 10% of upstream values during desilting.	Monthly extraction levels Rare and threatened species retained Turbidity measurements (at 1 hr intervals) at a point nominated by appropriate experts upstream and downstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction for wet and dry seasons over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction for wet and dry seasons over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Large waterfalls present (Stony Ck falls) which provide specialised habitats	4	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish		1		When performance indicators are breached a Reference Panel will establish possible corrective action.			
Frogs	Full complement of lowland species expected - *Litoria dayi*, *L. nannotis* & *L. rheocola*	4					
Freshwater turtles							
Regional ecosystems		1	Maintain existing flow regimes				

Infrastructure: Stony Ck Intake							
Major Catchment: Barron			**Subcatchment : Stony**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Flow regime types	Flows regulated and not unique.	1	Maintain difference in constancy and magnitude of dry and wet season flows. Use of natural stream channels for delivery of water to downstream users during periods of peak demand (dry season) is to be discouraged				

Infrastructure: Copperlode Dam & Freshwater Ck Intake							
Major Catchment: Barron			**Subcatchment : Freshwater**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Maintenance of flows important for persistence of important lowland stream habitat and the provision of nutrients to downstream freshwater and estuarine ecosystems	3	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse. High flows during historically dry periods must not occur	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	Mean turbidity < 10% of upstream values during desilting. <10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Several waterfalls present (specialised habitat)	4	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	Potential habitat for *Euastacus balanensis*	4					
Freshwater fish	Previously contained very high diversity of freshwater fishes but now heavily infested with *Oreochromis mossambicus*	2		When performance indicators are breached a Reference Panel will establish possible corrective action.			
Frogs	Contains full complement of lowland species expected for the area - *Nyctimystes dayi*, *Litoria nannotis* and *L. rheocola*	5					
Freshwater turtles							

Infrastructure: Copperlode Dam & Freshwater Ck Intake							
Major Catchment: Barron			**Subcatchment : Freshwater**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Regional ecosystems	Sustains variants of 7.3.22 & remnants of 7.3.4	2	Maintain existing flow regimes				
Flow regime types	Maintenance of flow regime which is typical of catchment is necessary to ensure diversity of WTWHA flow regimes	2	Maintenance of high wet season flows and constant dry season flows must be given priority to sustain habitat integrity and discourage noxious pest species				

Infrastructure: Bessie Point Intake							
Major Catchment: Trinity, Yarrabah, Bramston			**Subcatchment : Mick**		**Conservation Value: Moderate**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	1	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse. High flows during historically dry periods must not occur	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	Mean turbidity < 10% of upstream values during desilting. <10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high.	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish							
Frogs	Unlikely to contain R&T species of rainforest frogs	1					
Freshwater turtles				When performance indicators are breached a reference panel will establish corrective action.			
Regional ecosystems		1	Maintain existing flow regimes				
Flow regime types	Unlikely to be highly distinctive but maintenance of the flow regime will ensure habitat integrity	1	Should be no trend towards greater ephemerality than is already present				

Infrastructure: Bartle Frere / Woopen Ck Intake							
Major Catchment: Russell			**Subcatchment : Josephine**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Maintenance of high flows for maintenance of habitat integrity and connectivity with lowland and estuarine areas	2	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. Do not prolong extraction during dry periods by construction of weirs, excavation of streambed or other forms of interference with the watercourse	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	Records of *Syzygium boonjee*	2	Maintain integrity of watercourse				
Aquatic plants	Records of endangered *A. bullosus* & likely that *Torrenticola* occurs	4					
Freshwater invertebrates	Invertebrate diversity high.	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	*Euastacus balanensis* known from here	5					
Freshwater fish	Upland areas of low diversity but important habitat for *Glossogbious* sp. B & *Cairnsichthys rhombosomoides*	4		When performance indicators are breached a Reference Panel will establish possible corrective action.			

Infrastructure: Bartle Frere / Woopen Ck Intake							
Major Catchment: Russell			**Subcatchment : Josephine**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Frogs	Contains full complement of highland populations of R&T frogs expected for the part of the WTWHA (*L. nannotis*, *L. rheocola, L. nyakalensis, N. dayi, T. acutirostris* & *T. rheophilus*	5					
Freshwater turtles	Highly probable that this system would contain it's own morphological variant of *E.* aff. *dentata* given the distinctiveness of its fish fauna and the distributional pattern indicated in Cann (1998).	3					
Regional ecosystems	Assists in the maintenance of a range of REs of significance (7.3.3, 7.3.6 & 7.3.5) downstream	2	Maintain existing flow regimes				
Flow regime types	Ephemeral nature of system should be maintained	4	Maintain constancy and magnitude of dry season flows. Regulation should not alter flow pattern towards a greater difference between wet and dry season flows				

Infrastructure: Bramston Beach Minor & Major Intake							
Major Catchment: Trinity, Yarrabah, Bramston			**Subcatchment : Worth**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	3	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high.	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish	Highly likely to contain species of high conservation significance or those with disjunct distribution - *ie M. maccullochi, Pseudomugil gertrudae* & *Denariusa bandata*. Important coastal lowland wetlands.						
Frogs							
Freshwater turtles							

Infrastructure: Bramston Beach Minor & Major Intake							
Major Catchment: Trinity, Yarrabah, Bramston			**Subcatchment : Worth**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Regional ecosystems	Streams sustain endangered REs 7.3.1 & 7.3.6 & RE of concern 7.3.5	5	Maintain existing flow regimes				
Flow regime types	Unlikely to be highly distinctive but flow regime should be maintained to ensure habitat integrity	1	Maintain flow regime with an aim for no increase in ephemerality				

Infrastructure: Nyleta Intake							
Major Catchment: Liverpool, Moresby, Big Maria & Hull			**Subcatchment : South Liverpool**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Connectivity with the Tully River. Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	2	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish	Quality fish habitat. Headwaters relatively well protected	3					
Frogs							
Freshwater turtles							
Regional ecosystems		1	Maintain existing flow regimes				
Flow regime types	Maintenance of habitat integrity in subcatchments and in downstream reaches required	3	Maintain flow regime with an aim for no increase in ephemerality				

Infrastructure: Jurs Ck Intake							
Major Catchment: Liverpool, Moresby, Big Maria & Hull			**Subcatchment : Big Maria**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Entire river poorly protected and headwaters thus important for ecosystem function	3	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish		2					
Frogs	One of the few remaining lowland populations of *L. rheocola*	3					
Freshwater turtles							
Regional ecosystems	With streams sustaining endangered RE 7.3.6 (18)	4	Maintain existing flow regimes				
Flow regime types	Unlikely to be highly distinctive but maintenance of the flow regime will ensure habitat integrity	1	Maintain flow regime with an aim for no increase in ephemerality				

Infrastructure: Herbert (Wild River) Intake							
Major Catchment: Herbert			**Subcatchment : Wild**		**Conservation Value: Moderate**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	1	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a reference panel will establish possible corrective action	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish		1					
Frogs	Important connection between Herbert River drainage and the Johnstone River drainage	3					
Freshwater turtles	Probable that these drainages also contain the Johnstone River form of *E.* aff. *dentata* given the extent of drainage rearrangement between the upper reaches of these two river systems	3					
Regional ecosystems	Headwaters of feeder streams sustaining endangered RE 7.3.26 & 7.3.22	2	Maintain existing flow regimes				

Infrastructure: Herbert (Wild River) Intake							
Major Catchment: Herbert			**Subcatchment : Wild**		**Conservation Value: Moderate**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Flow regime types	Upstream reaches within this drainage contributes a great proportion of the flow in downstream reaches and therefore the maintenance of habitat integrity in these downstream is reliant on upstream flow	1	Maintain flow regime with an aim for no increase in ephemerality				

Infrastructure: Meunga Ck (Cardwell) Intake							
Major Catchment: Dallachy, Meunga & Conn			**Subcatchment : Meunga**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and near-shore ecosystems	2	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish							
Frogs	Known to contain one or two R&T species	4					
Freshwater turtles							
Regional ecosystems	Streams sustain one of 2 remaining major occurrences of endangered RE 7.3.6 & RE 7.3.7	5	Maintain existing flow regimes				
Flow regime types	Data unavailable, difficult to ascertain what natural pattern of flow might be or if any distinctive flow requirements						

Infrastructure: Boulder Ck (Rural) Intake							
Major Catchment: Tully			**Subcatchment : Banyan**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	2	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants	No significant species recorded		Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish	No significant species recorded	1					
Frogs	Full complement of lowland R&T species plus *T. acutirostris* in upland areas	4					
Freshwater turtles							
Regional ecosystems	Maintains feeder streams to remnant of important REs 7.3.5 & 7.3.4 (15a, 3b)	2	Maintain existing flow regimes				
Flow regime types	Integrity of upstream and downstream habitat essential especially given the paucity of lowland tributary streams of high quality.	4	The maintenance of flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types and related processes are maintained				

Infrastructure: Stanwell - Kuranda Weir							
Major Catchment: Barron			**Subcatchment : Barron Falls**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Maintenance of unique waterfall habitat	2	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Large waterfall present (Barron Falls - unique habitat)	4	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish		1					
Frogs	Full complement of lowland R&T species expected for the area - *N. dayi, L. nannotis,* & *L. rheocola*	4					
Freshwater turtles							
Regional ecosystems		1	Maintain existing flow regimes				

Infrastructure: Stanwell - Kuranda Weir							
Major Catchment: Barron			**Subcatchment : Barron Falls**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Flow regime types	Highly regulated system with considerable alteration to natural flow regime due to transfer of water from Lake Tinaroo into streams for use by downstream users	1	The maintenance of flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types, habitat integrity and related processes are maintained. High flows during historically low flow periods must not occur				

Infrastructure: Stanwell Koombaloomba, Kareeya							
Major Catchment: Tully			**Subcatchment : Carpenter**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	1	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey When performance indicators are breached a Reference Panel will establish possible corrective action. No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting.	Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*) Monthly extraction levels Identified rare or threatened species retained	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea	Important for several species of interest	4					
Freshwater fish	Contains genetically distinct populations of rainbow fishes plus *Mogurnda adspersa* & *M. mogurnda*. Latter two species very rarely found together. Entire area important from an evolutionary perspective due to complicated drainage rearrangement in recent geological past.	4					
Frogs	Area poorly surveyed, status and nature of frog populations unknown						

Infrastructure: Stanwell Koombaloomba, Kareeya							
Major Catchment: Tully			**Subcatchment : Carpenter**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Freshwater turtles							
Regional ecosystems		1	Maintain existing flow regimes				
Flow regime types	Maintenance of habitat integrity required.	2	Great care needs to be taken in this catchment to ensure that water is not transferred from one catchment to another. The maintenance of flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types, habitat integrity and related processes are maintained.				

Infrastructure: Paluma							
Major Catchment: Burdekin			**Subcatchment : Paluma**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	Important for delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	2	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey When performance indicators are breached a Reference Panel will establish possible corrective action. No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Birthday Ck and Camp Ck are sites of considerable importance for scientific research due to long term nature of the research undertaken in these systems	5	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							
Freshwater fish	Important for supply of water downstream for the maintenance of morphologically and phenotypically distinct rainbow fish	4					
Frogs	Previously known to contain *N. dayi* & *L. nyakalensis*	5					
Freshwater turtles	Burdekin River is the northernmost limit of the distribution of the long-necked turtle *Chelonia longicollis* and within this system it is restricted to the upper reaches and tributaries	4					

Infrastructure: Paluma							
Major Catchment: Burdekin			**Subcatchment : Paluma**		**Conservation Value: Very High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Regional ecosystems	Probably important for sustaining REs for the Dry Tropics Region		Maintain existing flow regimes				
Flow regime types	Natural flow regime must be maintained. High summer flows needed for the provision of downstream spawning habitat for a range of fish species	3	The maintenance of flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types, habitat integrity and related processes are maintained.				

Infrastructure: Crystal Ck							
Major Catchment: Trebonne Halifax			**Subcatchment : Crystal**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Ecosystem function	These rivers are characterised by the presence within the WTWHA of their headwaters only. Thus maintenance of flow from these reaches is critical for maintaining habitat integrity of downstream reaches and for near shore and estuarine ecosystems	3	Maintain existing flow regime	No alteration to extraction level Disturbance to terrestrial vegetation to be preceded by botanical survey No desilting of weir during low flows. Turbidity to remain within 10% of upstream values during desilting. When performance indicators are breached a Reference Panel will establish possible corrective action.	Monthly extraction levels Identified rare or threatened species retained Turbidity measurements (at 1 hr intervals) 100m downstream and upstream during desilting (to *Queensland Water Quality Monitoring Manual ,1995*)	<10% increase in extraction over previous year No loss of rare or threatened species or association comprising same unless approved by Authority Mean turbidity < 10% of upstream values during desilting.	>10% increase in extraction over previous year Loss of individuals or association comprising rare or threatened species without approval Downstream turbidity >10% above upstream sample
Rheophytic Plants			Maintain integrity of watercourse				
Aquatic plants							
Freshwater invertebrates	Invertebrate diversity high	3	No interference with watercourse including streambed Maintain existing flow quality Maintain flow regime necessary for habitat maintenance and continual survival				
Crustacea							

Infrastructure: Crystal Ck							
Major Catchment: Trebonne Halifax			**Subcatchment : Crystal**		**Conservation Value: High**		
Attribute	**Conservation Value**	**Rating**	**Management Implication**	**Condition**	**Monitoring**	**Performance Indicator**	**Intervention Threshold**
Freshwater fish	Very important fish habitat for declining species *Kuhlia rupestris* and other species endemic to the WT region such as *Tandanus sp.* & *Hephaestus sp.*. Value of Saltwater, Leichhardt, Sleeper Log and Bluewater reduced because of progressively less WTWHA within catchments. Maintenance of flows important for maintenance of downstream reaches	4					
Frogs	Contains *L. nannotis*	3					
Freshwater turtles							
Regional ecosystems	Streams sustain a coastal mosaic containing minor elements of REs of importance & sustain endangered REs 7.3.26 & 7.3.28	4	Maintain existing flow regimes				
Flow regime types	Maintenance of habitat integrity essential for the maintenance of fish populations. Downstream environmental needs must be considered.	3	Flow regime should not be altered to greater ephemerality than is already indicated.				



PART 3
(of 3)

Conservation Values of Waterways in the Wet Tropics World Heritage Area

Prepared by
Natural Resource Assessments Pty Ltd
River Research Pty Ltd and
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For
Wet Tropics Management Authority
3 September 1999

EXECUTIVE SUMMARY

The aim of this study was to place conservation values on the waterways of the Wet Tropics World Heritage Area in order to facilitate their management and to protect their World Heritage values. Conservation values needed to be determined for waterways of the region at the smallest possible scale. This is because the impacts of flow regulation are first felt at the local scale, while large-scale impacts are the accumulation of the effects of many, local scale impacts. The finest scale resolution possible was that of the sub-catchment within major drainages.

There are 328 sub-catchments contained partially or wholly within the WTWHA. Conservation values were given to each of these according to ten major attributes:

1. Ecosystem function values.
2. Rheophytic plants of specific conservation interest.
3. Aquatic plants of specific conservation interest.
4. The diversity of aquatic invertebrates.
5. Aquatic crustacea of specific conservation interest.
6. Freshwater fish of specific conservation interest including areas of important habitat and areas of high diversity.
7. Frogs of specific conservation interest.
8. Freshwater turtles of specific conservation interest.
9. Regional ecosystems of specific conservation interest.
10. Distinctive flow regime types and/or flow needs.

Each sub-catchment was accorded a value from 1 (low) to 5 (high) for each attribute. Overall conservation value was determined by a two step process wherein conservation value was determined to be Very High Conservation and Ecological Value (highest value, no water extraction) if any attribute was scored a 5; High Conservation and Ecological Value (intermediate to high value, abstraction possible following direct assessment only if impacts deemed acceptable) if no attribute scored a 5 and the mean score across all attributes was greater than 2; and Moderate Conservation Value (moderate value, abstraction possible with conditions) if the mean score was 2 or less.

Substantial across-drainage variation in conservation value for individual attributes and for mean conservation value was observed. Some drainages such as the Barron were ranked highly according to some attributes (*ie* frogs) but not others (*ie* fish). Overall the Johnstone, Russell and Mulgrave drainages were ranked most highly, irrespective of the attribute used.

Of the 328 sub-catchments examined, about one quarter had Moderate Conservation Value, a further quarter had Very High Conservation and Ecological Value and the remainder had High Conservation and Ecological Value. It is considered that this result affords good protection to the values of the WTWHA without greatly comprising the ability of landholders to access water.

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1. INTRODUCTION

Demand on the water resources of the Wet Tropics region is increasing as agricultural, urban and industrial needs expand in line with population growth and changing land-use practices (Pusey *et al*. 1999). Increasing demand on water resources increases the threat to fauna and flora, and indeed to whole ecosystems, that are dependent on the provision of adequate stream flow. Management of that threat within the Wet Tropics World Heritage Area (WTWHA) needs to focus on minimising the impacts of water extraction. Thus there is a need for information concerning which watercourses are most likely to be impacted by flow regulation or which contain taxa of special conservation value or interest.

This report is intended to identify watercourses of high value within the WTWHA.

2. METHODS USED FOR DETERMINING CONSERVATION VALUE

2.1 Objective and Spatial Scale of Examination

The objective of the current project was to identify streams of high conservation and ecological value within the WTWHA. This information is needed to identify streams suitable for development as sources of domestic and rural water supply without detriment to World Heritage values. Given that the Wet Tropics region contains many thousands of streams (the Mulgrave River alone contains 1816 first order streams and 925 second order streams (Pusey *et al*. 1999)), and that few of these are accessible let alone studied, an assessment scheme based upon the value of individual streams is clearly impossible.

Our ability to define the conservation value of individual stream reaches or entire streams is highly limited. The most appropriate scale must therefore be located between the river basin and the individual stream or stream-reach. The most appropriate spatial scale intermediate between entire river basins and individual streams is at that of the sub-catchment although it is recognised that conservation attributes determined at this intermediate scale may not necessarily apply to all streams within that intermediate scale area.

The sub-catchment level is suitable because:

- Streams form channel networks, and networks of rivers of the Wet Tropics region tend to be dendritic in form and therefore composed of a number of separate and similarly sized sub-catchments (Pusey *et al*. 1999). Moreover, sub-catchments represent those parts of the riverine landscape that are separated from others within the drainage by well defined topographical features, such as mountain ranges and ridge lines that have biological relevance for most aquatic organisms.
- The scale of sub-catchments is also appropriate for the level of spatial resolution in biological information available for most aquatic biota (*ie* distributional data or survey information).
- A classification scheme at this level of the sub-catchment has already been developed and is in use throughout north Queensland (DNR Water Resources).

As a result of using the DNR sub-catchment nomenclatural system, a total of 328 sub-catchments within 19 major drainage systems was identified. Of these major drainages, all but 1 (the upper Mitchell system) drain eastward and discharge into the Coral Sea or South Pacific Ocean (Normanby River). The Mitchell drains west into the Gulf of Carpentaria.

In order for a classification system to be both useful and defensible, it must allow sufficient spatial resolution, be simple to understand and capable of easily transmitting the intended information, and yet still allow some degree of finer scale resolution within categories. To this end, a tripartite scheme was devised:

Very High Conservation and Ecological Value. No extraction will be permitted (*ie* precautionary principle exercised). Meets the highest standards (key value) in at least one of the attributes considered (see below).

1. **High Conservation and Ecological Value**. Criteria may be satisfied but key value not met, extraction may proceed following direct assessment (*ie* prescription approach) only if impacts deemed acceptable.
2. **Moderate Conservation Value**. Key values not met and most criteria not met. Extraction can occur with conditions.

It should be noted that the scheme above does not include a category in which streams or sub-catchments of poor or low conservation value might be included as it was considered that sub-catchments of such low quality would not occur within the boundaries of the WTWHA.

2.2 Attributes and Criteria for Determining Conservation Status

This final tripartite scheme represents a distillation of the value of a sub-catchment with respect to that sub-catchment meeting conservation value criteria. The criteria chosen to accord conservation value were those upon which World Heritage status is assessed. These are that the sub-catchment:

WH Criterion 1: represents an outstanding example of the major stages of the earth's evolutionary history;

WH Criterion 2: be an outstanding example representing ongoing geological processes, biological evolution and human interaction with the natural environment;

WH Criterion 3: contains superlative natural phenomena, formations or features; and

WH Criterion 4: contains important and significant natural habitats where threatened species of animals or plants of outstanding universal value live.

In addition, the criteria included those suggested for the identification of areas of biodiversity significance and listed in the *FNQ 2010 Regional Environment Strategy 1998*. These are:

a. Rare and threatened Vegetation Community Types.

Natural vegetation or habitat of a type that is threatened with extinction or future non-viability, or of restricted distribution.

b. Habitats of Rare and Threatened Species.

Habitat areas of highest value for rare and threatened species and those areas with large concentrations of rare species.

c. Areas with Outstanding Biodiversity or Ecological/Structural Integrity

Outstanding species richness, structural variability and complexity or those areas that have best escaped degradation by human activities.

d. Areas of Outstanding Significance for Maintenance of Ecological Functions

Areas of ecological and biogeographic significance which may, for example, allow wildlife movement between areas, provide refuge during long-term climate change, be core habitat for regionally endemic taxa, be resource areas for feeding and breeding or areas with wider habitat values such as coastal wetlands and riparian forests.

To a significant degree, these latter criteria mirror those listed for World Heritage assessment. However, they allow greater scope for identification of sub-catchments that may not be of significant value according to WH criteria but which are essential for the maintenance of downstream habitats.

Several fluvial ecosystem attributes were identified which could be assessed against the above criteria. The attributes chosen included only those capable of being influenced by alterations to the flow regime or activities associated with water extraction. To do otherwise would have resulted in all sub-catchments being accorded a very high conservation value, simply by virtue of being contained within the WTWHA.

The attributes chosen characterised stream processes, faunistic and floristic composition and regulation, and human interaction. The list of attributes and the criteria that each addresses is given in Table 1.

Table 1. Attributes used to assess conservation value of individual sub-catchments and the criteria against which they were assessed.

Attribute of Interest	**World Heritage Criteria Addressed**				**FNQ 2010 Regional Environment Strategy Criteria Addressed**			
	1	**2**	**3**	**4**	**a**	**b**	**c**	**d**
1. **Ecosystem function** values		✓		✓				✓
2. Taxa of specific conservation interest - **rheophytic plants**	✓	✓		✓	✓	✓		
3. Taxa of specific conservation interest - **aquatic plants**	✓	✓		✓		✓		
4. Diversity - **freshwater invertebrates**		✓		✓		✓	✓	✓
5. Taxa of specific conservation interest - **crustacea**	✓	✓		✓		✓	✓	
6. Taxa of specific conservation interest - **freshwater fish** including important **fish habitat** and areas of high **fish diversity**	✓	✓		✓		✓	✓	✓
7. Taxa of specific conservation interest - **frogs**	✓	✓		✓		✓		
8. Taxa of specific conservation interest - **freshwater turtles**		✓		✓		✓	✓	
9. **Regional ecosystems** of specific conservation interest	✓	✓		✓	✓	✓	✓	
10. Distinctive **flow regime types** and/or **flow needs**		✓		✓				✓

The list is dominated by those attributes concerned with individual species of plants and animals, or ecosystems of regional significance, that are directly reliant on lotic processes and the availability of running water. The intention was to limit the choice of faunal groups

to those that are directly reliant on stream environments. Although it was recognised that a wide array of terrestrial vertebrates is associated with streams or riparian corridors to include these groups would have greatly decreased the ability to discriminate between sub-catchments. However, some aspects of terrestrial vertebrate ecology (*ie* movement along riparian corridors) are included within attribute 1. Flow related processes such as channel maintenance are not included despite being of primary significance in the maintenance of the ecological integrity of lotic ecosystems, because to do so would have resulted in all sub-catchments being accorded high value. However, an exception in this regard (attribute 1 also) has been made, the rationale for this exception is given below.

A scheme intended to allow the conservation value of one region to be ranked and compared to another region, to define whether water extraction may or may not occur, and to define prescriptive management outcomes based on those ranks must be both fair and rigorous. The scheme must therefore meet a number of criteria:

The attributes upon which rankings are based must be related to the desired management outcome (*ie* better flow management or protection of World Heritage values) and be capable of being influenced by changing flow regime.

It must be rigorous enough to withstand scrutiny if management outcomes dependent on it are challenged.

The process by which rankings are accorded must be sufficiently transparent to allow an assessment of its rigour to be made.

The process should be sufficiently transparent to allow a simple determination of how the conservation value of an individual sub-catchment was determined and flexible enough to be updated upon receipt of additional information.

The process by which rankings are accorded must be flexible enough to allow for challenges to be assessed and accommodated (*ie* through the provision of additional data).

2.3 Rationale for Inclusion of Each Attribute

The rationale for inclusion of each attribute is detailed below. In addition, the importance of separate aspects of each attribute in satisfying World Heritage criteria is indicated.

2.3.1 Ecosystem Function Values

The most important factor controlling the ecology of fluvial ecosystems, and other closely associated ecosystems, is the magnitude and temporal pattern of streamflow. The capacity of flowing water to erode and transport sediment (and other materials) forms and maintains the nature of the riverine environment (**WH criterion 2**), thus determining the distribution, abundance and integrity of different habitats (**WH criterion 4**). In addition, the water transported down the river channel may be responsible for creating, maintaining or establishing links with other ecosystems such as riparian zones, wetlands and floodplains (**FNQ 2010 criterion d**). The downstream transport of nutrients and organic carbon has been shown to be essential for the maintenance of the river ecosystem productivity as well as estuarine and near shore ecosystems. Streams and riparian corridors provide links between adjacent systems as they form corridors throughout the broader landscape thus facilitating gene flow between otherwise isolated populations of organisms (**WH criterion 2**). See Pusey *et*

al. (1999) for an expanded discussion of the importance of the maintenance of flow regime on fluvial and associated ecosystems.

2.3.2 Taxa of Specific Conservation Interest - Rheophytic Plants

In general, the riparian zone is of the utmost importance to the proper functioning of stream ecosystems, providing shade, bank stability and organic carbon directly to the stream ecosystem and to stream organisms. The integrity of the riparian zone is therefore of substantial importance in determining the integrity of waterways (**FNQ 2010 criterion d**). In the Wet Tropics region many of the plant species comprising the distinct riparian community are classified as rare or threatened and are of evolutionary significance (**WH criteria 1, 2 & 4, FNQ 2010 criteria a, b**).

Of the 433 vascular plant taxa of the Wet Tropics region classified officially as rare and/or threatened (395 of which occur within the WTWHA) (Goosem in WTMA 1998), and of others of specific conservation concern, only a relatively small sub-set are essentially rheophytic. Rheophytic means plants normally occurring immediately beside waterways whose occurrence appears directly related to a stream's flow regime, or plants confined to alluvial stream levees. These rheophytic plants comprise 22 taxa (including 20 officially listed rare and threatened plants) which are set out in Table 2 below. Such plants are those most likely to be adversely affected by water extraction.

In such cases water extraction may constitute a threatening process leading to further endangerment and possible extinction. As there exists an obligation under the World Heritage Convention to maintain those natural values for which an area such as the Wet Tropics of Queensland was listed, it is obligatory to maintain rare and/or threatened species habitats (see **WH criterion 4**) within the overall management strategy for the World Heritage Area. Accordingly, stream sub-catchments were considered systematically and allocated a score as follows:

- **score 5** - they contain streams that constitute the sole geographic range of an endangered, vulnerable or rare/restricted species or they provide habitat for 3 or more of such species
- **score 4** - they contain streams that provide a habitat stronghold for 2 of these species
- **score 3** - they contain streams that provide habitat for 2 of these species
- **score 2** - they contain streams that provide habitat for 1 such species
- **score 1** - they contain streams that may provide habitat for such species
- **no score** - occurrence of rare/threatened plant in riparian systems within sub-catchment not confirmed/unknown.

Table 2. Rare and/or threatened plant species likely to be affected by water extraction.

Species	Common Name	Status[1]	Comments
Acacia hylanoma	a wattle	R	not totally rheophytic but occurs within its restricted range on alluvial levees
'Acmena' sp. "Little Cooper Ck"	[no common name]	E	confined to a very restricted area of Little Cooper Ck - Qld Herbarium recognises this as a new genus for Australia & as a plant that is 'critically endangered'
Acmena smithii (small fruited form)	Lilly Pilly	P?	taxonomically distinct - confined to cool upland rainforest/ tall open Rose Gum (*Eucalyptus grandis*) creek systems
Ammomum dallachyi	Green Ginger	R	confined to creeks & soakages north of the Alexandra Range
Buckinghamia ferruginiflora	Spotted Oak	R	scattered populations in riparian rainforest from sea level to 350m largely between Bloomfield & the Daintree River
Endiandra cooperana	Cooper Creek Walnut	V	not rheophytic but occurs on alluvial levees in a very restricted distribution
Entlingera australasica	a ginger	R	wet tropics occurrence is highly disjunct - also occurs in Iron Range
Gymnostoma australianum	oak	R	survives in three discrete populations in lowland & upland riparian rainforest
Neostrearia fleckeri	[no common name]	R	occurs on alluvial levees between the Daintree River & Innisfail
Ostrearia australiana	Hard Pink Alder	R	along perennial creeks in well developed lowland & foothill rainforests between Rossville & Tully
Peripentadenia phelpsii	Mossman Quandong	R	restricted to several streams in the Mossman River Catchment
Randia sp. "boonjee" RFK3285	Bonjee Gardenia	P	an understorey plant of cool upland riparian rainforest
Romnalda gralata	[no common name]	R	a rheophyte similar in appearance and habitat preference to the more widespread Mat-rush (*Lomandra longifolia*)
Romnalda sp. "Roaring Meg" PIF4402	[no common name]	P	similar to the above with a much more restricted distribution
Syzygium alatoramulum	Tinkling Satinash	R	confined to creek banks flowing through rainforest on granitic parent material
Syzygium boonjee	Bonjee Satinash	R	confined to the riparian zone of small creeks draining the eastern fall of the Bellenden Ker rainforest massif
Syzygium xerampelinum	Mulgrave Satinash	R	in two disjunct populations that are confined to creek-side habitats
Waterhousea hedraiophylla	Gully/Red Satinash	R	confined to creeks & watercourses in well developed lowland to upland rainforest between Mossman & Innisfail
Waterhousia mulgraveana	[no common name]	R	within riparian rainforest occurring in two disjunct populations, one in the Mulgrave Catchment & the other in Noah Creek
Xanthostemon formosus	Cooper Creek Penda	R	the only bat-pollinated member of the genus with its bat pollinators using the creek as a flyway. Very restricted along the headwaters of Little Cooper & Myall Creeks
Xanthostemon graniticus	Mt Hemmant Penda	R	restricted to a few small creek headwaters north of the Daintree River
Xanthostemon verticillatus	Rock Penda	P	grows amongst boulders along upland rainforest streams

[1] Status is specified according to the conventional system where E=endangered, V=vulnerable, R=rare/geographically restricted & P=poorly known or status pending

2.3.3 Taxa of Specific Conservation Interest - Aquatic Plants

Knowledge of the distribution and conservation status of aquatic plants, even within a moderately well sampled and documented bioregion such as the Wet Tropics, is highly deficient. There is a profound need to remedy this deficiency by systematic sampling and research: however given the present task, emphasis will be placed on known occurrences of exclusively aquatic vascular plant taxa of special conservation interest. Although unlikely to be comprehensive, these taxa include:

- *Aponogeton bullosus* endangered
- Aponogeton lancesmithii ?vulnerable
- Aponogeton prolifera endangered
- *Aponogeton queenslandicus* rare
- *Aponogeton vanbruggenii* ?rare
- *Eleocharis retroflexa* vulnerable
- *Fimbristylis adjuncta* endangered
- *Torrenticola queenslandica* rare

These include three recently described species of *Aponogeton* as documented by Hellquist & Jacobs (1998) which are yet to be officially listed as rare/threatened in the Wildlife Schedules accompanying the *Nature Conservation Act* (1992). All of these species, with the exception of *A. queenslandicus*, are limited to the Wet Tropics region, often to individual rivers (**WH criteria 1 & 2**) and are highly dependent on the provision of adequate environmental flows. All show a preference for fast flowing waters and the maintenance of streams providing such habitat is vital to their continued survival (**WH criterion 4, FNQ 2010 criterion b**). The extent to which such plants contribute to aquatic food webs is unknown but it has been reported that *Aponogeton* species provide valuable habitat for newly metamorphosed juveniles of the endemic catfish *Tandanus cf. tandanus* (Pusey *et al*. 1999).

Sub-catchments containing streams in which the above species have been recorded were scored in a manner similar to that used for rare/threatened rheophytes.

Currently, some work is being undertaken on several non-vascular aquatics such as the mosses, but this information is not yet comprehensive, confirmed or able to inform the present exercise.

2.3.4 Diversity - Freshwater Invertebrates

Freshwater invertebrates (excluding Crustacea, which are treated separately) are now receiving considerable attention as biological indicators and extensive data sets are being gathered. There are several groups of invertebrates where the species are well known such as the Odonata (dragonflies and damselflies), Trichoptera (caddis-flies) and/or species of specific interest within the WTWHA (*eg* Chironomidae of gondwanan heritage) (**WH criterion 2**). However, there is insufficient data to use species of conservation interest as a discriminatory parameter for invertebrates. Due to the large

number of species usually present in any waterway, most of which are poorly known, the emphasis in sampling programs is on diversity and community structure rather than individual species of significant conservation interest.

For the WTWHA, the most extensive study is the program conducted by the Australian Centre for Tropical Freshwater Research (ACTFR) of James Cook University. This program sampled freshwater invertebrate communities throughout the WTWHA over three years. The full results of the program are currently being analysed and are not yet available. However, it is clear from preliminary reviews of the data (Prof. Richard Pearson, JCU *pers. comm.*, Pusey and Pearson 1999) that all sites examined had very high diversities and that this is a feature of the entire WTWHA (**FNQ 2010 criterion c**), even where streams are in non-rainforest habitats such as wet sclerophyll. Geographic variations in diversity are therefore of limited use as all streams in the WTWHA rate highly for this parameter. Nevertheless, it is likely that many species have restricted distributions, but more research is required to ascertain this.

Of the habitats present within the WTWHA, waterfalls stand out as having the most unique fauna, particularly for specialised species inhabiting the face of waterfalls (Clayton 1995) (**WH criterion 4, FNQ 2010 criteria b, c**). As they represent a restricted habitat type, and are susceptible to alterations in flow from water extraction, any streams or sub-catchments with significant waterfalls have been given a higher ranking.

Aquatic invertebrates are of significant importance to aquatic foodwebs. They are consumers of plant material (either allochthonously or autochthonously derived) and are themselves consumed by higher order predators. They thus form the major food supply for nearly all of the freshwater fishes of the WTWHA. Species of significance such as platypus, and a range of terrestrial animals (*ie* water rats, frogs, riparian birds that are dependent on emerging insects for reproduction) are dependent on carbon first produced or assimilated in the stream environment. Streams therefore support a range of levels in terrestrial food webs (**FNQ 2010 criterion d**).

The WTWHA includes extensive estuarine areas and these contain a distinctly different invertebrate fauna. Major estuarine areas within the WTWHA include the landward side of the Hinchinbrook channel south to the Herbert River, north of Cardwell from Meunga Creek to Murray River, the Hull River estuary, the Moresby River estuary, Mutchero Inlet and the Daintree River estuary. Trenerry (1991) surveyed the fauna of the Russell/Mulgrave, Daintree and Endeavour estuaries and concluded that their faunal diversity was exceptional. Graham *et al*. (1975) came to a similar conclusion after their survey of Trinity Inlet. There has been limited sampling of the Wet Tropics estuarine invertebrate fauna and discrimination between areas is not possible with the existing data set, though it is known that diversity of the communities is high and there are undoubtedly numerous species of conservation interest present.

2.3.5 Taxa Of Specific Conservation Interest - Freshwater Crustacea

In terms of body size, the Crustacea are the largest of the freshwater invertebrates in the Wet Tropics. There is more confidence in assessing conservation status within this group than is possible for most other freshwater invertebrates. Even so, the

information available on crustaceans in the WTWHA is limited and even basic survey data is lacking in most streams. In addition, many species have only recently been described and more species, even of a large body size, continue to be discovered (**WH criterion 2, FNQ 2010 criterion b**). Greater research effort is needed to properly document the diversity of Crustacea within the Wet Tropics region.

Crustaceans, including shrimps, crayfish and various microscopic forms, inhabit virtually all freshwater bodies in the Wet Tropics. However, it is apparent that two areas are especially important for crustacean biodiversity. These are high mountains such as Thornton Peak, Mt. Windsor and Mt. Finnigan and the streams of the upper Tully River above Koombooloomba Dam (**WH criterion 4, FNQ 2010 criteria b, and c**). For the former group, their location in difficult to access areas confers a high degree of protection, at least from direct human disturbances, though their limited distribution makes them highly susceptible to changes in climate and rainfall patterns. For the latter location, the value of the streams in the area is interesting given the existing stream modifications (*eg* hydropower station) that have occurred and those that have/are being proposed for the area.

Horwitz (1990) listed three *Euastacus* species (*balanensis, fleckeri* and *robertsi*) from the WTWHA as being of conservation interest and a fourth (*E. yigara*) was described in 1993 (Short and Davie 1993). The first of the three species listed by Horwitz (1990) has the widest distribution with known localities including waterways above 800m altitude west of Cairns, on the Atherton Tablelands and in the Mt. Bartle Frere area (Morgan 1988). *Euastacus fleckeri* is only known from altitudes above 1,000m in the limited area between Mt. Carbine and Mt. Spurgeon (Morgan 1988). This includes creeks draining east to the Mossman River and west to the Mitchell River (Morgan 1988). *Euastacus robertsi* is only known from altitudes above 1,000m at Mt. Finnigan and Thornton Peak - two geographically separated mountains (Morgan 1988).

None of these three species is known to occur near human habitation. Other *Euastacus* species are also known to have restricted distributions in high altitude and high rainfall areas of Queensland, including Mt. Elliot (*E. bindal*), Eungella National Park (*E. eungella*) and several similar sites in southern Queensland (Horwitz 1990).

Three new species from the area above Koombooloomba Dam have recently been described from just one creek in the upper Tully River area (O'Leary Creek at ~750m altitude). These include *E. yigara*, *Cherax parvus* and an undescribed *Macrobrachium* species (John Short, Queensland Museum, *pers. comm.*) (**WH criterion 4**). There are also several atyid shrimps of conservation interest. *Caridina zebra* has a wide distribution through the Atherton Tablelands, including the Barron, Mulgrave, North Johnstone and Herbert catchments and in the upper Tully River. Since this species has a low tolerance to disturbance (Choy and Marshall 1997) it may have potential as an indicator species.

The taxonomic status of the Crustacea of the WTWHA is such that new species of conservation interest may yet be found. Choy and Marshall (1997) recently described a related species (*Caridina confusa*) from the upper Barron and upper North Johnstone rivers. Species that have wide geographic distributions, such as *Paratya australiensis*

(occurring from Tasmania to north Queensland), may turn out to be several species with more restricted distributions (J. Short *pers. comm.*).

2.3.6 Taxa Of Specific Conservation Interest - Freshwater Fish Including Important Fish Habitat And Areas Of High Fish Diversity

The Wet Tropics region contains an extremely high diversity of freshwater fishes (>50% of the fauna of northern Australia) and is regionally distinctive (Pusey and Kennard 1996, Pusey and Pearson 1999). Spatial variation in composition (*ie* between river basins) tends to be most pronounced towards the margins of the Wet Tropics region (north and south) and these river basins represent areas of transition between faunas more characteristic of seasonal monsoonal rivers of Cape York Peninsula and the Townsville region, respectively. The core rivers of the region (Daintree River south to the Herbert River) are characterised by a generally homogenous fauna (*ie* low beta diversity) (Pusey and Kennard 1996) although there are subtle differences in the fauna north and south of the Barron River (Pusey and Pearson 1999). The latter authors speculated that such a difference might be similar to that observed for a range of terrestrial vertebrates (*ie* the Black Mountain corridor effect). Such an effect is clearly of evolutionary significance (**WH criterion 2**). The rivers of the region are distinctive in that within-river diversity is very high (**FNQ 2010 criterion c**) and the diversity thus far recorded from the Mulgrave River (Pusey *et al*. 1995, Pusey and Kennard 1996, Pusey *unpubl. data*) suggests that it may be the most speciose river in Australia (after adjusting for basin size). It has been argued that the origins and maintenance of the region's high diversity are directly related to the distinctive flow regimes of the region and that the maintenance of flow regime is critical in the long-term protection of the region's distinctive ichthyofauna (**WH criterion 4, FNQ 2010 criteria c&d**) (Pusey and Kennard 1996, Pusey and Pearson 1999).

The WTWHA also contains the headwaters of a number of streams that are clearly part of other distinctive biogeographic provinces (*ie* upper Mitchell River of the Gulf of Carpentaria, upper Normanby River of Cape York Peninsula and the headwaters of many important tributary streams of the Burdekin River of central Queensland)(**WH criterion 4**). The fauna of these systems is greatly different from that of easterly flowing streams (Pusey *et al*. 1998, Pusey and Pearson 1999) but were not included in the work of Pusey and Kennard (1996) which first clearly established the high diversity of fishes in the region. Therefore, the diversity of freshwater fishes found in the WTWHA is greater than that cited above. Moreover, the inclusion of these rivers, which have considerably different flow regimes than rivers east of the Great Divide, increases the complexity of flow management issues in the region (**FNQ 2010 criterion c**).

The region's ichthyofauna is also distinctive by virtue of its endemic species of which there are at least eight, although genetic research indicates the presence of substantially more (**WH criterion 2**). The best known of these is the Lake Eacham Rainbowfish (*Melanotaenia eachamensis*), formerly considered extinct in the wild but for which extant populations have been recently discovered (Moritz *pers. comm.*). This species is best considered a small upland stream dwelling species rather than a lacustrine one (Pusey *et al*. 1997). Its continued survival is highly dependent on the informed management of the flow regimes of rivers of the region. Other endemic

species include the Cairns Rainbowfish (*Cairnsichthys rhombosomoides*), the Northern Catfish (*Tandanus* cf. *tandanus*), the Scaleless Goby (*Schismatogobius sp*.), the Mulgrave River Goby (*Glossogobius sp. B*), Watson's Goby (*Stiphodon allen*), the Khaki Grunter (*Hephaestus sp*.) and the Bloomfield River Cod (description in preparation). Interestingly, several of these species are near obligate riffle dwellers or restricted to small tributary streams, and are therefore at risk from changes in flow regime which alter the suitability of these habitat types (**FNQ 2010 criteria b&c**).

Several of the above endemic species are paleoendemics (**WH criterion 1**) or are important factors in determining the distribution of closely related species and are therefore of significance in explaining the distribution and evolutionary history of the region's ichthyofauna (**WH criterion 2**). Pusey and Pearson (1999) argued that, in contrast to the pattern observed for terrestrial vertebrate and invertebrate fauna, widespread extinctions during glacial periods and subsequent recolonisation of rainforest areas during interglacial periods by species confined to climatic refugia appear to have played little part in determining the distribution and richness of the fauna (**WH criterion 1**).

The region also contains disjunct populations of more widely distributed populations such as Macculloch's Rainbowfish (*M. maccullochi*), Gertrude's Blue-eye (*Pseudomugil gertrudae*) and the Pennyfish (*Denariusa bandata*), and the maintenance of such populations is of significance with respect to the maintenance of genetic diversity of the species over its entire range. The region also contains many species that are normally not found, or ordinarily rare, on the Australian continent but which are common elsewhere (*ie Kuhlia marginata*) and species which are at their northern distributional limit on the east coast (*H. fuliginosus*) (**FNQ 2010 criterion b**).

Recent genetic work by scientists associated with the CRC for Rainforest Ecology and Management have indicated that genetic separation between populations formerly considered to be conspecific is sufficiently great to warrant re-examination of the systematics of some taxa. Thus, *Craterocephalus stercusmuscarum stercusmuscarum* populations from the upper Johnstone River and the upper Barron catchment may represent a new and endemic species (D. McGlashan, *pers. comm.*). Aspects of morphology and life history response to flow regime also support an inference of distinction from lowland populations (Pusey manuscript in prep.). Similarly, the distinctive rainbowfish known as "the Utchee Creek" rainbowfish, and previously identified either as *M. splendida splendida* (Allen 1995) or *M. eachamensis* (Pusey *et al*. 1997), may be sufficiently distinct to warrant elevation to full species status (C. Moritz, *pers. comm.*). Further such work will almost certainly identify other populations warranting systematic revision (**WH criterion 2**).

The distribution of fishes within the region is well known and several published studies exist for individual rivers and for the region as a whole (Russel and Hales 1993, Pusey *et al*. 1995, Russell *et al*. 1996a, 1996b, Pusey and Kennard 1996, Pusey *et al*. 1997, Pusey *et al*. 1998). In addition, active ongoing research (Griffith University, DPI and DNR) has collected further distributional information for many species in many rivers of the region ensuring that consideration of the conservation value of individual sub-catchments is founded on a substantial knowledge base.

2.3.7 Taxa Of Specific Conservation Interest - Frogs

Over half of Queensland's rainforest frogs (42 spp.), which constitute 37% of the total number of frog species in the state, are found in the Wet Tropics region (McDonald 1992) (**FNQ 2010 criterion b**). Moreover, of these species, 91% are endemic to the region (McDonald 1992) (**WH criteria 1&4**). Eight species are dependent on flowing stream environments as larvae and adults and are therefore susceptible to the effects of altered flow patterns. Importantly, highly significant reductions in abundance, to the point of suspected extinction, have occurred in the last decade (Richards *et al*. 1993).

The cause (or causes) of these declines is unknown (Czechura and Ingram 1990) but importantly, the declines are most strongly apparent for stream dwelling frogs highly dependent on the presence of flowing water (McDonald *pers. comm.*), and correspond in incidence to major structural changes in stream invertebrate fauna corresponding to long-term changes in the pattern of stream flow (R. Pearson, *unpubl. data* cited in Pusey and Pearson 1999). Of significance also is the fact that some species of frogs have declined most precipitously in upland areas whereas lowland populations remain intact. Conservation of these lowland populations and maintenance of flow regimes is therefore of utmost importance for the continued survival of these species and possibly for measures aimed at rehabilitating upland populations. Although some species may be apparently extinct in upland areas (**WH criterion 2**), habitat maintenance (*ie* the maintenance of flow regime) of these formerly occupied areas is paramount for rehabilitation and the protection of as yet unidentified populations.

Frogs are an important component of the region's aquatic fauna. The high degree of endemism is an important characteristic of the evolution of the region's fauna (**WH criterion 1**). Moreover, the present decline in frog populations may represent an important phase in the ongoing evolution of the frog fauna (**WH Criterion 2**) whereas maintenance of the critical habitat required for survival of several species of disappearing frogs is clearly of importance with respect to **WH criterion 4**.

2.3.8 Taxa Of Specific Conservation Significance - Freshwater Turtles

The Australian freshwater turtle fauna is not particularly species rich but is interesting by virtue of the widespread distribution of some species and the narrow endemism shown by others (Cann 1998). The Wet Tropics region mirrors this pattern and contains a high number of species (at least six) (**FNQ 2010 criterion c**), three of which (*Chelodina rugosa, C. longicolis* and *Emydura tanybaraga*) are restricted to rivers which have only a small portion of their headwaters within the boundaries of the WTWHA (Normanby, Burdekin and Mitchell rivers, respectively). Two of the remaining species are widely distributed throughout much of northern Australia (*Elseya latisternum*), and the eastern seaboard (*Emydura krefftii*). The northern limit of the distribution of *E. krefftii* is bounded by the northern edge of the Wet Tropics region. Significantly, species of *Elseya* nor *Emydura* cannot aestivate, in contrast to *Chelodina* species (Cann 1998), and therefore maintenance of flows is a critical requirement.

There is substantial debate concerning the evolution of narrowly restricted endemic species within the genus *Elseya*. Cann (1998) maintains that many river systems of eastern Australia contain their own endemic species within the *E. dentata* species complex and some river specific endemics have been described (Cann 1998) (**WH criterion 2**). Electrophoretic examination of a range of specimens has confirmed that specimens within this complex from the Johnstone River are distinct (Georges and Adams 1992)(**WH criteria 4, FNQ 2010 criteria b**). Cann (1998) maintained that other drainages of the Wet Tropics region also contained distinct forms. Given the high degree of narrow endemism seen in the genus *Aponogeton* (Hellquist and Jacobs 1999) and in some freshwater fishes, it is probable that substantially more genetic differentiation between populations in other rivers exists, particularly for those in the Mulgrave River (**WH criterion 2**).

2.3.9 Regional Ecosystems Of Specific Conservation Interest

Rare and/or threatened regional ecosystems have been identified and documented within the wet tropics region by Goosem *et al*. (1998) and are set out in Table 3. These were considered in view of the fact that stream discharge sustains many such systems. The maintenance of local hydrological regimes is of particular importance with respect to the coastal lowlands where there has been disproportionate destruction and fragmentation of the native vegetation cover for agricultural and residential land uses (**FNQ 2010 criterion b**). A major outcome of the *FNQ 2010 Planning Project* was the identification of these "priority coastal communities". Areas such as the Cape Tribulation lowlands, wetlands (including paperbark swamps) associated with the Daintree River estuary, wetlands (including paperbark swamps) along the coastal strip south of the Daintree River to Cairns, Trinity Inlet, the southern Malbon-Thompson lowlands, Wyvuri Swamp, Bramston Beach wetlands, Eubenangee Swamp, wetlands (including paperbark and feather palm swamps) (**WH criteria 1&2**) around Innisfail, Behana Creek, Figtree Creek, Harvey Creek, Basilisk Range corridor (which also includes paperbark swamps), the Mission Beach area, the Tully-Murray lowlands and the Cardwell lowlands were identified as being of outstanding biodiversity value in the *Regional Environment Strategy* (ACTFR 1998:7) (**FNQ 2010 criterion c**). Of the 105 different regional ecosystems identified by Goosem *et al*. (1998) as occurring in the Wet Tropics region, 24 are classified as endangered and a further 17 are of concern.

Discharge from Canal Creek, for example, sustains one of these areas of outstanding biodiversity - Eubenangee Swamp (**FNQ 2010 criteria b, c&d**). Furthermore, the occurrence of these rare and/or threatened regional ecosystems frequently amplifies the importance of a sub-catchment since several provide habitat strongholds for rare and/or threatened species. For example, the endangered regional ecosystem 7.3.24, and 7.3.27 that is of concern, support populations of the endangered Mahogany Glider (*Petaurus gracilis*) (**WH criterion 4, FNQ 2010 criterion b**). Similarly, endangered feather palm swamp forest (regional ecosystem 7.3.3) provides habitat for the endangered tassel fern *Huperzia dalhousieana*.

Stream discharge is considered vital for the maintenance of half (12 out of 24) of those regional ecosystems considered to be endangered and around 30% (5 of 17) of those considered to be of concern (Table 3). In addition, knowledge of important variants of

particular regional ecosystems (and of other communities, which represent relict floristic associations within the region and are therefore of evolutionary interest (**WHA criterion 2**)) has influenced values ascribed to sub-catchments.

A particular example of such a relict occurrence is a population isolate of Hoop Pine (*Araucaria cunninghamii*) along with consociate, essentially southern, taxa including Scrub Bloodwood (*Baloghia inophylla*), Mararie (*Pseudoweinmannia lachnocarpa*) and Cascarilla Bark (*Croton insularis*). Such an assemblage occurs at Huntsbrook Creek within the Mulgrave River system, which is remote from other occurrences south of Ingham and on the Hann Tableland in the Einasleigh Upland bioregion. Such considerations are reflected in the relative scores allocated to the various sub-catchments that contain streams maintaining these systems.

Table 3. Status of wet tropics regional ecosystems (after Goosem *et al*. 1998). Those considered to be dependent on sustained stream flows are highlighted. Numbering is consistent with that used by Goosem *et al*. (1998)

Endangered regional ecosystems	
7.2.1	Mesophyll rainforest on coastal beach sands; provinces 3, 9
7.2.2	Notophyll rainforest with *Acacia* emergents on coastal beach sands; province 8
7.3.1	Sedgeland (grassland freshwater swamp on coastal lowlands; provinces 1, 2, 3,
7.3.2	Sedgeland (grassland freshwater peat swamps of volcanic craters; province 4
7.3.3	Alexandra palm (*Archontophoenix alexandrae*) on poorly drained lowlands; provinces 1, 2, 3, 9
7.3.4	Fan palm (*Licuala ramsayi*) swamp rainforest on poorly drained lowlands; provinces 2, 3, 9
7.3.6	Melaleuca open forest/rainforest complex on poorly drained lowlands; provinces 1, 2, 3, 9
7.3.7	Eucalyptus/Melaleuca open forest complex on poorly drained lowlands; provinces 1, 2, 3
7.3.10	Complex mesophyll rainforest on well drained fertile lowland alluvials; provinces 2, 3, 9
7.3.12	Blue gum (*Eucalyptus tereticornis*) woodland on well drained lowland alluvials; provinces 2, 3, 9
7.3.13	*Corymbia nesophila* woodland on well drained lowland gravelly alluvial soils; province 9
7.3.22	Complex mesophyll riparian rainforest on well drained lowland alluvial levees; provinces 2, 6, 9
7.3.24	*Melaleuca dealbata* riparian open forest on lowland alluvia; provinces 1, 2
7.3.25	*Melaleuca*, eucalypt and notophyll rainforest spp. riparian forest, province 1
7.3.26	River Oak (*Casuarina cunninghamiana*) riparian forest, province 1
7.3.28	Herbfield and shrubland of river sandbars and river beds, provinces 1, 2, 3, 9
7.8.2	Complex mesophyll rainforest on basalt uplands; province 4
7.8.3	Complex notophyll rainforest on basalt lowlands, foothills and uplands; provinces 4, 9
7.8.6	Semi-deciduous mesophyll rainforest on basalt foothills; provinces 3, 9
7.8.7	Blue gum (*Eucalyptus tereticornis*) tall open forest on basalt uplands and highlands; province 4
7.8.8	*Eucalyptus phaeotricha* woodland on basalt uplands and highlands; province 4
7.11.2	Fan palm (*Licuala ramsayi*) forest on poorly drained metamorphic tablelands; province 8
7.11.8	Notophyll rainforest with *Acacia* on metamorphic lowlands and foothills; provinces 2, 3, 8
7.12.12	Notophyll rainforest with *Acacia* emergents on granite lowlands and foothills; provinces 5, 8
Regional ecosystems of concern	
7.1.3	Bulkuru (*Elaeocaharis dulcis*) swamp on poorly drained acid peats; provinces 1, 2, 3
7.2.4	Open forests and woodlands on old dune ridges; provinces 1, 2, 3
7.3.5	Swamp paperbark (*Melaleuca quinquenervia*) on poorly drained lowlands; provinces 1, 2, 3, 9

7.3.23	Semi-deciduous notophyll riparian rainforest on well drained alluvial levees; provinces 1, 5, 8
7.3.27	Eucalypt and swamp mahogany (*Lophostemon suaveolens*) riparian forest, provinces 1, 2, 3
7.8.1	Complex mesophyll rainforest on basalt lowlands and foothills; provinces 3, 4, 9
7.8.4	Complex notophyll rainforest on basalt uplands and highlands; province 4
7.8.9	Molloy red box (*Eucalyptus leptophleba*) woodland on dry basalt uplands, province 4
7.11.16	Tall open pink bloodwood woodland on moist metamorphic uplands, provinces 5, 6
7.11.20	*Corymbia nesophila* forest on metamorphic lowlands and foothills; province 9
7.12.2	Fan palm (*Licuala ramsayi*) mesophyll rainforest on poorly drained granite foothills; provinces 3, 9
7.12.10	Notophyll rainforest with hoop pine (*Araucaria cunninghamii*) on granite uplands; province 5
7.12.18	Microphyll rainforest with hoop pine (*Araucaria cunninghamii*) on granite uplands; province 5
7.12.21	Flooded gum (*Eucalyptus grandis*) forest on granite and rhyolite uplands, provinces 5, 6, 7, 9
7.12.22	Red mahogany (*Eucalyptus resinifera*) forest on granite and rhyolite uplands, provinces 5, 6, 7, 9
7.12.23	Pink bloodwood (*Corymbia intermedia*) woodland on granite and rhyolite uplands; provinces 5, 6
7.12.24	White mahogany (*Eucalyptus acmenoides*) woodland on granite foothills; provinces 2, 3, 6

2.3.10 Distinctive Flow Regime Types And/Or Flow Needs

A river's flow regime is the primary determinant of how it functions. The extent of interaction and transfer of materials between the riverine ecosystem and adjacent ecosystems (Sparks 1992), and alterations in the temporal pattern of discharge delivery, have the potential to impact upon many ecological components of the riverine environment (**WH criteria 2 & 4, FNQ 2010 criterion d**). Therefore, the degree of alteration of the temporal pattern of flow delivery, and the extent to which flow regulation impacts upon aquatic systems, need to be assessed in the context of the natural flow regime. Several different flow regime types are evident within the WTWHA and are primarily associated with latitudinal and longitudinal position within the catchment (see Appendix 1). Flow regime types include the strongly seasonal and predictable regimes evident in the northern extremity of the WTWHA, the more constant and highly predictable regimes typical of the central portion of the WTWHA, and the more erratic flow regimes typical of the southern extremities of the WTWHA. Flow regimes of the headwater sections of rivers arising in the western portion of the WTWHA are different again.

2.4 Other Attributes Of Potential Value For Allocating Conservation Value

Attributes other than those listed above that were consistent with World Heritage and FNQ 2010 criteria and that might potentially be impacted by flow regulation have also been considered. These are:

2.4.1 Taxa Of Specific Conservation Interest - Terrestrial Vertebrates

Few Australian terrestrial vertebrates are directly dependent upon lotic waters. Although a number of lizards (*eg Eulamprus quoyi* - Water Skink, *Physignathus leseurii* - Eastern Water Dragon) and snakes (*Morelia fusca* - Water Python, *Stegonotis cucculatus* - Slaty Grey Snake, *Tropidonophus mairii* - Freshwater Snake, *Enhydris polylepis* - Macleay's Water Snake) are frequently found in the vicinity of streams, none are restricted to the WTWHA or to the region, nor are they completely dependent on aquatic habitats. *Ornithorhynchus anatinus* (Platypus) is completely

dependent on the aquatic environment but is similarly widespread and not limited to the WTWHA or region. Consequently, the species listed above have not been considered; however, alterations in flow regime, or infrastructural development associated with water extraction, may impact on these species. A sub-catchment's conservation value may be enhanced if it and adjoining sub-catchments foster the movement of more restricted taxa such as the endemic (**WH criterion 1**) Cassowary (southern sub-species) and Tree Kangaroo between important habitat areas (**WH criteria 2 and 4**). If sub-catchments satisfied this criterion, a higher value was accorded to them within attribute 1 - Ecosystem function values.

2.4.2 Major Stages In The Earth's Evolutionary History And Examples Of Ongoing Evolution And Evolutionary Process

The paleoendemic fishes of the region offer substantial insights into the climatic and geomorphological evolution of Australia. For example, the high diversity of these species (plus the generally high genetic diversity) suggests that the riverine ecosystems of the region did not experience the same Pleistocene climatic perturbation as was experienced by the terrestrial biome.

The Bloomfield River Cod is the only tropical Australian representative of the Percichthyidae, an otherwise southern temperate Gondwanan family. Its presence in the upper reaches of the Bloomfield (**WH criterion 4**) is indicative of a prior cooler climatic regime (*ie* pre Miocene) and its biogeography is a result of continental inundation during the Cretaceous (Pusey and Kennard, *in prep*.) (**WH criterion 2**). The current distribution of this species and the distinction between the region's ichthyofauna and that occurring west of the Great Divide are good examples of biogeography being associated with major changes in continental geomorphology and landscape evolution (**WH criterion 3**). Hybrid zones such as that in the Tully River between northern and southern populations of *Littoria nannotis* are also important in this regard.

Biological and genetic diversity are important in the maintenance of ecological function, providing links between different trophic levels or the ability to adapt to new circumstances (**FNQ 2010 criterion d**).

If sub-catchments were deemed to have high value due to examples of the above, then that value was included within the individual faunal attributes.

2.4.3 Sites Of Significant Human Interaction

It is recognised that rivers and streams are of substantial significance to indigenous peoples of the region but the study was constrained from allocating conservation value to sub-catchments on this basis due to issues of cultural sensitivity and access to the necessary information. Moreover, in light of issues concerning process transparency raised in Section 2.2, there are no means by which to include such considerations. However, this issue is important and must be properly considered and incorporated into the decision-making process by those more qualified and culturally suitable.

Sites of scientific interest or ongoing long-term research are of importance and may potentially be impacted by flow regulation (**WH criterion 2**). Streams and riparian zones in which significant research has been undertaken in the past, or which are the current focus of studies intended to provide long-term data, should be protected to support the continuity of those studies and as a means of monitoring the values of the WTWHA in the future. For example, scientific studies initiated to monitor the decline and/or recovery of endemic stream dwelling frogs may provide additional information on ecosystem health in the broader sense. Such studies will be of little use if flow regimes are altered.

2.5 Allocating Value To Individual Attributes And To Sub-catchments And Basins

A series of proforma sheets was produced for each attribute and major drainage. The conservation value of each sub-catchment was ranked from 1 to 5 according to the World Heritage and FNQ 2010 criteria listed above. Justification for ranks was included for each sub-catchment and the source of information upon which judgement was made was also included. Work sheets for each attribute and major drainage are included as Appendix 2. The rankings for each attribute and sub-catchment and the overall derived conservation value for each sub-catchment are included in Appendix 3. An electronic copy (Microsoft Excel 97) is also included.

The overall conservation value for each sub-catchment was derived according to the following two step process:

1. If any attribute for a sub-catchment was awarded a **5**, then the sub-catchment was determined to be of **Very High Conservation and Ecological Value**, regardless of the value of any other attribute. In this way, a sub-catchment can be afforded high protection if it contains a single species of high conservation significance. Similarly, if a sub-catchment contained no taxa of specific conservation interest but was of very high ecosystem function value for other sub-catchments which did contain such species, it could also be rated as of **Very High Conservation and Ecological Value**. Scores of 5 were allocated very conservatively.

2. If no attribute was scored as a 5, then the overall conservation value was determined by determination of the mean attribute score across all attributes. Mean scores of 2 or less were accorded **a Moderate Conservation Value**, whereas mean scores of greater than 2 (but not 5) were accorded a **High Conservation and Ecological Value**.

3. CONSERVATION VALUES OF WATERWAYS IN THE WTWHA

3.1 Spatial Variation In Conservation Value Within Attributes

A mean score across all sub-catchments within each major drainage basin was estimated for each attribute. Sub-catchments for which no score was possible for individual attributes due to insufficient information were not included. In some drainages, and for some attributes, this resulted in no mean score being derived. This does not indicate that the drainages

contain sub-catchments of low value but highlights drainages for which substantial research effort to document the presence of taxa of specific conservation interest is required.

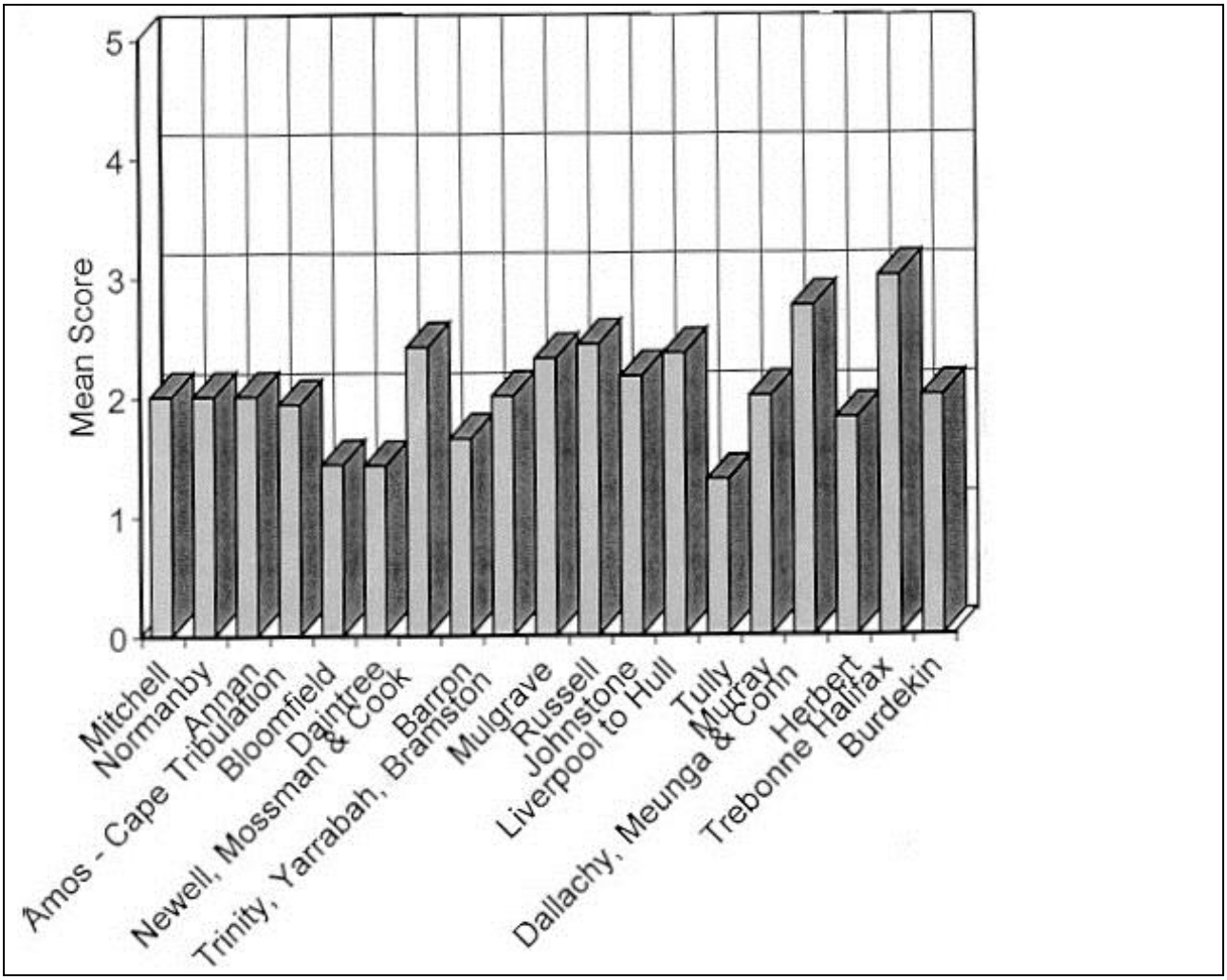
3.1.1 Ecosystem Process Values

All streamflow has some value in a range of ecosystem processes including maintenance of stream geometry, habitat integrity, floodplain inundation *etc*. It is perhaps less meaningful to compare mean scores across catchments than it is to compare within drainages for this attribute as the intent was to discriminate sub-catchments within drainages that were of comparatively greater value. None-the-less, spatial variation across catchments was apparent (Fig. 1).

Sub-catchments of the Newell, Mossman & Cook drainages scored comparatively highly due to the generally small size of the streams. Over-regulation of these streams could substantially impact on the streams themselves by altering channel maintenance processes, and affecting the delivery of nutrients to downstream reaches, their short estuaries and the near-shore environment. Several sub-catchments had high connectivity value, especially Crees to Robbins, linking the Barron and Mossman drainages.

The Dallachy, Meunga and Conn drainage and the Trebonne Halifax drainage also scored highly for the same reasons.

Figure 1. Mean conservation value for major drainages based upon ecosystem function values.



3.1.2 Taxa Of Specific Conservation Interest - Rheophytic Plants

Information concerning the presence of rare and threatened rheophytes was not available for five major drainages and it is significant that these drainages were located at the latitudinal extremes of the WTWHA (Normanby River in the north and Murray, Dallachy - Meunga - Conn, Trebonne - Halifax and Burdekin in the south) (Fig. 2).

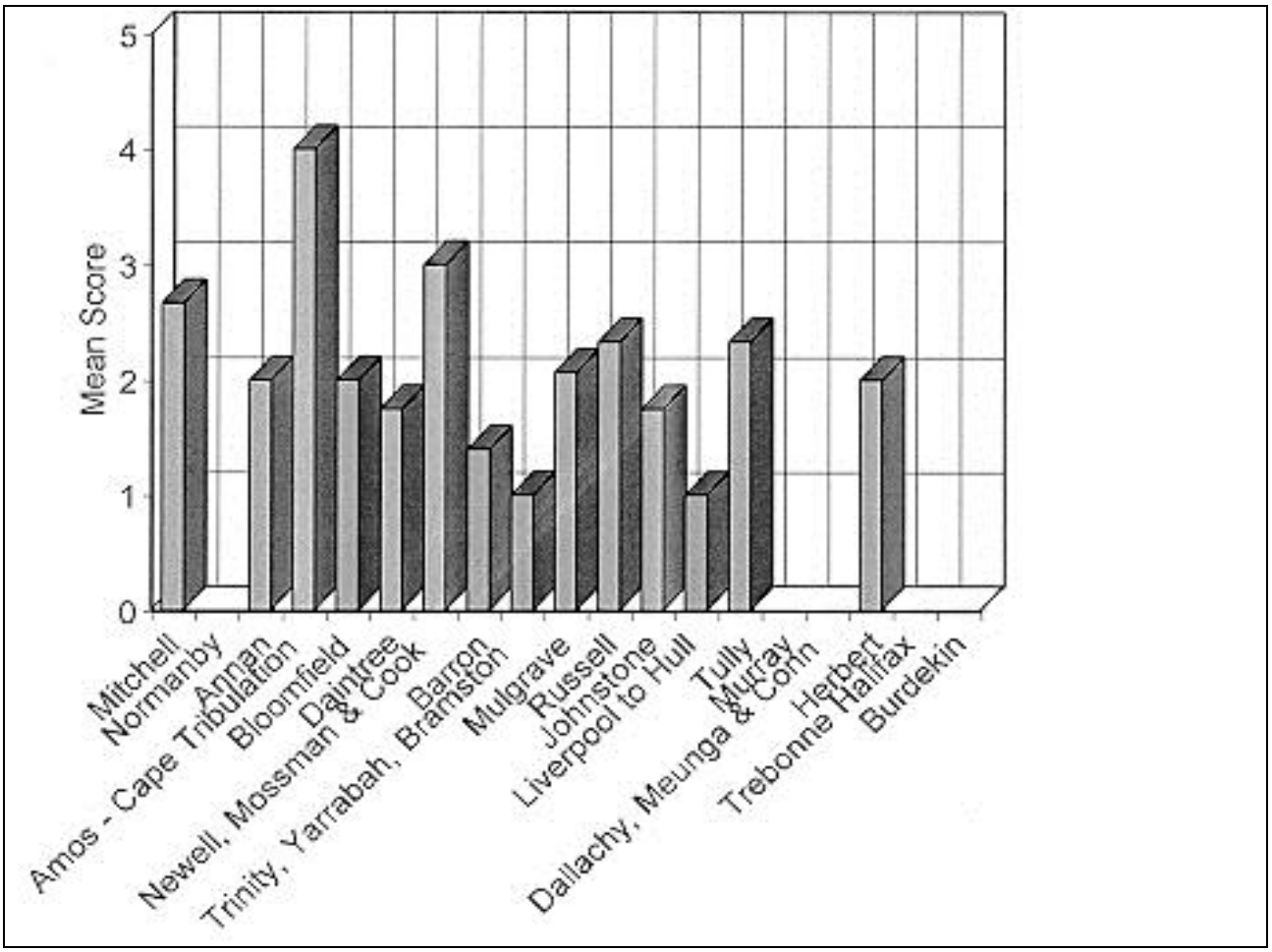
The Mitchell drainage contains two species of significance, *Ostrearia fleckeri* and *Romnalda gralata*, however data is lacking for all but three of the sub-catchments (See Appendix 2). A single sub-catchment provides the only data for the Annan drainage and this sub-catchment is known to contain O. *fleckeri*. The Amos - Cape Tribulation drainage contains 14 species of rare and threatened rheophytes and accordingly has a very high mean score. Five of the sub-catchments (Gap, Mason, Myall, Noah & Cooper) were given a score of 5 and each contained three to six rare and threatened rheophytes with the exception of the Cooper Creek drainage which contained eight species and is the only known location for the rare taxa *Acmena* sp. LCC and *Endiandra cooperana*.

South Mossman and Platypus sub-catchments of the Mossman River also scored highly due to the presence of *Waterhousea hedraiophylla* and *Peripentadenia phelpsii*.

The Mulgrave and Russell drainages contained *Syzygiom xerampelinum, S. alatoramullum, S. boonjee, W. mulgraveana, O. fleckeri, Neostrearia fleckeri* and

Acacia hylanoma. Babinda was the only sub-catchment to be ranked 5; the remaining sub-catchments tended to be ranked 2,3 or 4.

Figure 2. Spatial variation in conservation value according to the presence of rheophytic plants of specific conservation interest.



Although the Bloomfield drainage did not score a high mean value, one sub-catchment, Roaring Meg, was accorded a value of 5 due to the presence of *Buckinghamia furriginiflora, Gymnostoma australianum, Romnalda gralata, Romnalda sp*. and *Xanthostemon graniticus*.

The Newell - Mossman - Cook drainage also scored highly as two sub-catchments (Platypus and Sth Mossman) contain *Buckinghamia furriginiflora* and *Peripentadenia phelpsii*.

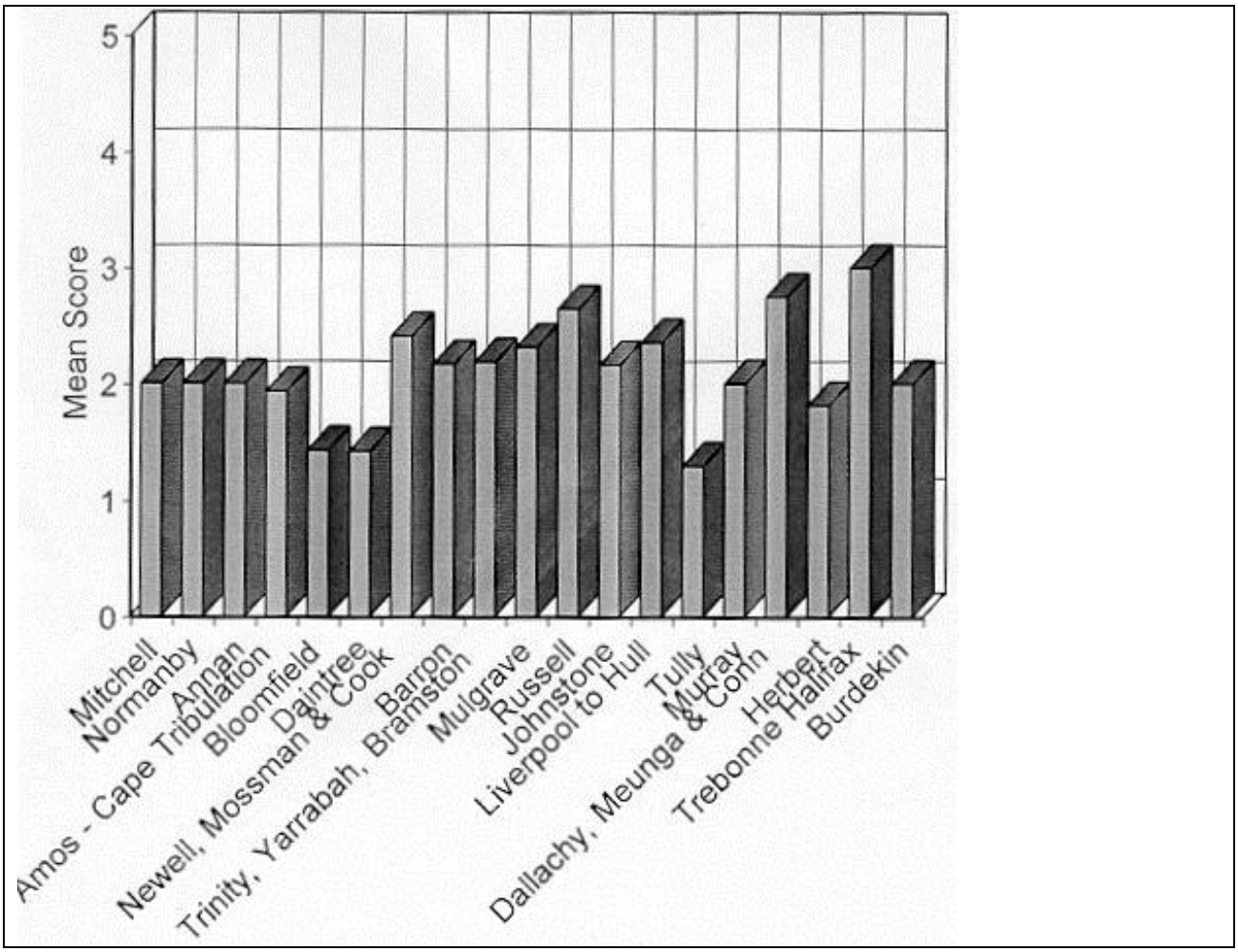
Although no sub-catchment in the Mulgrave was accorded a value of 5, several sub-catchments were ranked at 2 or 3 due to the presence of one or two of the following species; *S. xerampelinum, W. mulgraveana, A. hyalanoma* or *S. boonjee*. The Little Mulgrave was the most highly ranked sub-catchment (4) due to the presence of *S. xerampelinum, W. mulgraveana* and *S. alatoramullum*. A similar situation was observed in the Russell drainage with four sub-catchments being accorded a value of 3 due to the presence of one or two of the following species: *N. fleckeri, S. boonjee* or *W. hedraiophylla*. The Babinda sub-catchment was accorded a value of 5 due to the presence of these species as well as *O. fleckeri*.

The Tully River drainage also scored a mean value above 2 due to the presence of *O. fleckeri, Acmena smithii* and *A. smithii* "small fruited form". It should be stressed that information was available for only 22% of the total number of sub-catchments.

3.1.3 Taxa Of Specific Conservation Interest - Aquatic Plants

The most significant aspect of the spatial variation in conservation significance according to this attribute is the paucity of information available (Fig. 3). There is a significant need for a systematic survey of the aquatic plants of the Wet Tropics region with a substantial focus on the provision of material suitable for examination by relevant systematic experts.

Figure 3. Spatial variation in conservation value according to the presence of aquatic plants of specific conservation interest



It is not surprising that all of the drainages for which data exist with the exception of the Mulgrave River, score highly (2 or greater) given that herbarium records for these drainages or the revision of the genus *Aponogeton* (Hellquist and Jacobs 1998) are associated with species endemic, or nearly so, to each river. The Lower Mowbray, Collard and Cook sub-catchments contain *Aponogeton vanbruggenii* and these sub-catchments are the only locations within the WTWHA for which it has been recorded. Its distribution also includes the upper Mitchell, the Claudie River and Pascoe rivers of

Cape York Peninsula, and several drainages in Arnhem Land (Hellquist and Jacobs 1998).

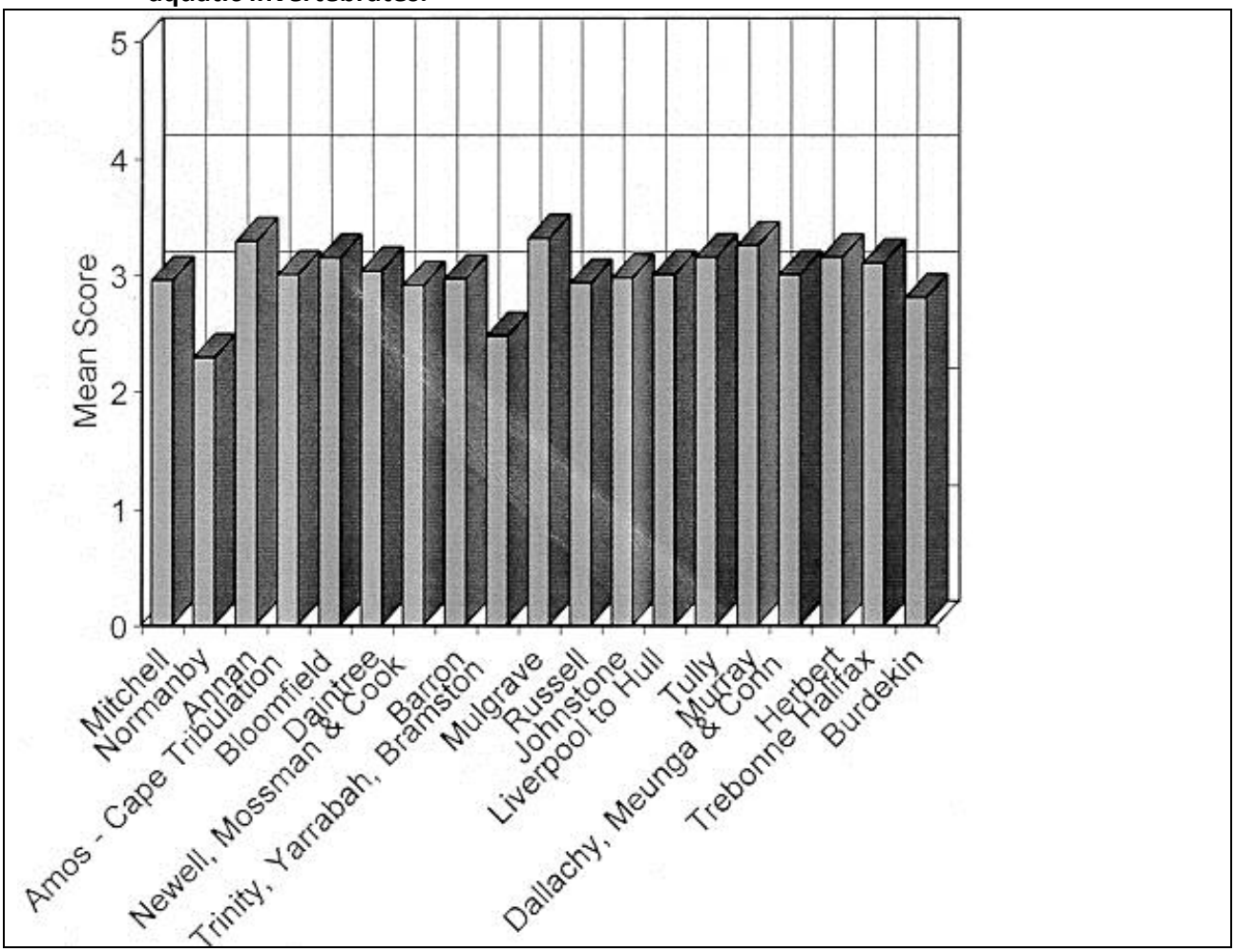
The Russell River contains several sub-catchments in which *Torrenticola queenslandica* (Rare), the endangered *Aponogeton bullosus* and the river endemic A. *lancesmithii* occur.

The Johnstone River also ranked highly due to the presence of *T. queenslandica* and the widespread but endangered *A. bullosus*. This river appears to represent a stronghold for this species within the WTWHA. Another *Aponogeton* species has been recorded from the Johnstone River but the only known locations from which it has been collected are outside the boundaries of the WTWHA. This species, *A. prolifera* has only been recently described (Hellquist and Jacobs 1998) but is highly endangered and possibly extinct in the wild due to indiscriminate collection by unscrupulous aquarium suppliers. It is considered critical that further research documenting its presence and distribution within the Johnstone River is undertaken.

3.1.4 Diversity Of Freshwater Invertebrates

There is little apparent spatial variation in conservation value of drainages in the WTWHA according to differences in invertebrate diversity, due to the generally high diversity recorded for this group in streams throughout the Wet Tropics region (*ie* most sub-catchments scored a 3 or 4) (Fig. 4).

Figure 4. Spatial variation in conservation value according to variation in the diversity of aquatic invertebrates.



Higher value was accorded to sub-catchments containing waterfalls, as these habitats are known to contain a distinctive fauna.

Only two sub-catchments were accorded a value of 5, Smoko (Herbert) and Paluma (Burdekin). These sub-catchments contain Yuccabine Creek (Smoko), and Birthday and Camp Creeks (Paluma) which have been the subject of almost two decades of scientific research. This research has revealed many aspects of the ecology of aquatic systems of the region and provides the best long-term data set yet available for monitoring purposes. These sub-catchments contain the most diverse aquatic invertebrate communities in all of Australia.

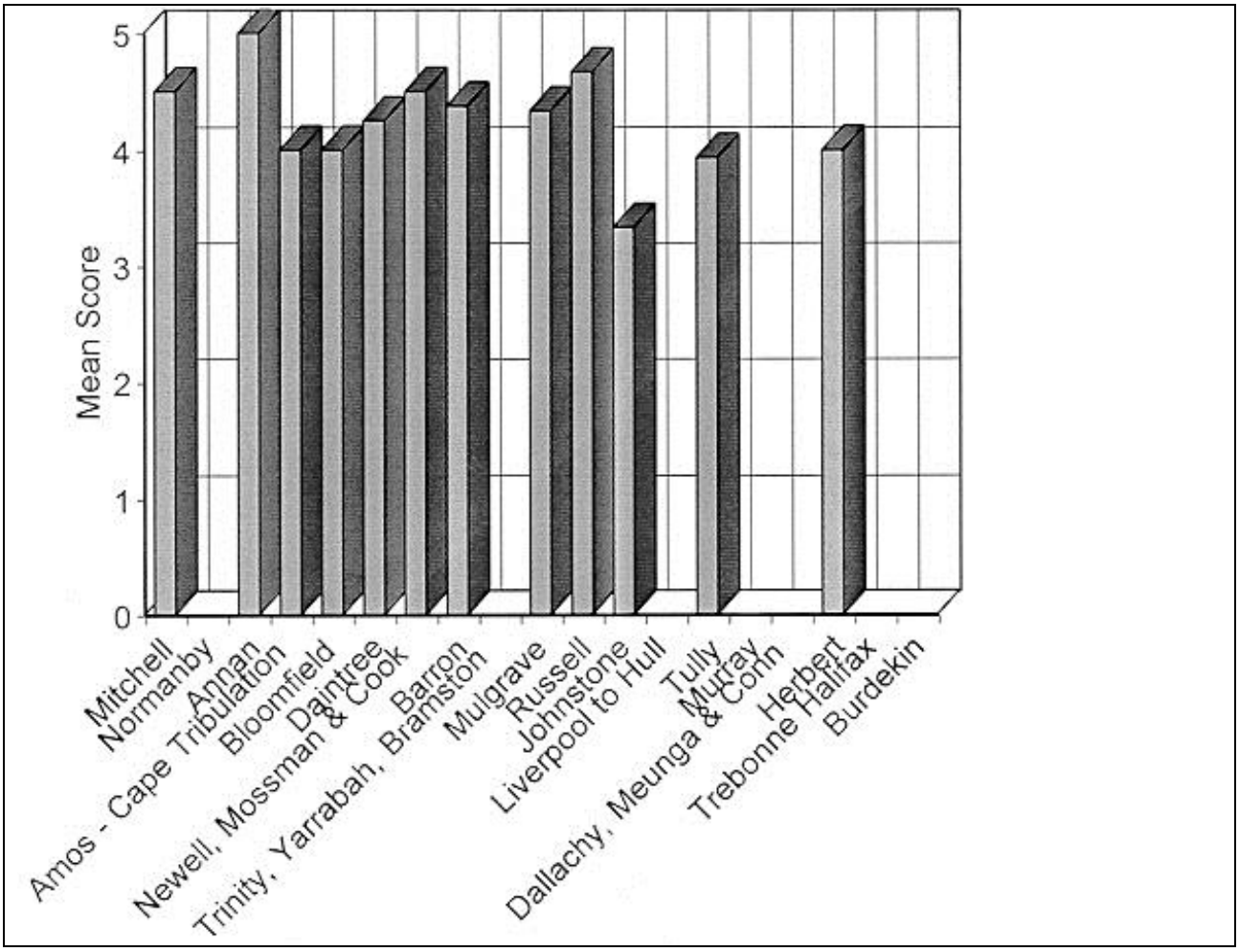
3.1.5 Taxa Of Specific Conservation Interest - Freshwater Crustacea

All drainages for which there are data concerning the presence of rare or threatened crustacea scored high mean scores reflecting the importance of the Wet Tropics region as a centre of diversity and endemism of freshwater crustacea (Fig. 5).

Four sub-catchments of the Mitchell system are known or suspected to contain the spiny crayfish *Euastacus fleckeri* (Mary and Bushy, Reedy and Half Ton). The congeneric *E. robertsi* is known to occur in the Parrot sub-catchment of the Annan and was accordingly ranked as 5. Information concerning the presence of this or similar

species in other sub-catchments of this river is lacking and the overall high value is due to the known presence of this species.

Figure 5. Spatial variation in conservation value according to the presence of freshwater crustacea of conservation significance.



Euastacus fleckeri or *E. robertsi* are known or suspected to occur in all drainages to the north of the Barron. Within the Barron drainage it is replaced by *E. balanensis*, which also occurs in the Mulgrave and Russell drainages. The rainforest endemic shrimp *Caradina zebra* also occurs in the Barron River.

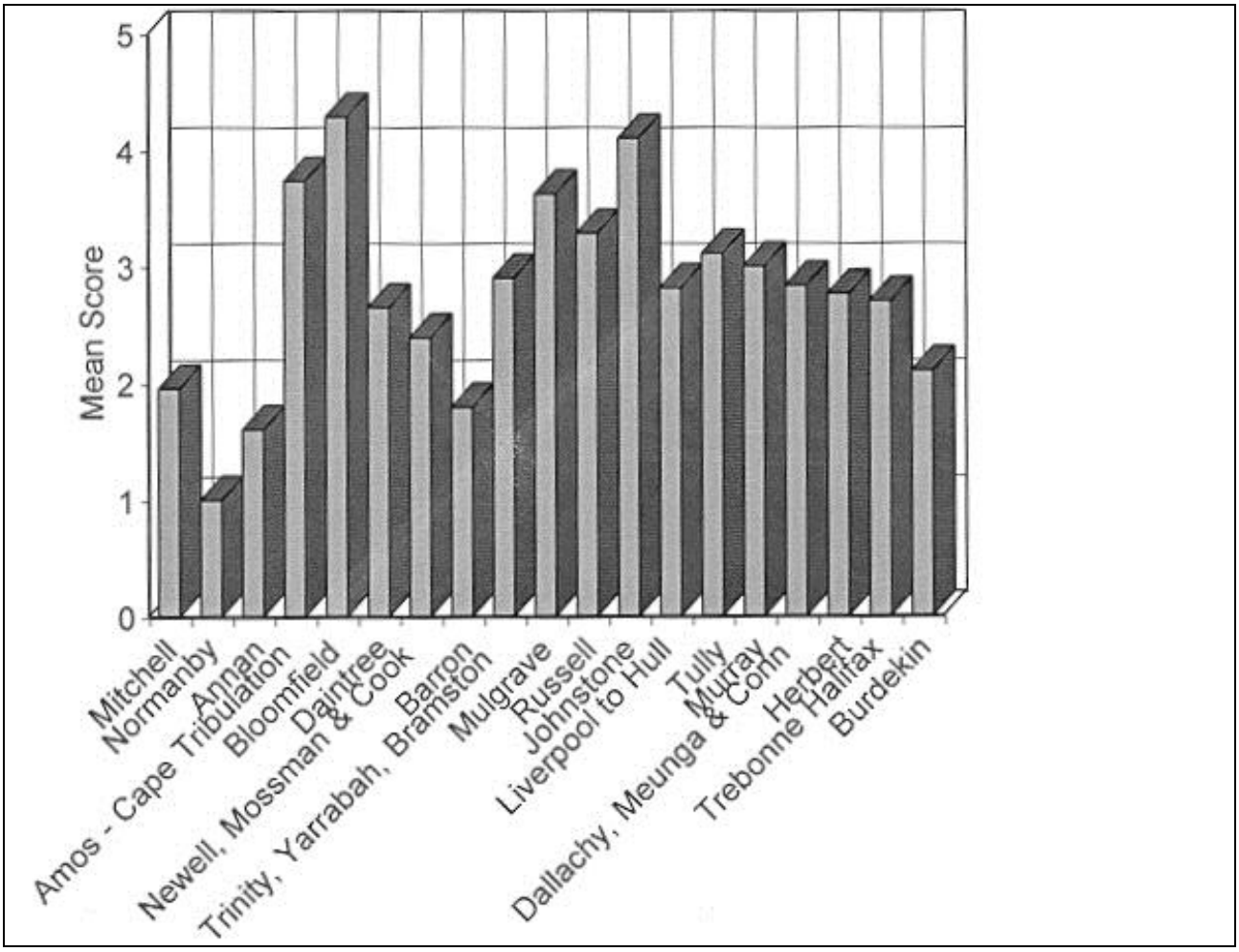
The Tully and Herbert River sub-catchments for which information is available contain a number of crustacea of interest. *Caradina zebra* is widespread in the Tully system and several sub-catchments contain one or more of the following endemics; *E. yigara, C. zebra, Cherax parvus* and an undescribed new species of *Macrobrachium*.

3.1.6 Taxa Of Specific Conservation Interest - Rare And Endemic Fishes And Areas Of High Fish Diversity

Many of the drainages of the Wet Tropics region exhibited high mean scores for this attribute and this is not surprising given the high diversity and presence of a distinct fauna, many of which are regional or river specific endemics reported by Pusey and Kennard (1994, 1996). All but four drainages scored greater than a mean value of 2 (Mitchell, Normanby, Annan and Barron) (Fig. 6). Of these, only the headwaters of the

Mitchell and Normanby Rivers are contained within the WTWHA and accordingly diversity is low. It should be emphasised that although the Annan River scored comparatively poorly, one sub-catchment, Wallaby, scored highly (4) due to the presence of a distinct colour form of the rainbowfish *Melanotaenia trifasciata*. It is not so much that the colour form present here is distinct but rather that this sub-catchment, plus Gap in the Amos-Cape Tribulation drainage, is the southern limit for this species.

Figure 6. Spatial variation in conservation value according to the presence of freshwater fishes of specific conservation interest and areas of high diversity.



Cape Tribulation streams scored highly mainly due to the importance of the habitat provided by many short steep coastal streams found here. These streams are inhabited by a significant number of species not normally found in the region. Moreover, the degree of beta diversity across these streams was equivalent to that observed for drainages across the entire Wet Tropics region (Pusey and Kennard 1996). These authors attributed this to the random nature of colonisation processes of marine/estuarine species into these drainages.

The Bloomfield River scored the highest overall score due to the presence of a recently discovered
genus and species of percichthyid cod in the upper reaches of the river (Pusey and Kennard 1996, Pusey and Kennard, description in preparation). This genus is limited to the Bloomfield River and within this system is restricted to that portion of the river

between the downstream Bloomfield Falls and the upstream Roaring Meg Falls. The family is typically a southern Australian representative of Gondwana origins and the next most northerly distributed species, *Macquaria ambigua*, occurs in the Fitzroy River, over 1000km to the south. Pusey and Kennard (in prep.) argue that the Bloomfield River Cod is a Miocene relic and is perhaps indicative of a much cooler climate prevailing in the area. It is of great conservation and phylogenetic significance.

The downstream reach of the Bloomfield River is the only known location in Australia of a member of the sicydine goby genera *Sicyopterus*. This goby, which has only been recorded from two locations within the river and appears restricted to torrent areas, was originally referred to as S. cf. *macrostetholepis* in Pusey and Kennard (1996) it is probably more closely allied to *S. micrurus* (R.Watson, *pers. comm.*) and warrants further examination.

The Daintree and Newell to Cook drainages scored moderately highly due to consistent rankings of 2 or 3 for most drainages, despite no endemic species being recorded from these drainages. However, both drainages provide excellent habitat for *Kuhlia rupestris*, for which concern over its survival exists, and for *K. marginata*, a rarely recorded flagtail species. Pusey and Kennard (1994) collected a single specimen of the New Guinean eel species *Anguilla macrostoma* from the Daintree drainage (from a tributary of Douglas Creek). High scores were accorded to the Luttra, Steart and Barratt sub-catchments because of their habitat value and because there is substantial connectivity between lowland reaches of the river and headwaters contained within high integrity forest. The Daintree sub-catchment also scored highly (4) because its floodplain is largely intact and the river is of high fish habitat value. An isolated population of *M. maccullochi* has also been recorded from the Forest sub-catchment.

The Mulgrave, Russell and Johnstone river drainages also scored high mean scores. These rivers are the most well surveyed rivers in the region. Their high standing is due not so much to the high diversity occurring in them (which is partially a function of research effort) but to the high number of Wet Tropics' and river specific endemics present. The Mulgrave and Russell systems contain an endemic species of goby, *Glossogobius sp*. B. This species is limited to these rivers and to a few creeks within the Trinity - Yarrabah drainage. Its presence in these latter sub-catchments is relictual due to the oscillation in the course of the Mulgrave River throughout the Pliestocene. The Mulgrave River alternated between a river mouth in Trinity Inlet and a mouth in Mutchero Inlet as each channel became clogged with sediment. The species is of biogeographic significance for the region and is phylogenetically significant, as it is the only known member of this genus that breeds entirely within freshwater (Pusey *unpub. data*).

These drainages also contain two other highly restricted gobiids. *Schismatogobius sp*. has only been recorded thus far from the Daintree, Mossman, Mulgrave/Russell and Johnstone drainages. Within these drainages it is highly restricted in distribution due to microhabitat preference. It is restricted to a few metres upstream of the head of fast flowing riffles where flow is sub-critical and tending towards laminar flow (Pusey *unpub. data*.). *Stiphodon allen* was recently described on the basis of a single specimen collected from a riffle in Harvey Creek.

Harvey Creek is also known to contain a distinct population of Blue-eye *Pseudomugil signifer*. This species attains comparatively great size, spectacular colour and finnage in this creek but populations are at risk from uninformed and perhaps unscrupulous aquarists.

The Mulgrave and Russell system contains very secure populations of the Cairns rainbowfish *Cairnsichthys rhombosomoides*. This species is a paleoendemic and the most primitive of the rainbowfishes within the family Melanotaeniidae. It is found in other drainages of the Wet Tropics to the south (Johnstone, Tully and Hull).

The Mulgrave River contains substantial populations of the Khaki Grunter, *Hephaestus sp*. a regional endemic. Specimens from this river form the type material for the species (Allen and Pusey, in prep.).

The Johnstone River is notable for the number of rainbowfishes found within its catchment. Lowland feeder streams contain isolated populations of the disjunctly distributed *M.maccullochi* (and *P. gertrudae*). These populations currently enjoy no formal protection being outside of the WTWHA and are at substantial risk due to floodplain reclamation and clearing. Most notable however, is the widespread presence of the previously considered extinct species *M. eachamensis* within the catchment (Pusey *et al*. 1997). In addition, a rainbow fish identified as *M. eachamensis* by Pusey *et al*. (1997) and previously known by aquarium hobbyists as the "Utchee Creek" rainbow (it is also found in a range of other creeks) has recently been shown to possibly warrant elevation to full species status (K. McGuigan, *pers. comm.*).

Genetic research has also shown that several distinct populations of the hardyhead *Craterocephalus stercusmuscarum stercusmuscarum* exist within the Johnstone River and that the upland population warrants elevation to full species status (D.McGlashan, *pers. comm.*).

The Tully River scored highly because many of the upland reaches have been shown to contain a heterogenous mix of *Mogurnda spp*. The heterogenous genetic composition is indicative of substantial drainage rearrangement from a variety of mechanisms and occurring over an extended period (Hurwood and Hughes 1998). In addition, the Jarra sub-catchment was accorded a value of 5 because it is one the very few lowland major tributaries within the Wet Tropics regions that is predominantly contained within the WTWHA. It therefore has very high habitat value. Stony Creek sub-catchment within the Herbert River was accorded a value of 5 for the same reason.

Although none of the streams of the Trebonne Halifax drainage are known to contain river-specific endemic species, many were accorded high value (3-4) for the following reasons. First, the headwaters of these streams are perennial and are the southern limit for a number of regional endemics including *Tandanus* cf. *tandanus* and *Hephaestus sp*. (J. Tait, *pers. comm.*). They have not been surveyed adequately and research should be focussed on these drainages to ascertain their true value.

The survey of Pusey and Kennard (1994) had its southern limit some 50 kms to the north of the Herbert River mouth. It is to be expected that the streams of the region would contain a fauna transitional between that of the Wet Tropics and that of central Queensland. Further research in these streams would almost certainly increase the overall diversity of the region.

Second, these streams provide excellent habitat for the Jungle Perch, *K. rupestris*, as do their lower reaches for a range of other species, many of which have recreational significance. The lowland reaches of these streams (which are outside of the WTWHA) tend towards ephemerality (in contrast to the upper reaches), and the continued integrity and fisheries values of the lower reaches is dependent on the maintenance of discharge from upstream perennial headwaters.

3.1.7 Taxa Of Specific Conservation Interest - Frogs

Generally high mean scores were observed across most major drainages (Fig. 7) reflecting the high diversity of endemic rainforest frogs found across the region and the importance of some sub-catchments as habitat for residual populations of declining frog species.

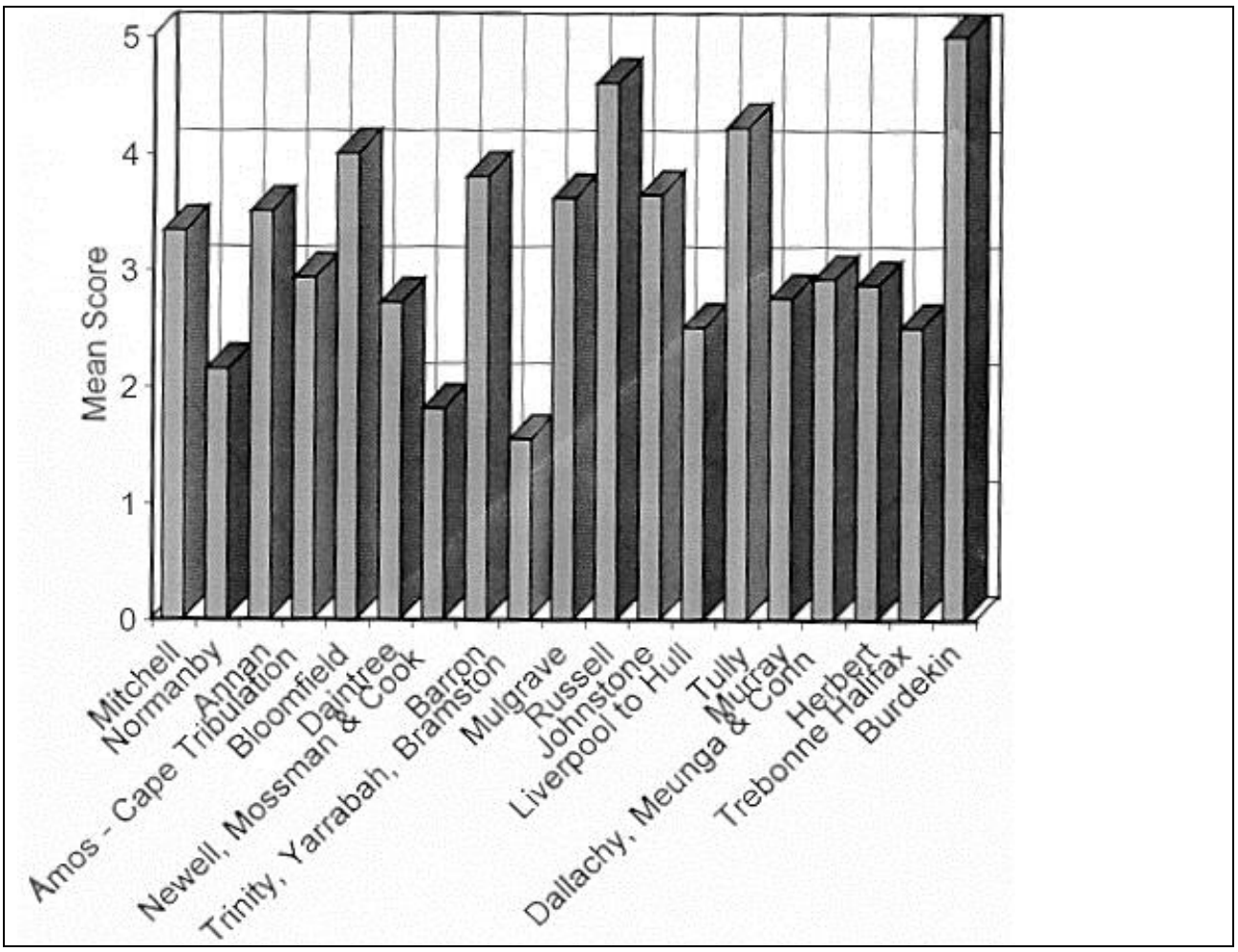
The Mitchell River sub-catchments partially or totally within the WTWHA contain a high number of rare and threatened frog species. Two sub-catchments, Mary and Bushy, contain all of the species of Wet Tropic endemic rainforest frogs currently experiencing declines in population size (*Littoria rheocola, L. nannotis, L. lorica, L. nyakalensis, Nyctomistes dayi, Taudactylus acutirostris* and *T. rheophilus*).

The Annan River drainage scored a similarly high value for the same reason. The Bloomfield River drainage also scored highly with the Baird, Roaring Meg and Woobadda sub-catchments containing 5, 7 and 5 rare and threatened species, respectively. Further survey work is required in this catchment.

This attribute is one of the few for which the Barron drainage scored highly due to the presence of the full complement of upland rare and threatened species (*L. nannotis, L. nyakalensis, L. rheocola, N. dayi* and *T. acutirostris*) in a high number of sub-catchments. The Freshwater Creek drainage in the lowland portion of the catchment was ranked highly (5) due to the presence of secure and abundant populations of all expected lowland rare and threatened species.

High elevation catchments of the Mulgrave and Russell Rivers, including Behanna Creek, contain the full complement of highland rare and threatened frogs expected for this part of the Wet Tropics region (*L. nannotis, L. rheocola, L. nyakalensis, N. dayi, T. acutirostris* and *T. rheophilus*). Harvey Creek and Babinda sub-catchments also contained the full complement of species. Many of the sub-catchments of the Johnstone River drainage contain a high number of rare and threatened species although many populations have suffered serious declines.

Figure 7. Spatial variation in conservation value according to the presence of frogs of specific conservation interest.



The remaining drainages also contain some but not all species of rare and threatened frogs and accordingly were ranked highly. The Tully River is notable because although 18 of the sub-catchments are insufficiently sampled to allow an estimate of the distribution of frog species within them, eight of the remaining nine sub-catchments (five upland and three lowland sub-catchments) were ranked 4 or 5 due to the presence of five or four species of rare and threatened frogs. The Theodore sub-catchment is notable as it is the type locality of *L. nannotis* and is an important hybrid zone between northern and southern populations of this species, reflecting geologically recent convergence of previously isolated Pleistocene remnant populations (C. Moritz, *pers. comm.*).

The very high mean score for the Burdekin drainage is somewhat misleading as it was based on data for only one sub-catchment (Paluma) which was previously known to contain populations of *N. dayi* and *L. nyakalensis*.

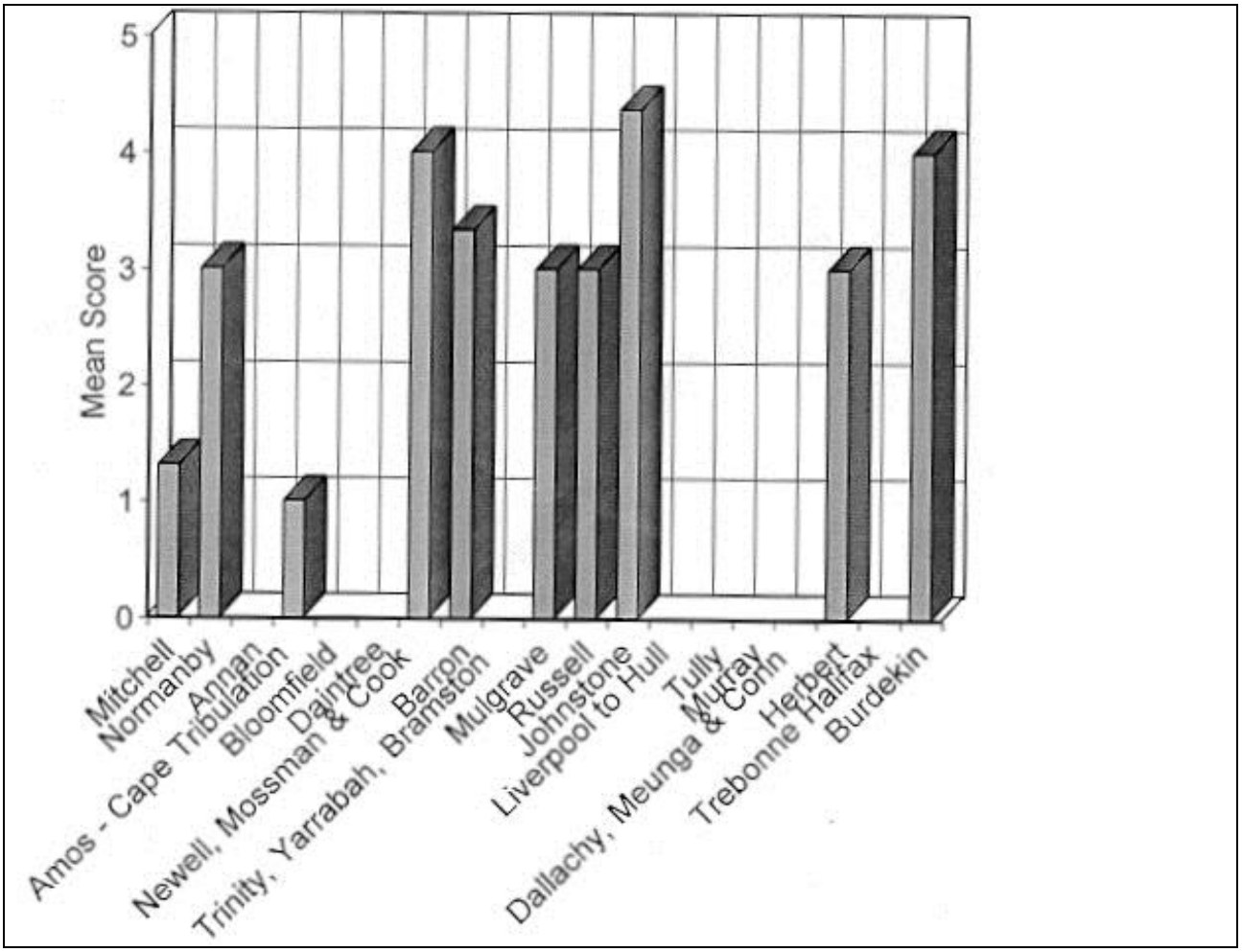
3.1.8 Taxa Of Specific Conservation Interest - Freshwater Turtles

Data concerning the distribution, habitat requirements and identity of turtles within the Wet Tropics region is very patchy (Fig. 8). Moreover, the systematics of this group remains unresolved. These factors caused considerable difficulty when determining

the conservation value of sub-catchments with respect to this attribute. Greater research effort is needed to remedy this situation.

The Johnstone River is known to contain a distinctive and endemic species of *Elseya* currently referred to as *E. aff. dentata* "Johnstone River" (Cann 1998, Georges and Adams 1992). Many of this drainage's sub-catchments contain this species (Pusey *unpubl. obs*.) and were accordingly ranked highly. The Hartley Creek drainage within the Newell, Mossman and Cook basins is known to contain this form (Cann 1998) and all sub-catchments were accorded a rank of 4 in the belief that this species would be widespread within the general vicinity of Hartleys Creek.

Figure 8. Spatial variation in conservation value according to the presence of freshwater turtles of specific conservation interest.



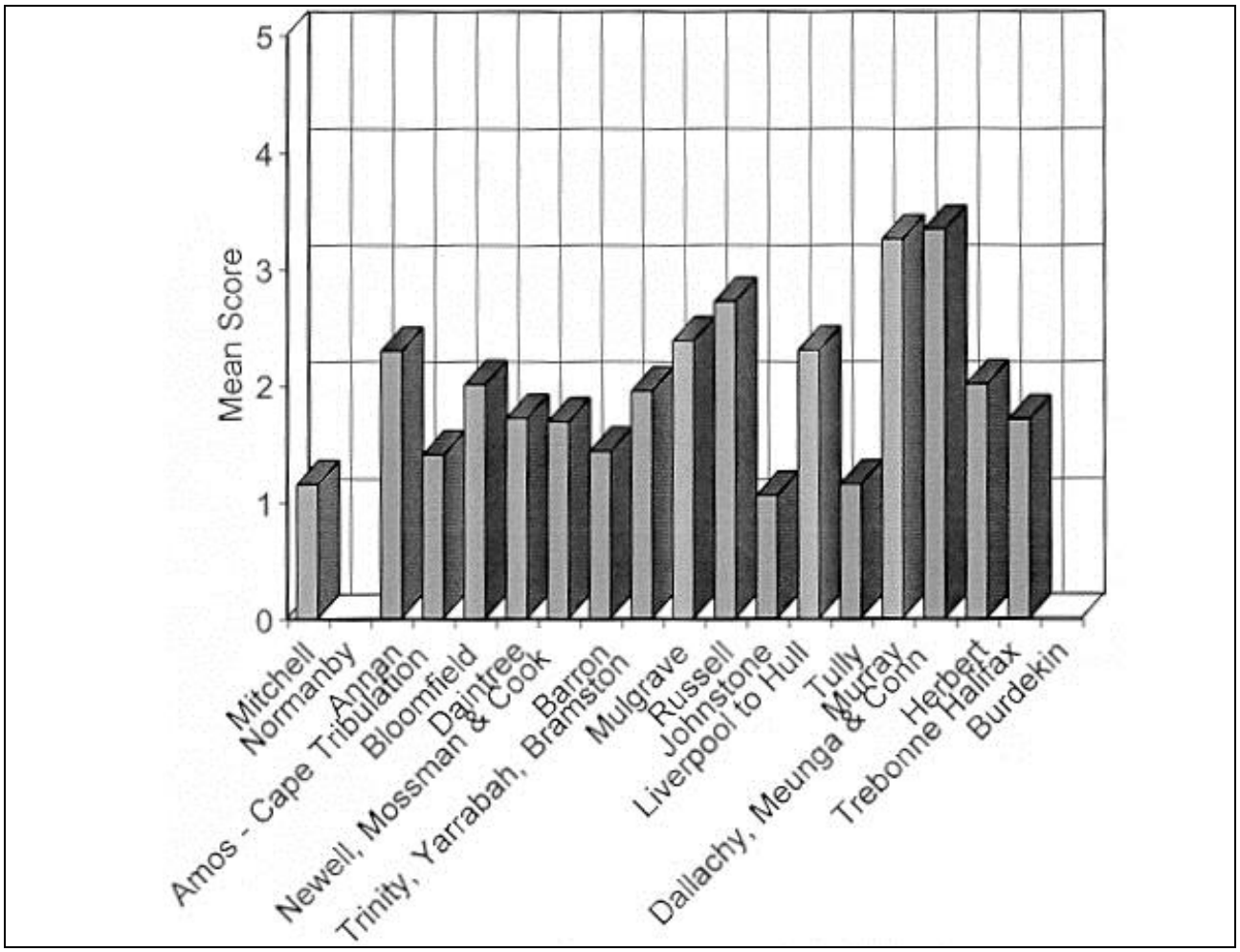
Sub-catchments of the Mulgrave and Russell drainages were accorded moderately high value (3) in the belief that these drainages were likely to contain either *E. aff. dentata* "Johnstone River" or a river-specific form of their own. In the latter case, the high degree of endemism witnessed for freshwater fishes and aquatic plants adds veracity to this supposition.

3.1.9 Rare And Threatened Regional Ecosystems

All of the drainages considered contained Endangered Regional Ecosystems or Regional Ecosystems of Concern that are dependent on the maintenance of streamflow (Fig. 9). The Annan contains remnants of the endangered ecosystem 7.3.22 (1c) (complex mesophyll rainforest on well-drained lowland alluvial levees), as do all of the sub-catchments of the Bloomfield River.

Streamflow in the Daintree River is necessary for the sustenance of three ecosystem types; 7.3.4 (Fan palm swamp rainforest), 7.3.7 (*Eucalyptus / Melaleuca* open forest on poorly drained lowlands) and 7.3.5 (swamp *M. quinquenervia* forests on poorly drained lowlands). Streams of the Newell, Mossman and Cook drainages support a variety of rare and endangered ecosystem types including types 7.3.5, 7.3.7, 7.2.1 (mesophyll rainforest on coastal beach sands) and 7.3.23 (semi-deciduous notophyll rainforest on well drained alluvial levees). The most notable regional ecosystem within the Barron drainage is 7.3.2 (sedgeland and grassland freshwater peat swamps on volcanic craters) in the Peterson sub-catchment. Types 7.3.22 and 7.3.4 are also sustained by streamflow from sub-catchments in this drainage.

Figure 9. Spatial variation in conservation value according to the presence of regional ecosystems of conservation interest.



Four sub-catchments: Wyvuri; Worth; the unnamed sub-catchment south of Worth and Ella; and that within the Trinity, Yarrabah and Bramston drainage group, contain or sustain Endangered Regional Ecosystems or Regional Ecosystems of Concern (7.3.1

(mesophyll rainforest on coastal beach sands), 7.3.6 (*Melaleuca* open forest/rainforest complex on poorly drained lowlands) and 7.3.5).

Fisheries, Blackwell and Behanna sub-catchments within the Mulgrave drainage sustain regional ecosystems 7.3.22 and 7.3.6. In addition, Huntsbrook contains a highly significant isolate of hoop pine in close proximity to the creek line.

Ecosystem types 7.3.3 (Alexander palm forests), 7.3.5 and 7.3.6 are all sustained within or by many of the sub-catchments of the Russell drainage.

Fan palm forest (7.3.4), *Melaleuca* swamplands (7.3.6 and 7.3.5) are an important component of the floristic diversity of many of the southern sub-catchments of the Liverpool, Moresby, Maria and Hull drainage group.

Streamflow from the Murray River sustains three regional ecosystems; 7.3.2, 7.3.5 and 7.3.6. The latter two types are an important component of the floristic diversity of the Dallachy, Meunga and Conn drainage group. River oak (*Casuarina cunninghamiana* - 7.3.26) is an important ecosystem type in many of the sub-catchments of the Herbert river located on the Tablelands. Lowland sub-catchments contain *Melaleuca dealbata* riparian forests (type 7.3.24); the only location of this type within the study area. River oak forests (7.3.26) and swamp mahogany forests *Lophostemon suaveolens* - 7.3.27) also occur in lowland sub-catchments.

3.1.10 Distinctive Flow Regime Types And Flow Needs

The Mitchell River drainage scored relatively highly with regard to this attribute as it was considered that the perennial nature of the flow in the headwater streams was important for the maintenance of fish and frog species.

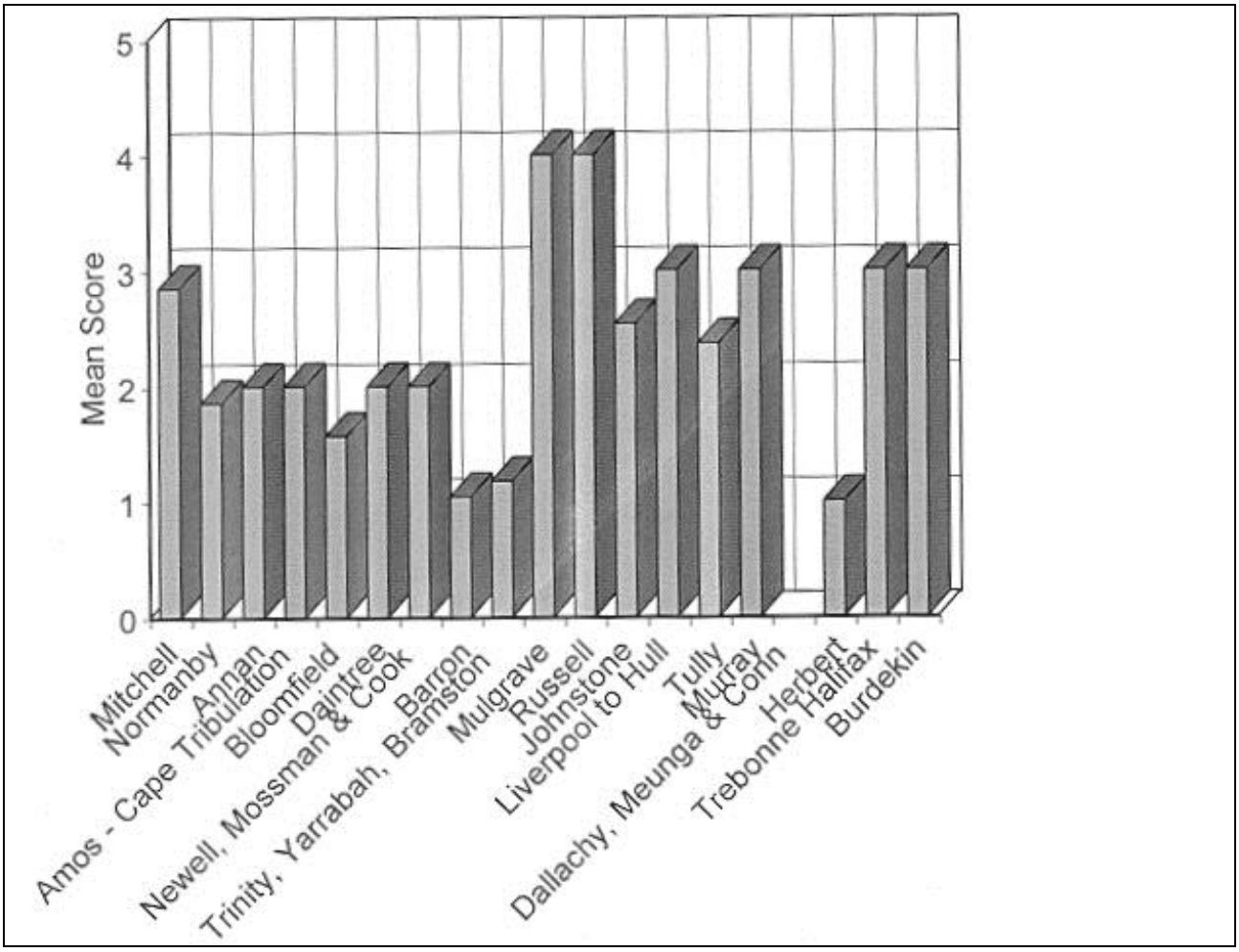
The highest mean scores were recorded for the Mulgrave and Russell rivers because of their distinctive flow regime and needs. The flow regime of these rivers is not particularly distinctive when compared to nearby rivers (see Appendix 1) but are perhaps the most predictable and least variable flow regimes in all of mainland Australia. Moreover, it was considered that great care must be taken to ensure that flow regulation does not result in a decrease in dry season flows (thus emphasising the difference between wet and dry season flows) or result in greater variability in flow during the dry season in which flows are ordinarily very stable. This concern applies to most of the rivers within the Wet Tropics region.

The Murray River received a mean score of 3, as its flow regime is distinct, even from the neighbouring Tully River. Flows in this river tend to be more seasonal than rivers to the immediate north and it is effectively transitional between the more constant rivers of the Wet Tropics region and the seasonally variable rivers to the south.

Streams of the Trebonne Halifax drainages consistently scored highly (3) for two reasons. The headwaters of these streams tend towards pereniallity whereas downstream reaches are much more seasonal and tend towards ephemerality. Moreover, the downstream reaches of these short coastal streams are important fisheries habitat and maintenance of flows is required to sustain downstream habitats.

Streams of the Burdekin River scored moderately highly (3) given their distinctive flow regimes compared to other similarly sized streams of the region. Flows tend to be much more variable and contain a stronger seasonal signal. The most distinctive feature is the high summer flows, which are necessary to provide spawning habitat for a number of species of freshwater fish.

Figure 10. Spatial variation in conservation value according to the presence of distinctive flow regime type or flow needs.



3.2 Spatial Variation In Total Mean Conservation Value

Overall mean conservation value was obtained by estimating the mean conservation value for each sub-catchment (*ie* across all attributes) and then estimating the grand mean over all sub-catchments within a drainage. Clear differences in the overall conservation value for each drainage are apparent in Fig. 11. The Russell drainage was identified as having the highest overall mean score (3.12) closely followed by the Mulgrave drainage (3.00). The Barron drainage scored the lowest overall value (1.98).

The remaining drainages were distributed between these two extremes with drainages in the southern part of the WTWHA having the greatest overall scores. This may reflect a greater research effort in this part of the WTWHA.

It is not unexpected that all of the drainages scored relatively highly (only one drainage falling into the Moderate Conservation Value category) given that all of the sub-catchments are partially or wholly contained within the WTWHA. It must be emphasised that although these data indicate that some drainages are of greater conservation value than others, the focus has been on the value of sub-catchments and, moreover, given the binary system of allocating value (*ie* a 5 scored a Very High Conservation and Ecological Value irrespective of the value of any other attribute, whereas if no 5 was scored then value was assigned according to mean score), mean overall value does not necessarily reflect the conservation value of drainages accurately.

The number or proportion of sub-catchments within a drainage that were ranked as Very High, High and Moderate Conservation and Ecological Value, better reflects the overall conservation value of major drainages.

Although the Barron River drainage scored the lowest overall mean conservation value of all drainages within the WTWHA, it contained a comparatively high number (8) of sub-catchments of Very High Conservation and Ecological Value (Table 4). Its lower mean score resulted from the high number of sub-catchments rated as of Moderate Conservation Value (14).

Values presented are the number of sub-catchments in each value category within individual drainages (number), the proportion of sub-catchments of each value within each drainage as a proportion (%) of the total number of sub-catchments in the WTWHA (WTWHA %), and proportion (%) in each value category within individual drainage basins (drainage %).

The Johnstone River drainage contained the greatest number of sub-catchments rated Very High Conservation and Ecological Value (20), followed by the Russell (12), Barron (8), and Mulgrave (7) drainages, and accordingly these drainages contributed the greatest number of sub-catchments of high value to the regional total (WTWHA %). To a degree, the importance of these drainages to the regional total is a function of the size of the drainages and the number of sub-catchments contained within them.

The highest number of sub-catchments of Moderate Conservation Value occurred, surprisingly, in the Daintree River. It is felt that this may more properly reflect a low level of research concerning freshwater fish, frogs, turtles, crustacea and aquatic plants, rather than genuine low value. This remains to be determined however, and further research in this drainage is highly desirable.

The Barron drainage and the Trinity, Yarrabah & Bramston drainage group also contained many sub-catchments accorded a Moderate Conservation Value.

The Normanby drainage and the Trebonne Halifax drainage were the only drainages not to contain a single sub-catchment rated as of Very High Conservation and Ecological Value. The drainages are on the northern and southern limits, respectively, of the WTWHA.

Five drainages contained no sub-catchments with a Moderate Conservation Value. These were Mulgrave, Russell, Murray, the Dallachy, Meunga and Conn group and the Burdekin.

When the high number of sub-catchments of Very High Conservation and Ecological Value and the absence of sub-catchments of Moderate Conservation Value is considered, the Mulgrave and Russell drainages stand out as basins of very high value.

Seven of the drainage basins were distinguished by more than 40% of their catchments being within the highest conservation value (Very High Conservation & Ecological Value). In order of proportion these were Russell, Bloomfield, Johnstone, Mulgrave, Annan, Dallachy, Meunga and Conn, and Amos - Cape Tribulation.

Four drainages were distinguished by more than 50% of their sub-catchments being accorded a Moderate Conservation Value: Trinity, Yarrabah & Bramston, Normanby, Mitchell and Daintree.

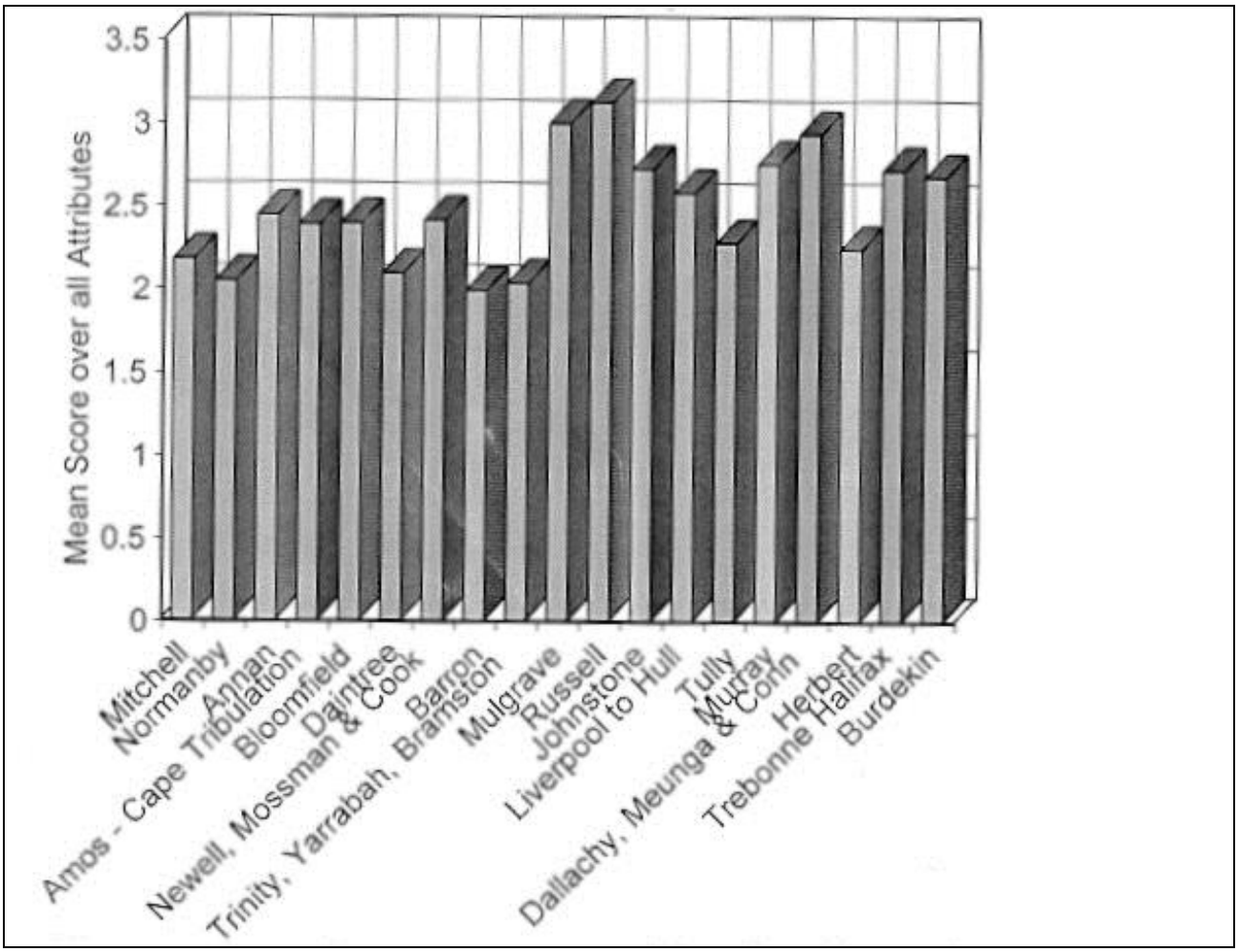
The conservation value for individual catchments is given in Table 5. The basis for ranking is given in Appendix 2.

Table 4. Distribution of conservation values within drainages.

Major drainage		Conservation value		
		Very High Conservation & Ecological Value	High Conservation & Ecological Value	Moderate Conservation Value
Mitchell	Number	5	4	11
	WTWHA %	1.5	1.2	3.4
	Drainage %	25.0	20.0	55.0
Normanby	Number	0	3	4
	WTWHA %	0.0	0.9	1.2
	Drainage %	0.0	42.8	57.2
Annan	Number	3	2	2
	WTWHA %	0.9	0.6	0.6
	Drainage %	42.9	28.6	28.6
Amos - Cape Tribulation	Number	6	4	5
	WTWHA %	1.8	1.2	1.5
	Drainage %	40.0	26.7	33.3
Bloomfield	Number	4	2	1
	WTWHA %	1.2	0.6	0.3
	Drainage %	57.1	28.6	14.3
Daintree	Number	2	12	17
	WTWHA %	0.6	3.7	5.2
	Drainage %	6.5	38.7	54.8
Newell, Mossman & Cook	Number	2	17	3
	WTWHA %	0.6	5.8	0.3
	Drainage %	9.1	86.4	4.5
Barron	Number	8	6	14
	WTWHA %	2.4	2.1	4.0
	Drainage %	28.6	25.0	46.4
Trinity, Yarrabah, Bramston	Number	6	2	9
	WTWHA %	1.5	0.6	3.0
	Drainage %	29.4	11.8	58.8
Mulgrave	Number	7	9	0
	WTWHA %	2.1	2.7	0.0
	Drainage %	43.8	56.3	0.0
Russell	Number	12	2	0
	WTWHA %	3.4	0.9	0.0
	Drainage %	78.6	21.4	0.0
Johnstone	Number	20	15	2
	WTWHA %	6.1	4.6	0.6

Major drainage		Conservation value		
		Very High Conservation & Ecological Value	High Conservation & Ecological Value	Moderate Conservation Value
	Drainage %	54.1	40.5	5.4
Liverpool to Hull	Number	5	10	2
	WTWHA %	1.5	2.4	1.2
	Drainage %	29.4	47.1	23.5
Tully	Number	6	16	5
	WTWHA %	1.8	4.6	1.8
	Drainage %	22.2	55.6	22.2
Murray	Number	1	3	0
	WTWHA %	0.3	0.9	0.0
	Drainage %	25.0	75.0	0.0
Dallachy, Meunga & Conn	Number	5	7	0
	WTWHA %	1.5	2.1	0.0
	Drainage %	41.7	58.3	0.0
Herbert	Number	5	14	9
	WTWHA %	1.5	4.9	1.8
	Drainage %	18.5	59.3	22.2
Trebonne Halifax	Number	0	9	1
	WTWHA %	0.0	3.0	0.0
	Drainage %	0.0	100.0	0.0
Burdekin	Number	1	9	0
	WTWHA %	0.3	2.7	0.0
	Drainage %	10.0	90.0	0.0

Figure 11. Mean conservation value of individual drainages.



4. INDICATORS AND MONITORING

Given the high number of sub-catchments examined and the diversity of attributes used to accord conservation value, there are a variety of reasons for sub-catchments being ranked either highly or not. A blanket approach to stipulating which fauna or attributes might be used as indicators, or for ongoing monitoring to assess the impacts of flow regulation, is therefore not appropriate. Each sub-catchment must be assessed individually.

Appendix 2 is included to demonstrate the process by which conservation value was accorded and to provide a basis for assessment of requests for flow regulation, choice of indicator species, and the basis of ongoing monitoring.

5. SUMMARY

The aquatic environments of the WTWHA are characterised by diverse floral and faunal communities, unique landforms and distinctive flow regimes. In addition, stream flows of the rivers of the region are important for the maintenance of several rare and threatened regional ecosystems and have great value for the maintenance of downstream riverine reaches not within the WTWHA as well as estuarine and near shore environments.

Approximately 25% of all the sub-catchments considered were accorded a Moderate Conservation Value, whereas a further 30% were accorded Very High Conservation and Ecological Value. The remainder were accorded High Conservation and Ecological Value. This level of discrimination allows scope for responsible extraction of the region's water resources whilst ensuring that protection is given to those areas of outstanding value.

Table 5. Conservation value of individual sub-catchments

CONSERVATION VALUE					
Moderate Conservation Value		**High Conservation & Ecological Value**		**Very High Conservation & Ecological Value**	
DRAINAGE	**SUB-CATCHMENT**	**DRAINAGE**	**SUB-CATCHMENT**	**DRAINAGE**	**SUB-CATCHMENT**
Mitchell	Boggy	**Mitchell**	Reedy	**Mitchell**	Picaninny
	East Spencer		Half Ton		West Spencer
	Little Sandy		Luster		Spencer
	Spear		Upper rifle		Mary
	Garioch	**Normanby**	Boolbun North		Bushy
	Lagoon		Poverty south	**Annan**	Parrot
	Wattle		East Normanby Nth Branch		Wallaby
	Camp				Mungumby
	Rooty	**Annan**	Romeo	**Amos - Cape Tribulation**	Gap
	Little Mitchell		Trevethan		Mason
	unnamed sth of Wattle	**Amos - Cape Tribulation**	Ashwell		Myall
			Tachalbadga		Noah
			Emmagen		Cooper
Normanby	Yard		Alexandra		Hutchinson
	Sporing	**Bloomfield**	Unnamed nth of Watermelon	**Bloomfield**	Keating
					Baird
	Diggers		Ayton		Roaring Meg
	Upper Granite	**Daintree**	Upper Daintree		Woobadda
Annan	Adams		Adeline	**Daintree**	Hilda
	Sampson		Boolbun		Daintree
	Banana		unnamed east of Duncan	**Newell, Mossman & Cook**	Platypus
					South Mossman
Amos - Cape Tribulation	Forsberg		Niau	**Barron**	Poona
	McAdam		Little Naiu		Robson
	Cowie		Kiely		Varch
	Melissa		Allanton		Tinaroo
	Bind		Martin		Emerald

CONSERVATION VALUE					
Moderate Conservation Value		**High Conservation & Ecological Value**		**Very High Conservation & Ecological Value**	
DRAINAGE	**SUB-CATCHMENT**	**DRAINAGE**	**SUB-CATCHMENT**	**DRAINAGE**	**SUB-CATCHMENT**
Bloomfield	Watermelon		Luttra		Davies
			Stewart		Bridle
			Barrat		Freshwater
			Forest		
Daintree	Smith	**Newell, Mossman & Cook**	Wonga	**Trinity, Yarrabah, Bramston**	Josey
	Dagmar east		Whyanbeel		Wyvuri
	Dagmar west		unnamed sth of Whyanbeel		Worth
	Timbi				unnamed south of Worth
	Bargoo		Cassowary		Mutchero Inlet
	Bargoo north		Crees		Ella
	Paterson		Lower Mowbray	**Mulgrave**	West Mulgrave
	Rodoni		Collard		Luscombe
	Adastra		unnamed sth of Collard		Upper Mulgrave
	Moase		unnamed sth of Lwr. Mowbray		Kearneys Falls
	Kobi		Oak		Stallion
	Lewin				Behana
	Ronald		Robbins		Fishery Falls
	Lucas			**Russell**	Coopooroo
	Duncan		Spring		Kiandra
	Gold		Upper Mowbray		Bartle Frere
	Landers		Turtle		Wankaroo
Newell, Mossman & Cook	Carson		Hartley		Josephine
	Finn				
	Marr		Tin		Unnamed east of Norries
Barron	Kambul		Moore's		Pughs
	Rainy	**Barron**	Morans		Niringa
	Carrington		Peterson		Babinda
	Upper Barron		Jumrun		Harvey
	Oaky		Mobo		Meringulah
	Big Rooty		Barron Falls		Noories
	Track		Surprise	**Johnstone**	Glen Allyn
	Myola		Stoney		Topaz
	Pearce	**Trinity, Yarrabah, Bramston**	Wright		Topaz south
	Shoteel		Bells Peak		Theresa
	Reid	**Mulgrave**	Butcher		South
	Kauri		Toohey		Dirran
	unnamed east of Pearce		Uhr		Badgery
			Huntsbrook		Lower Badgery
	Thomatis		Fisheries		Beatrice
Trinity, Yarrabah, Bramston	False		Little Mulgrave		Waraker
	Mick		Blackwell		Mourilyan
	Kweto		Pyramid		Karangaree
	Skeleton		Malbon Thompson		Kaarru
	Chinaman	**Russell**	Tewon		Charappa
	Blackfellow		Woopen		Maple
	Maskey	**Johnstone**	Coolamon		unnamed (Henrietta Ck)
			Elinjaa		
	unnamed east of Maskey		Mungalli		Utchee West
			Mystery		Utchee
	Buddabadoo		Rankin		Mitcha
Johnstone	Poorka		Fisher		River
	Meingan		Tregothanan	**Liverpool to Hull**	Silkwood
Liverpool to Hull	Kittabah		Polly		Moresby
	Brown		Clancys Overflow		Hull
Tully	Barbed Wire		Downey		North Hull
	Echo North		Lower Downey		Wongaling
	Echo		McNamee	**Tully**	Cochable
	Table Top		Lower McNamee		Coochimbeerum
	Timberoonie		Egan		Cheetah
	Luttra		Mena		Theodore
	Stewart	**Liverpool to Hull**	South Liverpool		O'Leary

CONSERVATION VALUE					
Moderate Conservation Value		**High Conservation & Ecological Value**		**Very High Conservation & Ecological Value**	
DRAINAGE	**SUB-CATCHMENT**	**DRAINAGE**	**SUB-CATCHMENT**	**DRAINAGE**	**SUB-CATCHMENT**
	Barrat		Meuribal		Jarra
	Forest		Jingu	**Murray**	Upper Murray
			Taringbah	**Dallachy, Meunga & Conn**	Whitfield
Herbert	Wild		Kittabah		Alma
	Nigger		Bombeta		Kennedy
	Cedar		Little Liverpool		Hinkler
	Waterfall		Maria		Meunga
	Henrietta		West Liverpool	**Herbert**	Vine
	Tinkle		Scindah		Smoko
	Lannercost	**Tully**	Boundary		Gowrie
	Seaforth		Nitchaga		Stony
	Seaforth Channel		Campbell		Broadwater
Trebonne Halifax	Frances		Carpenter		
			Niblet	**Burdekin**	Paluma
			Koombooloomba		
			Sylvania		
			Kooroomool		
			Goddard		
			Costigan		
			Luff		
			Culpa		
			Davidson		
			Banyan		
			Tyson		
			Silky Oak		
		Murray	North Branch		
			King Ranch		
			Deep		
		Dallachy, Meunga & Conn	Dallachy		
			Wreck		
			Boggy Camp		
			Scrubby		
			File Mile		
			Damper		
			Porter		
		Herbert	Blunder		
			unnamed sth of Vine		
			Cameron		
			Blencoe		
			Herkies		
			Yamanie		
			Sword		
			Longtail		
			Pinnacles		
			Garrawalt		
			Dalrymple		
			Stone West Branch		
			Upper Stone		
			Seymour		
		Trebonne Halifax	Waterview		
			Crystal		
			Ollera		
			Hencamp		
			Rollingstone		
			Saltwater		
			Leichhardt		
			Sleeper Log		
			Bluewater		
		Burdekin	Black Burdekin		
			Michael		
			Running		
			Puzzle		
			Blue Gum		
			Blue Gum south		

CONSERVATION VALUE					
Moderate Conservation Value		High Conservation & Ecological Value		Very High Conservation & Ecological Value	
DRAINAGE	SUB-CATCHMENT	DRAINAGE	SUB-CATCHMENT	DRAINAGE	SUB-CATCHMENT
			Little Star		
			Keelbottom West		
			Keelbottom East		

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APPENDIX 1

FLOW REGIME TYPES WITHIN THE WTWHA

1.1 Background and Rationale

A river's flow regime is the combination of the amount of water it discharges and the temporal variation in the delivery of that discharge. Flow regimes differ from country to country (McMahon 1986, 1989, Puckridge *et al*. 1998), region to region (Pusey *et al*. 1999), and even within major catchments (Pusey *et al*. 1993, Pusey and Arthington 1996).

In general, Australian streams are among the most variable in the world (McMahon 1986, 1989, Puckridge *et al*. 1998). The discharge regimes of some streams of the Wet Tropics region are highly distinctive and are the least variable flow regimes in Australia (Pusey *et al*. 1995, 1999). Similar flow regimes occur only in south-western Tasmania (P. Davies, *pers. comm.*) and south-west Western Australia (Bunn *et al*. 1986). The flow regimes of these areas are however much more temperate.

It has been argued that a river's flow regime is one of the most important, if not the most important, determinant of the regulation and maintenance of the ecosystem it supports (Poff and Ward 1989, Sparks 1992). Spatial variation in flow regimes is therefore of considerable significance in determining spatial variation in ecosystem function and regulation (Poff and Ward 1989). Arthington *et al*. (1992) state that, in order for the impacts of river regulation to be minimised and managed effectively, the flow regime of the river in question must be quantified and put into a regional context.

For these reasons, an analysis of spatial variation in flow regime was undertaken using daily flow records for a number of major catchments within and bordering on the WTWHA. Flow analyses have already been undertaken for a number of rivers of north Queensland (Pusey *et al*. 1999); the results of these are combined with new analyses for ten additional catchments.

1.2 Methods

Daily flow data for 32 gauging stations located throughout the Wet Tropics region were provided by the Queensland Department of Natural Resources (QDNR) as part of a research program undertaken by the Centre for Catchment and In-Stream Research, Griffith University. The gauging stations were located in 11 major catchments: the Endeavour, Annan, Bloomfield, Daintree, Barron, Russell/Mulgrave, Johnstone, Liverpool, Tully, Murray and Herbert rivers. Additional data were sourced from published quantitative descriptions of flow regimes for the Burdekin River (Pusey and Arthington 1996) and for the upper Normanby River (Pusey *et al*. 1999).

Flow regimes were quantified using the flow analysis program ADVISE (Analysis of Discharge Volumes Including Significant Events) produced by Flanders and Pusey (CCISR - Griffith University). The initial data input was in the form of daily flow volumes (in megalitres). Analyses were conducted using either daily flows or flows summed over longer time intervals (*ie* months). Several metrics were computed. These were:

1. **Mean annual runoff (megalitre.km-2)**. A measure of total mean annual discharge (Q) divided by the area of the catchment. This measure allows direct comparison of rivers of different size.

2. **CV of annual flow**. The coefficient of variation (standard deviation divided by the mean) is a measure of the variability of annual flows.
3. **Average contribution of the discharge resulting from the historically six driest months of the year to the total discharge**. This metric may be used to estimate the degree of seasonality present within a flow regime.
4. **CV of daily flow**. The coefficient of variation of the mean daily flow for each year estimated over the total length of record. Historically used as a measure of seasonality but care must be exercised when doing so to ensure that the record is not dominated by long periods of low flow punctuated by extreme events.
5. **Colwell's (1974) index of contingency of minimum monthly instantaneous flows**. Colwell's analysis can be used to determine the predictability of cyclic phenomena. Predictability as defined by Colwell (1974) is composed of the sum of two sub-components known as constancy and contingency. Constancy is a measure of how much predictability is apportioned to constancy through time whereas contingency is a measure of how much of the predictability can be apportioned to the magnitude of variable X (in this case, discharge) at time y being contingent upon the magnitude of X at time y-1. It is therefore a measure of seasonality. Minimum monthly flows are the lowest instantaneous flow to occur in each month and therefore, the contingency of minimum monthly flows is a measure of the seasonality of low flows. The value is expressed as a decimal fraction of predictability termed M/P.
6. **Colwell's (1974) index of contingency of maximum monthly instantaneous flows**. A measure of the seasonality of extreme events (*ie* floods).
7. **Colwell's (1974) index of contingency of total monthly flows**. A measure of the seasonality of the total volume discharged per month. A measure of the degree of seasonality of the flow regime when total monthly flows rather than daily flows are examined.
8. **Colwell's (1974) index of contingency of the ratio of maximum to minimum instantaneous flows within each month**. The ratio of maximum to minimum instantaneous flows for any given month is a measure of how "flashy" or variable is the flow for each month over an entire year. The contingency of this ratio is a measure of how seasonal are temporal variations in flashiness. For example, some Queensland rivers have comparatively low ratios during the period of August to November and this is important for the successful recruitment of many fish species. In such a case, contingency would be high.

The analyses were conducted using a 20 year data set from 1969-1989. It is important to keep both record length and period of examination constant when comparing the flow regimes of different rivers. The length of record used here has been shown to be adequate for rivers of the Wet Tropics region (Pusey *et al*. 1999) and the period of record has been used in other studies in Queensland (Pusey *et al*.1993, Pusey and Arthington 1996).

1.3 Results and Discussion

The results of the analyses are presented in graphical form in Figures 1.1 and 1.2. With the exception of the plot of runoff against catchment area, the main intent here was to describe spatial variation in flow regimes. This was achieved by plotting the magnitude of the various metrics against latitude (degrees South).

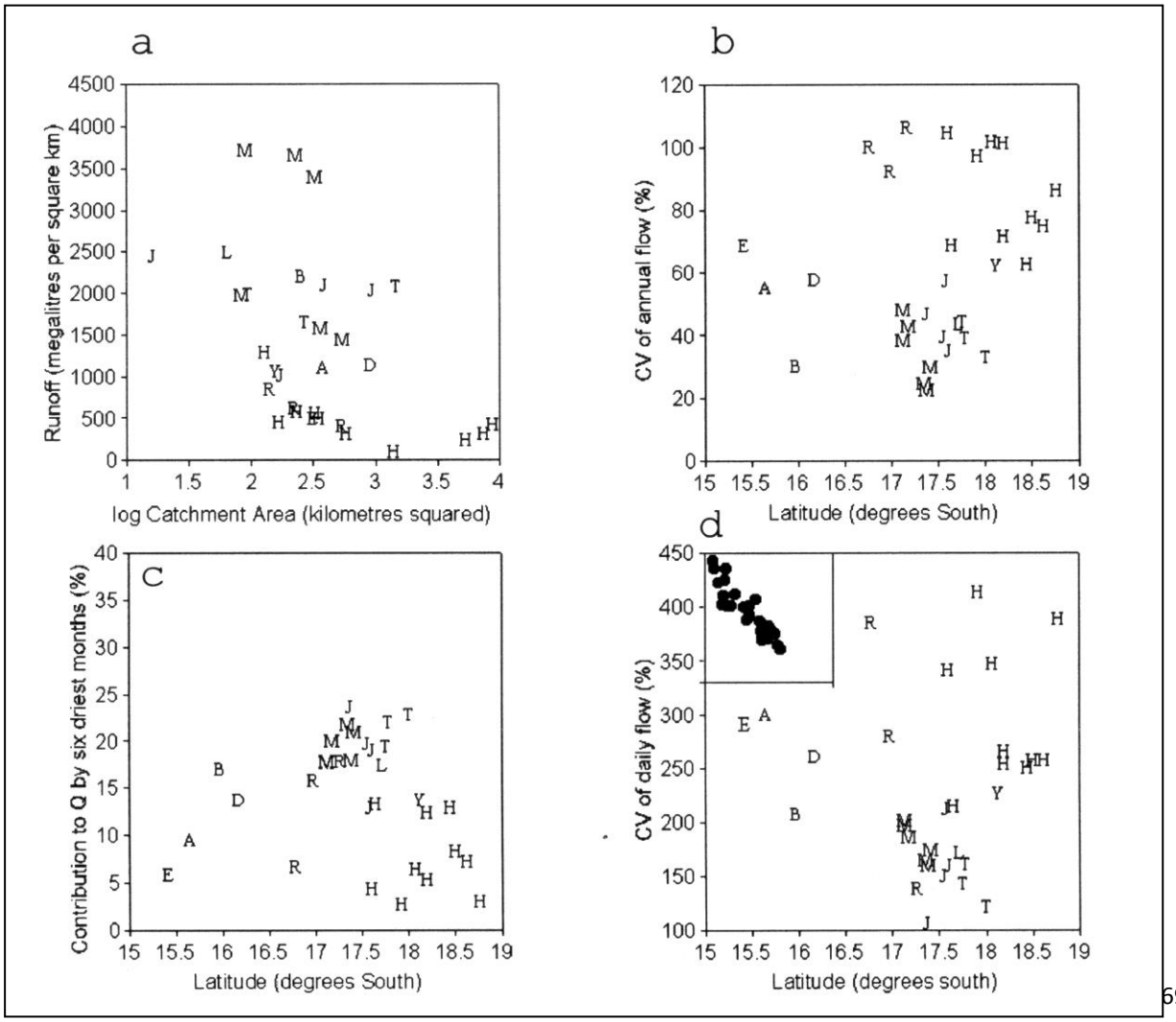
1.3.1 Runoff

Substantial spatial variation in mean runoff is evident in Figure 1.1a. The Russell River recorded the greatest runoff over the period of investigation, averaging between 3000 and 4000 ML.km-2. The lowest runoff values, between 100 and 600 ML.km-2, was recorded for streams of the Herbert River catchment, particularly for those streams located on the western margin of the Atherton Tablelands. The remaining gauging stations within individual drainages were located between these two extremes but it is evident that the runoff for the Barron River (gauging stations located on the Atherton Tablelands also) and for the most upstream station on the Johnstone River (also on the Tablelands) is low compared to other stations throughout the region.

Runoff is comparatively low for the stations located on the Endeavour and Annan rivers. The remaining rivers, Bloomfield River to the Murray River, have similar runoff values (given the exception of the Russell River) although it should be noted that the runoff from the Bloomfield catchment is anomalously high compared to either neighbouring catchment (*ie* Daintree or Annan rivers).

The runoff values presented here are, in general, much greater than that recorded for either the East or West branch of the Normanby River (gauging stations 105106 and 105105, respectively), both of which have their headwaters within the WTWHA. These rivers have mean runoff values of 488 and 330 ML.km-2 (Pusey *et al*. 1999). Runoff values for the Barron and Herbert rivers are similar to these northern rivers. The Burdekin River, which also has its headwaters in the WTWHA has an even lower runoff (48 ML.km-2) (Pusey *et al*. 1999).

Figure 1.1 Spatial variation in flow regime characteristics a) runoff, b) CV of annual flow, c) contribution to annual discharge by the flow derived from the six driest months and d) CV of daily flow.



Symbols used to denote gauging stations within drainage basins; E - Endeavour River, A - Annan River, B - Bloomfield River, D - Daintree River, R- Barron River, M - Mulgrave/Russell River, J - Johnstone River, L - Liverpool River, T - Tully River, Y - Murray River and H - Herbert River. The inset in c) indicates the relationship between the contribution of the six driest months and CV of daily flow.

1.3.2 CV of Annual Flow

Three main groups of rivers, distinguished by the variability of their annual flows, are apparent in Figure 1.1.b. Annual variability in Q was highest for the Barron and Herbert rivers being between 75 and 110%. The feeder streams of the Herbert River located on the Atherton Tablelands tended to be the most variable of the streams within this drainage although the Millstream had a low CV. The majority of stations located between 17 and 18o S had similar CV values being less than 50%. The Murray River was intermediate between that of its neighbouring catchment to the north (the Tully) and that to the south (the Herbert). The rivers within the northern part of the WTWHA were distinguished by CV values between 55 and 70% except for the Bloomfield River which had a CV of 33%, equivalent to that of the Mulgrave River.

These data indicate two gradients in the variability of mean annual flow. The first was a gradient running east–west reflecting distance from the coast and the position of headwaters on the western margins of the Atherton Tablelands. The second gradient was latitudinal, with streams of the northern part of the WTWHA being moderately variable whilst variability decreased with increasing latitude until the Murray River while variability increased for the Herbert River.

Streamflow in the headwaters of the Normanby River is as variable as that observed for the Herbert River, with values of 105 and 76% being recorded for the West and East branches respectively (Pusey *et al*. 1999). Higher CV values have been recorded from Burdekin River tributaries which drain the WTWHA - 113%.

These data indicate very pronounced spatial variation in the variability of mean annual flows - variability is greatest on the northern and southern extremities of the WTWHA. It should be emphasised that the CV values recorded for the core WTWHA rivers (Bloomfield south to the Tully but excluding the Daintree and Barron) are amongst the lowest recorded for any Australian rivers (McMahon 1989).

1.3.3 Contribution by the six driest months

A clear bell shaped curve relating the extent of seasonality to position within the WTWHA is evident in Figure 1.1c. The most northern rivers have strongly seasonal flows with less than 15% of the total occurring in the dry half of the year. Drainages located in the southern part of the WTWHA are similarly seasonal. The least seasonal flow regimes occur in the central part of the WTWHA - Barron to Tully.

The Bloomfield River is again, more similar to other rivers located further south. The headwaters of the Normanby and the Burdekin rivers appear to be strongly seasonal as defined by this metric with both catchments having less than 5% of total discharge occurring in the six driest months (Pusey *et al*. 1999).

1.3.4 CV of daily flows

Spatial variation in the CV of daily flows is pronounced in the WTWHA (Fig. 1.1d). Drainages located on the northern and southern extremities of the WHA have the greatest variation in mean daily flows reflecting the greater difference between wet season and dry season flows evident in Figure 1.1c. The inset within Figure 1.1d shows the relationship between the CV of daily flow (y axis) and the contribution by the six driest months (x axis).

The Mulgrave/Russell, Johnstone, Liverpool and Tully rivers have very low CV of daily flow values indicating far less difference in wet and dry season flows.

The headwaters of the Burdekin river within the WTWHA are even more variable than the rivers included in Figure 1.1. CV of daily flow for these streams averages 494% reflecting the great disparity between wet and dry season flows (Pusey and Arthington 1996).

1.3.5 Minimum monthly flows

Low flows are more seasonal in their incidence towards the northern and southern extremities of the WTWHA (Fig. 1.2.a) and there is little difference between seasonality of incidence from the Daintree south to the Tully River. Low flows tend to occur (logically) during the dry season for the rivers on the extremes of the WTWHA but may occur at any time for the remainder. This is evident in the inset relating seasonality of low flows to the contribution by the six driest months. It should be emphasised here that the term “low flow” is a relative one - it is the lowest flow for any month, it does not infer that flow ceases. In fact, cessation of flow is an extremely rare event in the WTWHA.

The seasonality of low flows in the upper Normanby is similar to that depicted for the Endeavour River (0.59 –0.62) (Pusey *et al*.1999). Low flows in the upper reaches of the Burdekin, are in contrast, not highly seasonal (contingency value of 0.31) indicating that low flows may occur at any time of the year. Further, flow ceases completely for, on average, 20% of all days (Pusey and Arthington 1996).

An important characteristic of the low flows of both the upper Normanby and the upper Mitchell is that although low flows may occur at any time of the year, flow is perennial over most years. Such a characteristic requires the utmost protection.

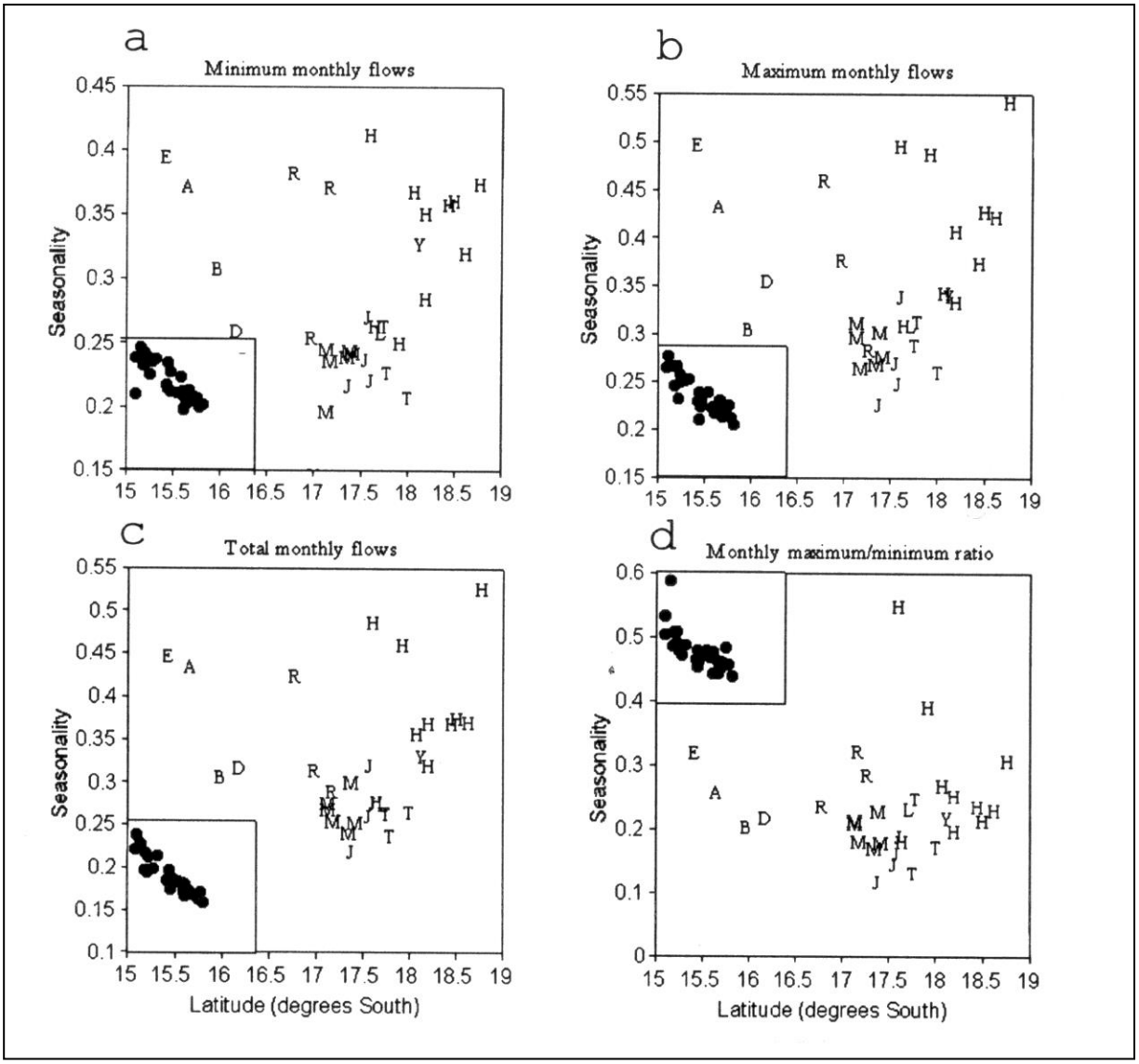
1.3.6 Maximum monthly flows

Similarly consistent spatial variation in the seasonality of maximum monthly flows is evident in Figure 1.2.b. Streams on the northern and southern limits of the WTWHA are more seasonal in their incidence of high flows (see inset).

The upper reaches of the Normanby River are more seasonal again, with M/P values of 0.56 and 0.53 (West and East branches, respectively). The tributaries of the Burdekin river within the WHA have M/P values of 0.47, similar to that of the Herbert River (Pusey and Arthington 1996).

Figure 1.2 Spatial variation in flow regime characteristics a) seasonality of minimum monthly instantaneous flows, b) seasonality of maximum monthly instantaneous flows, c) seasonality of total monthly flows and d) seasonality of the ratio between maximum and minimum monthly

instantaneous flows. Symbols used to denote gauging stations within drainage basins; E - Endeavour River, A - Annan River, B - Bloomfield River, D - Daintree River, R- Barron River, M - Mulgrave/Russell River, J - Johnstone River, L - Liverpool River, T - Tully River, Y - Murray River and H - Herbert River. The inset in each indicates the relationship between the contribution of the six driest months and the variable in each individual panel.



1.3.7 Seasonality of total monthly flows

In general, seasonality of total monthly flow is poorly expressed in rivers of the Wet Tropics region except for those drainages on the limits of the region (Annan and Herbert) or outside of the region (Endeavour). That is not to say that seasonal changes in flow are not present for such is indicated by Figure 1.2.c. Colwell's analysis defines seasonality in terms of the quantity in any one month being contingent upon that in the preceding month. Wet season increases in discharge in the region (WT) are typically due to the incidence of cyclones which in themselves may typically occur in any month from December to April and are thus relatively unpredictable in incidence. Moreover, cyclone incidence, or at least great increases in discharge associated with them, tends to be limited to one and very rarely two events per year. As a consequence, the overall increase in discharge during the wet season indicated by Figure 1.2.c tends to be the result of a single flood event. This does not give rise to marked seasonality per se.

In contrast, the upper reaches of the Normanby River are distinguished by higher levels of seasonality of monthly flows (M/P = 0.55 and 0.56 for the West and East branches, respectively) (Pusey *et al*. 1999). Drainages of the Burdekin river system arising in the WTWHA are about as seasonal as those of the Herbert River and have mean M/P values of 0.46 (Pusey and Arthington 1996).

1.3.8 Seasonality of monthly maximum/minimum ratios

There is little difference in the seasonality of max/min ratios across the WTWHA except for two streams occurring on the Tablelands within the Herbert River drainage (Fig. 1.2.d). These streams are more seasonal in their 'flashiness' with both high and low flows occurring during the summer months. Elsewhere, high and low flows tend to occur within any one month at any time of the year but are most strongly evident within the months from August to November (Pusey *et al*. 1999)

Flashiness is also pronounced in the upper reaches of the Normanby system but is more seasonal than elsewhere in the region with high and low flows being confined mostly to the wet season months.

1.4 Summary

Stream flow over the entire WTWHA is reasonably uniform in the nature of its temporal variation with the exception of those drainages on the extremities of the WTWHA. The "core" rivers, which are those that drain eastward into the Coral Sea (Bloomfield south to the Herbert), are distinguished by:

- high predictability of flow with respect to annual variability (generally less than 50% CV)
- lowest variability within the central part of the WTWHA (*ie* Mulgrave and Russell Rivers)
- high predictability of total monthly flows but with a low predictability of seasonal signal. The low seasonality index arises because dry season base flows are high as a result of consistent and elevated base flow contributions and because elevated wet season flows tend to be limited to a limited number of short very high flow events
- low flows are also highly predictable but because high flow events are of short duration, low flow events are not strongly seasonal
- the contribution to total discharge arising from the six driest months of the year tends to be very high (relative to elsewhere in Australia)
- although the seasonality of 'flashiness' is not well expressed, most core streams of the Wet Tropics are least flashy between the months of August to November
- perennial flow - periods of zero flow are extremely rare in rivers of the WTWHA.

These characteristics do not apply consistently to drainages such as the Burdekin, Mitchell or Normanby. However, of greatest interest concerning the flow regimes of the headwaters of the Normanby River and Mitchell River is their perenniality. They are much more strongly seasonal in their lower reaches (Pusey *et al*. 1999).

In addition to the latitudinal variation in flow regime, there exists also some longitudinal variation which is most strongly expressed for those drainages which have their headwaters on the Atherton Tablelands. These streams tended to be less predictable and have a greater seasonal

signal (greater difference between wet season and dry season flows). This difference was expressed most strongly for the westernmost tributaries of the Herbert River.

No stream flow data was available for drainages of the Paluma Range but, based on the results of the analyses presented here, it is probable that they are less predictable than those of the Tully, Johnstone and Mulgrave/Russell Rivers and are characterised by greater differences between wet and dry season flows than these rivers. They are likely to be more 'flashy'. These drainages are, however, more likely to be similar to the flow regimes of other drainages of the WTWHA than to drainages to the south such as the Black, Alice and the Burdekin, which are highly variable (Beumer 1979, Pusey and Arthington 1996, respectively).

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APPENDIX 2

WORKSHEETS

Ecosystem function values

Taxa of specific conservation interest - rheophytic plants

Taxa of specific conservation interest - aquatic plants

Diversity - freshwater invertebrates

Taxa of specific conservation interest - freshwater crustacea

Taxa of specific conservation interest - freshwater fish including important fish habitat and areas of high diversity

Taxa of specific conservation interest - frogs

Taxa of specific conservation interest - freshwater turtles

Rare and threatened regional ecosystems

Distinctive flow regime types and flow needs

ECOSYSTEM FUNCTION VALUES

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE

The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**	2	Maintenance of flow needed for the maintenance of aquatic habitats in subcatchments as well as downstream habitats in areas not within the WTWHA. In addition, theses catchments, because they are in a comparatively high rainfall area, are the source of a large proportion of dry season discharge. In addition, these areas are likely to be a substantial source of organic carbon to downstream reaches. Bushy subcatchment scores more highly because of its connectivity value.	
Picaninny	**2**	2		
West Spencer	**3**	2		
Spencer	**2**	2		
East Spencer	**1**	2		
Reedy	**2**	2		
Half Ton	**2**	2		
Mary	**3**	2		
Bushy	**3**	3		
Luster	**2**	2		
Little Sandy	**1**	2		
Spear	**1**	2		
Garioch	**3**	2		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Lagoon	**2**	2		
Wattle	**4**	2		
Camp	**5**	2		
Upper Rifle	**5**	2		
Rooty	**5**	2		
Little Mitchell	**1**	2		
unnamed south of Wattle	**5**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE

The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Normanby

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Yard	**1**	2	Maintenance of flow needed for the maintenance of aquatic habitats in subcatchments as well as downstream habitats in areas not within the WTWHA. In addition, theses catchments, because they are in a comparatively high rainfall area, are the source of a large proportion of dry season discharge. In addition, these areas are likely to be a substantial source of organic carbon to downstream reaches.	
Sporing	**1**	2		
Boolbun North	**4**	2		
Poverty South	**2**	2		
East Normanby North Branch	**1**	2		
Diggers	**1**	2		
Upper Granite	**1**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**	2	Maintenance of flow needed for the maintenance of aquatic habitats in subcatchments as well as downstream habitats in areas not within the WTWHA. In addition, theses catchments, because they are in a comparatively high rainfall area, are the source of a large proportion of dry season discharge. In addition, these areas are likely to be a substantial source of organic carbon to downstream reaches.	
Parrot	**5**	2		
Adams	**2**	2		
Sampson	**2**	2		
Banana	**2**	2		
Wallaby	**4**	2		
Mungumby	**2**	2		
Trevethan	**2**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**	2	As for Annan catchment	
McAdam	**5**	1	Well protected	
Ashwell	**5**	1		
Gap	**2**	3	Headwaters only within the WTWHA, higher ranking needed for maintenance of downstream reaches	
Cowie	**5**	2	Important connectivity value plus important for the delivery of carbon and other nutrients to the near shore environment	
Melissa	**5**	2		
Bind	**5**	2		
Tachalbadga	**5**	2		
Emmagen	**5**	2		
Mason	**4**	3	Assume higher value because lowland reaches are without WH protection	
Myall	**4**	3		
Noah	**5**	1	As for McAdam	
Cooper	**5**	1	As for McAdam	
Hutchinson	**5**	1	As for McAdam	
Alexandra	**5**	3	High value due to provision of connectivity between river and lowland wetlands	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE

The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**	1	Well protected	
Baird	**5**	1		
Roaring Meg	**5**	1		
Watermelon	**5**	1		
Unnamed north of Watermelon	**4**	2	Maintenance of flow in the headwaters necessary for maintenance of habitat quality (especially of riffles) in lowland reaches, the provision of carbon and maintenance of channel geometry	
Ayton	**2**	2		
Woobadda	**4**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE

The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**	1	Well protected	
Smith	**5**	1		
Dagmar East	**5**	1		
Dagmar West	**5**	1		
Timbi	**5**	1		
Bargoo	**5**	1		
Bargoo North	**5**	1		
Paterson	**5**	1		
Adeline	**4**	1		
Rodoni	**5**	1		
Boolbun	**3**	3	Maintenance of water delivery required for maintenance of habitat integrity and carbon delivery needed given extent of subcatchment not under WH protection	
Adastra	**5**	1	Well protected	
Moase	**5**	1		
Kobi	**5**	1		
Lewin	**5**	1		
Ronald	**5**	1		
Lucas	**5**	1		
Duncan	**5**	1		
unnamed est of Duncan	**5**	1		
Hilda	**5**	1		
Gold	**4**	1		
Landers	**4**	1		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Niau	**4**	2	Maintenance of lowland habitat integrity required as is delivery of organic carbon from headwaters to lower reaches. Stewart subcatchment ranked more highly due to the extensive riparian clearing in this catchment and proliferation of weeds. Flow maintenance therefore needed to maintain channel geometry	
Little Naiu	**2**	2		
Martin	**2**	2		
Kiely	**4**	2		
Allanton	**2**	2		
Luttra	**2**	2		
Stewart	**4**	3		
Barratt	**4**	1	Well protected	
Forest	**2**	2	As for Niau *etc.*	
Daintree	**5**	4	High value due to value of connectivity between floodplain and main river and because of value of connectivity between Newell drainages (Wonga) and those of the Cape Tribulation area	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**	2	Important for maintenance of flow regime and delivery of organic carbon to downstream reaches and in maintaining connectivity	
Whyanbeel	**3**	2		
unnamed south of Whyanbeel	**3**	2		
Coop		1		
Carson	**1**	2		
Platypus	**4**	3	Probably a major source of water and carbon for the Mossman River given subcatchment size	
Marr	**2**	2	As for Wonga *etc.*	
South Mossman	**3**	2		
Cassowary	**2**	2		
Crees	**1**	3	Important for the delivery of organic carbon to lowland reaches and near shore environment and for their high connectivity value linking Barron, Cook, Newell and Mossman drainages.	
Lower Mowbray	**3**	3		
Collard	**4**	3		
unnamed south of Collard	**2**	3		
unnamed south of Lower Mowbray	**3**	3		
Oak	**3**	3		
Robbins	**4**	3		
Spring	**3**	2		
Upper Mowbray	**2**	2		
Turtle	**5**	2		
Hartley	**5**	2		
Tin	**4**	2		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Finn		2		
Moore's	**1**	3	Connectivity value	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE

The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**	4	High value connectivity between Barron and Johnstone rivers	
Morans	**4**	4		
Peterson (lakes)	**1**	1		
Mobo	**2**	2	Connectivity between Barron and Mulgrave rivers	
Robson	**3**	2		
Varch	**4**	1		
Tinaroo		1		
Kambul		1		
Oaky	**1**	1		
Big Rooty	**4**	1		
Track	**2**	1		
Emerald	**3**	1		
Rainy	**1**	1		
Carrington	**1**	1		
Upper Barron	**1**	1		
Pearce	**1**	1		
Davies	**2**	1		
Brindle	**3**	1		
Shoteel	**5**	1		
Reid	**2**	1		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Kauri	**3**	2	Connectivity value	
unnamed east of Pearce	**4**	2		
Myola	**2**	3	High value connectivity between Barron and Cook drainage areas	

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Barron Falls	**4**	2	Maintenance of unique waterfall habitat	
Surprise	**3**	2		
Jumrum		2		
Stoney	**4**	2	Important for the delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	
Thomatis	**1**	2	Very important for the delivery of freshwater, carbon and nutrients to downstream estuarine and nearshore ecosystems	
Freshwater	**3**	3	Maintenance of flows important for the maintenance of important lowland stream habitat and the provision of nutrients to downstream freshwater and estuarine ecosystems	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE

The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**	1		
Mick	**4**	1		
Kweto	**2**	1		
Skeleton	**1**	2	Provision of freshwater discharge and nutrients important for function of downstream reaches and receiving estuarine areas and for the maintenance of channel geometry.	
Chinaman	**1**	2		
Blackfellow	**2**	2		
Wright	**2**	2		
Maskey	**1**	2		
unnamed east of Maskey	**2**	2		
Buddabadoo	**4**	2	High connectivity value	
Bells Peak	**5**	3		
Josey	**5**	1		
Wyvuri	**3**	3	Important for the maintenance of the hydrological regimes of coastal wetland ecosystems and for connectivity value	
Worth	**2**	3		
unnamed south of Worth	**2**	3		
Mutchero inlet	**3**	3		
Ella	**2**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

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MAJOR CATCHMENT Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	2	Maintenance of highly predictable flows critical in this system for maintenance of channel morphology and downstream ecosystems vital. Delivery of normal budget of organic carbon also vital.	
Luscombe	**5**	2		
Upper Mulgrave	**5**	2		
Kearneys Falls	**5**	2		
Butcher	**4**	2		
Toohey	**4**	2		
Stallion	**5**	2		
Uhr	**5**	2		
Huntsbrook	**4**	2		
Fisheries	**3**	2		
Little Mulgrave	**4**	2		
Blackwell	**3**	3	Maintenance of comparatively more ephemeral flow regime necessary.	
Pyramid	**2**	3		
Behana	**4**	3	Maintenance of habitat integrity and carbon delivery in lowland tributary streams important for these streams and downstream estuarine habitats.	
Malbon Thompson	**4**	3		
Fishery Falls	**3**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

RATIONALE The provision of water and maintenance of water is critical to the maintenance and function of riverine ecosystems, ensuring the provision of habitat especially for spawning and rearing in addition to the maintenance of channel morphology. In addition, the delivery of organic carbon derived from upland forested catchments is necessary to fuel downstream trophic webs and estuarine and near shore communities and fisheries based upon them. Maintenance of normal hydrological regime is crucial to the integrity of lowland wetlands. Streams also provide avenues for dispersal and maintain important connectivity between upland and lowland reaches and between adjacent drainages.

MAJOR CATCHMENT Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	2		
Kiandra	**3**	3	High connectivity value	
Bartle Frere	**5**	2	Maintenance of flow for channel geometry, habitat structure and organic carbon delivery needed	
Wankaroo	**5**	2		
Tewon	**5**	2		
Josephine	**3**	2		
Woopen	**2**	3	Higher value because of the disturbed nature of downstream reaches and loss of riparian vegetation (ie. decrease organic inputs)	
Norries	**2**	3	High value connectivity with Johnstone system	
Unnamed east of Norries	**2**	2	As for Woopen and Bartle Frere to Josephine	
Pughs	**2**	2		
Niringa	**1**	2		
Babinda	**3**	2		
Harvey	**3**	3	Maintenance of high flows for maintenance of habitat integrity and connectivity with estuarine areas	
Meringulah	**3**	3	Flows needed to maintain ecological integrity of lowland coastal tributaries and for downstream estuarine habitat.	

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MAJOR CATCHMENT Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**	3	High connectivity value plus high value due to importance of carbon inputs as a result of degraded upstream riparian areas	
Topaz	**4**	2	Maintenance of carbon inputs and magnitude of flows required to maintain ecosystem function, habitat integrity and channel geometry, respectively, of the Tablelands reaches of this river.	
Topaz south	**5**	2		
Theresa		2		
South		2		
Five Mile	**3**	2		
Coolamon	**5**	2		
Elinjaa	**2**	2		
Mungalli	**3**	2		
Mystery	**5**	2		
Dirran	**1**	4	High connectivity value plus justification as for Topaz to Mystery	
Badgery	**5**	2	As for Topaz to Mystery	
Lower Badgery	**5**	2		
Rankin	**1**	2		
Fisher	**1**	2		
Poorka	**3**	1		
Beatrice	**3**	4	As for Dirran	
Waraker	**4**	1		
Tregothanan	**1**	2	Maintenance of downstream tributaries habitat structure required.	

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Polly		2		
Mourilyan	**1**	2	Generally well protected, however maintenance of flows required to sustain downstream ecosystems	
Clancys Overflow	**3**	2		
Karangaree	**5**	2		
Kaarru	**5**	2		
Charappa	**5**	2		
Maple	**5**	2		
Downey	**5**	2		
Lower Downey	**5**	2		
McNamee	**5**	2		
Unnamed (Henrietta Creek?)	**5**	2		
Lower McNamee	**5**	2		
Meingen		2		
Utchee West	**5**	2		
Utchee	**1**	4	High connectivity value	
Mitcha	**5**	2		
Egan	**5**	2		
River	**4**	2	Maintenance of riverine and estuarine reaches required	
Mena	**1**	3	Little but headwaters contained in WTWHA and flow protection required for maintenance of downstream reaches	

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MAJOR CATCHMENT Liverpool, Moresby, Big Maria & Hull

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Liverpool	**5**	1		
Scindah	**5**	1		
South Liverpool	**4**	2	Connectivity with the Tully river	
Meuribal	**3**	2	Maintenance of flow regime, carbon transport and habitat integrity	
Jingu	**4**	2		
Kittabah	**3**	2		
Taringbah	**3**	2		
Bombeta	**2**	2		
Little Liverpool	**3**	2		
Silkwood	**2**	3	Connectivity with the Moresby river	
Brown	**1**	2		
Moresby	**2**	3	Connectivity with northern and southern drainages plus maintenance of estuarine ecosystem dynamics	
Big Maria	**2**	3	Entire river poorly protected and headwaters thus important for ecosystem function	
Hull	**3**	4	Very high connectivity value, especially for Cassowary, plus important for maintenance of estuarine reaches and wetlands	
North Hull	**4**	4		
Wongaling	**1**	4		

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MAJOR CATCHMENT Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**	1		
Coochimbeerum	**5**	1		
Cheetah	**5**	1		
Boundary	**5**	1		
Theodore	**4**	1		
Nitchaga	**3**	1		
Campbell	**5**	1		
Carpenter	**5**	1		
Niblet	**5**	1		
Koombooloomba	**5**	1		
Sylvania	**5**	1		
Kooroomool	**5**	1		
Goddard	**5**	1		
Costigan	**5**	1		
Luff	**5**	1		
O'Leary	**5**	1		
Culpa	**5**	1		
Barbed Wire	**3**	1		
Echo North	**1**	1		
Echo	**4**	1		
Table Top	**3**	1		
Timberoonie	**2**	1		
Jarra	**4**	3	Important for delivery of carbon to lower reaches of lowland streams, maintenance of wetland systems and connectivity	
Davidson	**3**	3		
Banyan	**2**	2		
Tyson	**1**	2		
Silky Oak	**2**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

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MAJOR CATCHMENT Murray

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
North Murray	**4**	2	Important for maintenance of wetland systems and connectivity	
King Ranch	**1**	2		
Deep	**1**	2		
Upper Murray	**4**	2		

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ATTRIBUTE OF INTEREST Ecosystem function values

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MAJOR CATCHMENT Dallachy, Meunga & Conn

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Dallachy	**3**	3	Important for the maintenance of wetland hydrologic regime	
Whitfield	**3**	3		
Wreck	**3**	3		
Alma	**3**	2	Important for maintenance of habitat integrity in lowland streams and for maintenance of connectivity	
Kennedy	**4**	2		
Hinkler	**4**	2		
Boggy Camp	**2**	2		
Meunga	**3**	2		
Scrubby	**2**	2		
Five Mile	**2**	4	Important for the delivery of freshwater, carbon and other nutrients to Hinchinbrook Channel	
Damper	**3**	4		
Porter	**5**	4		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Ecosystem function values

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MAJOR CATCHMENT Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**	1		
Nigger	**2**	1		
Cedar	**1**	1		
Vine	**1**	1		
Blunder	**2**	3	High connectivity value	
Unnamed sth of Vine	**2**	2		
Cameron	**2**	2	Provision of carbon downstream and habitat maintenance important	
Blencoe	**2**	2		
Smoko	**3**	2		
Waterfall	**1**	1		
Herkes	**3**	1		
Yamanie	**4**	1		
Sword	**5**	1		
Longtail	**4**	1		
Gowrie	**3**	2	As for Cameron	
Pinnacles	**5**	1		
Garrawalt	**3**	2		
Stony	**4**	3	Provision of lowland spawning habitat	
Henrietta	**1**	1		
Broadwater	**1**	2	As for Cameron	
Dalrymple	**2**	2		
Stone West branch	**2**	3	High connectivity value	
Upper Stone	**1**	3		
Lannercost		2		
Tinkle	**1**	2	As for Cameron	
Seymour	**1**	3	Important for wetland and estuarine ecosystem maintenance	
Seaforth	**2**	3		
Seaforth Channel	**5**	3		

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MAJOR CATCHMENT Trebonne Halifax

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Frances	**1**	3	Important for connectivity value and for near shore and estuarine ecosystems	
Waterview	**2**	3		
Crystal	**3**	3	These rivers are characterised by the presence within the WTWHA of their headwaters only. Thus maintenance of flow from these reaches is critical for maintaining habitat integrity of downstream reaches and for near shore and estuarine ecosystems	
Ollera	**2**	3		
Hencamp	**2**	3		
Rollingstone	**3**	3		
Saltwater	**2**	3		
Leichhardt	**2**	3		
Sleeper Log	**2**	3		
Bluewater	**2**	3		

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ATTRIBUTE OF INTEREST Ecosystem function values

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MAJOR CATCHMENT Burdekin

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Black Burdekin	**3**	2	Maintenance of flow from these headwater streams is critical for downstream river health given the extent of total discharge during low flow periods derived from them. Probably also important source of downstream carbon	
Michael	**1**	2		
Paluma	**3**	2		
Running	**3**	2		
Puzzle	**1**	2		
Blue Gum	**2**	2		
Blue Gum South	**2**	2		
Arnott	**1**	2		
Little Star	**2**	2		
Keelbottom West	**2**	2		
Keelbottom East	**1**	2		

INFORMATION SOURCE

Conservation value according to the criterion of Ecosystem Function Value derived from the collective opinion of members of the Australian Centre for Tropical Freshwater Research, James Cook University and the Centre for Catchment and In-Stream Research, Griffith University and based also on consideration of the values accorded under the remaining criteria.

TAXA OF SPECIFIC CONSERVATION INTEREST- RHEOPHYTIC PLANTS

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare &Threatened Rheophytic Plants

RATIONALE

The Wet Tropics region contains many rare and threatened plants species, many of which are of great phylogenetic significance. Of these, rheophytic plants comprise an identifiable and important subset. The continued survival of these plants is highly dependent on the integrity of the watercourse along which they grow and therefore dependent on maintenance of the natural flow regime.

MAJOR CATCHMENT

Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**			
Picaninny	**2**			
West Spencer	**3**			
Spencer	**2**			
East Spencer	**1**			
Reedy	**2**			
Half Ton	**2**	2	records of *Ostrearia, Romnalda gralata*	1
Mary	**3**	3	records of *Ostrearia, Romnalda gralata*	1
Bushy	**3**	3	records of *Ostrearia* & likely provides habitat for *R. gralata*	1,2
Luster	**2**			
Little Sandy	**1**			
Spear	**1**			
Garioch	**3**			
Lagoon	**2**			
Wattle	**4**			
Camp	**5**			
Upper Rifle	**5**			
Rooty	**5**			
Little Mitchell	**1**			
unnamed south of Wattle	**5**			

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MAJOR CATCHMENT

Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**			
Parrot	**5**	2	records of *Ostrearia fleckeri*	1
Adams	**2**			
Banana	**2**			
Wallaby	**4**			
Mungumby	**2**			
Trevethan	**2**			

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MAJOR CATCHMENT

Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**			
McAdam	**5**			
Ashwell	**5**	2	likely to provide habitat for 1 or more of those below	1
Gap	**2**	5	records of *Ammomum dallachyi, Ostrearia fleckeri, Waterhousea hedraiophylla*	1
Cowie	**5**			
Melissa	**5**			
Bind	**5**			
Tachalbadga	**5**			
Emmagen	**5**			
Mason	**4**	5	records of both gingers (*Ammomum & Etlingera australasica)* plus *Syzygium xerampelinum*	1
Myall	**4**	5	records of *Etlingera, S. xerampelinum* & very restricted *Xanthostemon formosus*	1
Noah	**5**	5	records of *S. xerampelinum, Etlingera Gymnostoma, Buckinghamia, Waterhousea mulgraveana* plus the very restricted *X. graniticus*	1
Cooper	**5**	5	**by far the most important sub-catchment for this attribute** - contains sole geographic range of *Acmena* sp. LCC & *Endiandra cooperana* plus records of *X.graniticus, X.formosus, Romnalda gralata, Romnalda* sp., *Syzygium xerampelinum, Waterhousea mulgraveana*	1
Hutchinson	**5**	3	records of *Ammomum, S.xerampelinum*	1
Alexandra	**5**	2	records of *Gymnostoma*	1

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MAJOR CATCHMENT

Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**	1	likely to provide habitat for *Buckinghamia and/or Ammomum*	1
Baird	**5**	2	records of *Buckinghamia ferruginiflora*	1
Roaring Meg	**5**	5	records of *Buckinhamia ferruginiflora, Gymnostoma australianum, Romnalda gralata, Romnalda sp., Xanthstemon graniticus*	1
Watermelon	**5**	1	likely to provide habitat for *Ammomum*	1
Unnamed north of Watermelon	**4**	2	records of *Ammomum dallachyi*	1
Ayton	**2**	1	likely to provide habitat for *Ammomum*	1
Woobadda	**4**	2	records of *Buckinghamia ferruginiflora*	1

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MAJOR CATCHMENT

Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**			
Smith	**5**			
Dagmar East	**5**			
Dagmar West	**5**			
Timbi	**5**			
Bargoo	**5**			
Bargoo North	**5**			
Paterson	**5**			
Adeline	**4**	2	records of *Syzygium alatoramullum*	1
Rodoni	**5**			
Boolbun	**3**			
Adastra	**5**			
Moase	**5**			
Kobi	**5**			
Lewin	**5**			
Ronald	**5**			
Lucas	**5**			
Duncan	**5**			
unnamed east of Duncan	**5**	1	likely to provide habitat for one or both of the following	2
Hilda	**5**	3	records of *Buckinghamia, Gymnostoma*	1
Gold	**4**			
Landers	**4**			
Niau	**4**			
Little Naiu	**2**			
Kiely	**4**	1	likely to provide habitat for *Buckinghamia*	
Allanton	**2**			
Luttra	**2**			
Stewart	**4**			
Barratt	**4**			
Forest	**2**			
Daintree	**5**			

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MAJOR CATCHMENT

Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**			
Whyanbeel	**3**	2	records of *Neostrearia fleckeri*	1
unnamed south of Whyanbeel	**3**	1	likely to provide habitat for the above	2
Carson	**1**			
Platypus	**4**	5	records of *Buckinghamia, Waterhousea hedraiophylla* & stronghold of *Peripentadenia phelpsii*	1
Marr	**2**			
South Mossman	**3**	4	records of *Waterhousea hedraiophylla* & part of stronghold of *P. phelpsii*	1
Cassowary	**2**			
Crees	**1**			
Lower Mowbray	**3**			
Collard	**4**			
unnamed south of Collard	**2**			
unnamed south of Lower Mowbray	**3**			
Oak	**3**			
Robbins	**4**			
Spring	**3**			
Upper Mowbray	**2**			
Turtle	**5**			
Hartley	**5**			
Tin	**4**			
Moore's	**1**			

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MAJOR CATCHMENT

Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**			
Morans	**4**			
Peterson (lakes)	**1**			
Mobo	**2**	1	likely to contain *S. alatoramullum*	2
Tinaroo	**1**	2	records of *Syzygium alatoramullum*	1
Robson	**3**	2	as above	1
Varch	**4**	1	likely to contain the above species	2
Oaky	**1**			
Big Rooty	**4**			
Track	**2**			
Pearce	**1**			
Davies	**2**			
Brindle	**3**			
Emerald	**3**	1	likely to contain *Sygygium alatoramullum*	2
Rainy	**1**			
Carrington	**1**			
Upper Barron	**1**			
Shoteel	**5**			
Reid	**2**			
Kauri	**3**			
unnamed east of Pearce	**4**			
Myola	**2**			
Barron Falls	**4**			
Surprise	**3**			
Stoney	**4**			
Thomatis	**1**			
Freshwater	**3**			

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MAJOR CATCHMENT

Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**			
Mick	**4**			
Kweto	**2**			
Skeleton	**1**			
Chinaman	**1**			
Blackfellow	**2**			
Wright	**2**			
Maskey	**1**			
unnamed east of Maskey	**2**	1	likely to contain *Acacia hylanoma*	2
Buddabadoo	**4**			
Bells Peak	**5**			
Josey	**5**			
Wyvuri	**3**			
Worth	**2**			
unnamed south of Worth	**2**			
Mutchero Inlet	**3**			
Ella	**1**	**1**		

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MAJOR CATCHMENT

Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	1	likely to contain habitat for one or both of *Syzygium xerampelinum, Waterhousea mulgraveana*	2
Luscombe	**5**	1	as above	2
Upper Mulgrave	**5**	1	as above	2
Kearneys Falls	**5**	1	as above	2
Butcher	**4**	2	records of *S. xerampelinum*	1
Toohey	**4**	2	as above	1
Stallion	**5**	3	records of *Syzygium xerampelinum, Waterhousea mulgraveana*	1
Uhr	**5**	2	likely to provide habitat for the above	2
Huntsbrook	**4**	2	as above	2
Fisheries	**3**	3	records of *S.xerampelinum, W.mulgraveana*	1
Little Mulgrave	**4**	4	records of *S.xerampelinum, W.mulgraveana* & likely to provide habitat for *S. alatoramullum*	1,2
Blackwell	**3**	2	records of *W.mulgraveana*	1
Pyramid	**2**			
Behana	**4**	3	records of *W.mulgraveana* & *Acacia hylanoma* on creek bank	1,3
Malbon Thompson	**4**	2	records of *A. hylanoma*	1
Fishery Falls	**3**	2	records of *Syzygium boonjee*	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare &Threatened Rheophytic Plants

RATIONALE

The Wet Tropics region contains many rare and threatened plants species, many of which are of great phylogenetic significance. Of these, rheophytic plants comprise an identifiable and important subset. The continued survival of these plants is highly dependent on the integrity of the watercourse along which they grow and therefore dependent on maintenance of the natural flow regime.

MAJOR CATCHMENT

Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	3	records of *Neostrearia fleckeri, Syzygium boonjee* & likely to contain habitat for *W.hedraiophylla*	1,2
Kiandra	**3**	1	likely to support one or more of the above	2
Bartle Frere	**5**	3	records of *Syzygium boonjee, W.hedraiophylla*	1
Wankaroo	**5**	3	as above	1
Tewon	**5**	2	records of *W.hedraiophylla*	1
Josephine	**3**	2	records of *S.boonjee*	1
Woopen	**2**	2	records of *W.hedraiophylla*	1
Norries	**2**	1	likely to contain habitat for one or more of those listed	2
Unnamed east of Norries	**2**	1	as above	2
Pughs	**2**	2	records of *S.boonjee*	1
Niringa	**1**			
Babinda	**3**	5	records of *Ostrearia, Neostrearia, S. boonjee, W.hedraiophylla*	1
Harvey	**3**	3	records of *S. boonjee, W. hedraiophylla*	1
Meringulah	**3**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare &Threatened Rheophytic Plants

RATIONALE

The Wet Tropics region contains many rare and threatened plants species, many of which are of great phylogenetic significance. Of these, rheophytic plants comprise an identifiable and important subset. The continued survival of these plants is highly dependent on the integrity of the watercourse along which they grow and therefore dependent on maintenance of the natural flow regime.

MAJOR CATCHMENT

Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**			
Topaz	**4**			
Topaz south	**5**			
Five Mile	**3**			
Coolamon	**5**			
Elinjaa	**2**			
Mugalli	**3**			
Mystery	**5**			
Dirran	**1**			
Badgery	**5**	2	records of *Waterhousea hedraiophylla*	1
Lower Badgery	**5**	1	probably supports the above species	2
Rankin	**1**			
Fisher	**1**			
Poorka	**3**	1	as above	2
unnamed (Henrietta Ck?)	**5**	2	records of *Ostrearia fleckeri*	1
Beatrice	**3**			
Waraker	**4**			
Tregothanan	**1**			
Mourilyan	**1**			
Clancys Overflow	**3**			
Karangaree	**5**			
Kaarru	**5**			
Charappa	**5**			
Maple	**5**	2	records of *Ostrearia fleckeri*	1
Downey	**5**	2	as above	1
Lower Downey	**5**	2	as above	1
McNamee	**5**	2	as above	1
Lower McNamee	**5**	2	as above	1
Utchee West	**5**			
Utchee	**1**			
Mitcha	**5**			
Egan	**5**			
River	**4**			
Mena	**1**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare &Threatened Rheophytic Plants

RATIONALE

The Wet Tropics region contains many rare and threatened plants species, many of which are of great phylogenetic significance. Of these, rheophytic plants comprise an identifiable and important subset. The continued survival of these plants is highly dependent on the integrity of the watercourse along which they grow and therefore dependent on maintenance of the natural flow regime.

MAJOR CATCHMENT

Liverpool, Moresby, Big Maria & Hull

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Liverpool	**5**			
Kittabah	**3**	1	likely to contain *Ostrearia fleckeri*	2
Scindah	**5**			
South Liverpool	**4**			
Meuribal	**3**			
Jingu	**4**			
Taringbah	**3**			
Bombeta	**2**			
Little Liverpool	**3**			
Silkwood	**2**			
Brown	**1**			
Moresby	**2**			
Big Maria	**2**			
Hull	**3**			
North Hull	**4**			
Wongaling	**1**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare &Threatened Rheophytic Plants

RATIONALE

The Wet Tropics region contains many rare and threatened plants species, many of which are of great phylogenetic significance. Of these, rheophytic plants comprise an identifiable and important subset. The continued survival of these plants is highly dependent on the integrity of the watercourse along which they grow and therefore dependent on maintenance of the natural flow regime.

MAJOR CATCHMENT

Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**	3	records of *Ostrearia fleckeri, Acmena smithii* small fruited form	1
Coochimbeerum	**5**	3	as above	1
Cheetah	**5**	2	records of *A.smithii*	1
Boundary	**5**			
Theodore	**4**			
Nitchaga	**3**	2	as above	1
Campbell	**5**	2	as above	1
Carpenter	**5**			
Niblet	**5**			
Koombooloomba	**5**			
Sylvania	**5**			
Kooroomool	**5**			
Goddard	**5**			
Costigan	**5**			
Luff	**5**			
O'Leary	**5**			
Culpa	**5**			
Barbed Wire	**3**			
Echo North	**1**			
Echo	**4**			
Table Top	**3**			
Timberoonie	**2**			
Jarra	**4**	2	records of *Ostrearia fleckeri*	1
Davidson	**3**			
Banyan	**2**			
Tyson	**1**			
Silky Oak	**2**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare &Threatened Rheophytic Plants

RATIONALE

The Wet Tropics region contains many rare and threatened plants species, many of which are of great phylogenetic significance. Of these, rheophytic plants comprise an identifiable and important subset. The continued survival of these plants is highly dependent on the integrity of the watercourse along which they grow and therefore dependent on maintenance of the natural flow regime.

MAJOR CATCHMENT

Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**			
Nigger	**2**			
Cedar	**1**			
Blunder	**2**	2	records of *A.smithii* sff	
Cameron	**2**	2	as above	
Unnamed sth of Vine	**2**			
Blencoe	**2**			
Smoko	**3**			
Waterfall	**1**			
Herkies	**3**			
Yamanie	**4**			
Sword	**5**			
Longtail	**4**			
Gowrie	**3**			
Pinnacles	**5**			
Garrawalt	**3**			
Stony	**4**			
Henrietta	**1**			
Broadwater	**1**			
Dalrymple	**2**			
Stone West branch	**2**			
Upper Stone	**1**			
Tinkle	**1**			
Seymour	**1**			
Seaforth	**2**			
Seaforth Channel	**5**			

INFORMATION SOURCES

1. Records of the Queensland Herbarium.
2. G. Werren, personal opinion based on 20 years of extensive field knowledge of the flora of the Wet Tropics region.
3. G. Werren, unpublished data.

TAXA OF SPECIFIC CONSERVATION INTEREST- AQUATIC PLANTS

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Aquatic Plants

RATIONALE Significant occurrences of Rare and Threatened aquatic plant species and for which streams of the Wet Tropics region represent the only known habitat. Flows required for the maintenance of habitat.

MAJOR CATCHMENT Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**			
Whyanbeel	**3**			
unnamed south of Whyanbeel	**3**			
Coop		?		
Carson	**1**			
Platypus	**4**			
Marr	**2**			
South Mossman	**3**			
Cassowary	**2**			
Crees	**1**			
Lower Mowbray	**3**	3	records of *Aponogeton vanbruggenii*	1,2
Collard	**4**	3	as above	1,2
unnamed south of Collard	**2**	3	as above	1,2
unnamed south of Lower Mowbray	**3**			
Oak	**3**			
Robbins	**4**			
Spring	**3**			
Upper Mowbray	**2**			
Turtle	**5**			
Hartley	**5**			
Tin	**4**			
Moore's	**1**			
Finn		?		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Aquatic Plants

RATIONALE Significant occurrences of Rare and Threatened aquatic plant species and for which streams of the Wet Tropics region represent the only known habitat. Flows required for the maintenance of habitat.

MAJOR CATCHMENT Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**			
Mick	**4**			
Kweto	**2**			
Skeleton	**1**	3	Contains the endangered sedge *Eleocharis retroflexa*	
Chinaman	**1**	3		
Blackfellow	**2**	3		
Wright	**2**	3		
Maskey	**1**			
unnamed east of Maskey	**2**			
Buddabadoo	**4**			
Bells Peak	**5**			
Josey	**5**			
Wyvuri	**3**			
Worth	**2**			
unnamed south of Worth	**2**			
Mutchero Inlet	**3**			
Ella	**2**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Aquatic Plants

RATIONALE Significant occurrences of Rare and Threatened aquatic plant species and for which streams of the Wet Tropics region represent the only known habitat. Flows required for the maintenance of habitat.

MAJOR CATCHMENT Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**			
Luscombe	**5**			
Upper Mulgrave	**5**	2	records of *Torrenticola*	3
Kearneys Falls	**5**	2	records of *Torrenticola*	3
Butcher	**4**			
Toohey	**4**			
Stallion	**5**			
Uhr	**5**			
Huntsbrook	**4**			
Fisheries	**3**	1	Records of *Torrenticola*	
Little Mulgrave	**4**	2	records of *Torrenticola*	
Blackwell	**3**			
Pyramid	**2**			
Behana	**4**	1	Records of *Torrenticola*	3
Malbon Thompson	**4**			
Fishery Falls	**3**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Aquatic Plants

RATIONALE Significant occurrences of Rare and Threatened aquatic plant species and for which streams of the Wet Tropics region represent the only known habitat. Flows required for the maintenance of habitat.

MAJOR CATCHMENT Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	2	records of *Torrenticola*	1,2
Kiandra	**3**	2	as above	1,2
Bartle Frere	**5**	2	as above	1,2
Wankaroo	**5**	4	records of *Torrenticola* plus endangered *Aponogeton bullosus*	1,2
Tewon	**5**	4	as above	1,2
Josephine	**3**	4	records of endangered *A.bullosus* & likely that *Torrenticola* occurs	1,2
Woopen	**2**	4	habitat of restricted *A.lancesmithii* & Type Locality	1,2
Norries	**2**	5	Contains the endangered aquatics *Eleocharis retroflexa* and *Fimbristylus adjuncta*	
Unnamed east of Norries	**2**	3	records of *A.lancesmithii*	1,2
Pughs	**2**			
Niringa	**1**			
Babinda	**3**	2	records of *Torrenticola*	1,2
Harvey	**3**	1	likely that *Torrenticola* occurs	1,2
Meringulah	**3**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Aquatic Plants

RATIONALE Significant occurrences of Rare and Threatened aquatic plant species and for which streams of the Wet Tropics region represent the only known habitat. Flows required for the maintenance of habitat.

MAJOR CATCHMENT Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**			
Topaz	**4**			
Topaz south	**5**			
Five Mile	**3**			
Dirran	**1**			
Theresa	**?**	**4**	several records of endangered *Aponogeton bullosus* (a stronghold?)	1,2
Coolamon	**5**	**2**	records of *Torrenticola queenslandica*	1,2
Elinjaa	**2**	**2**	as above	1,2
Mugalli	**3**			
Mystery	**5**	**2**	as above	1,2
Badgery	**5**	**4**	records of endangered *Aponogeton bullosus*	1,2
Lower Badgery	**5**			
Rankin	**1**			
Fisher	**1**			
Poorka	**3**			
Beatrice	**3**	**4**	several records of endangered *Aponogeton bullosus* (a stronghold?)	1,2
Waraker	**4**			
Tregothanan	**1**			
Mourilyan	**1**			
Clancys Overflow	**3**			
Karangaree	**5**			
Kaarru	**5**			
Charappa	**5**			
Maple	**5**			
Downey	**5**			
Lower Downey	**5**			
McNamee	**5**			
Unnamed (Henrietta Ck?)	**5**			
Lower McNamee	**5**			
Utchee West	**5**			
Utchee	**1**			
Mitcha	**5**			
Egan	**5**			
River	**4**			
Mena	**1**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Aquatic Plants

RATIONALE Significant occurrences of Rare and Threatened aquatic plant species and for which streams of the Wet Tropics region represent the only known habitat. Flows required for the maintenance of habitat.

MAJOR CATCHMENT Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**			
Nigger	**2**			
Cedar	**1**	**2**	records of *Torrenticola*	1,2
Vine	**?**	**2**	as above	1,2
unnamed sth of Vine	**?**	**2**	as above	1,2
Blunder	**2**			
Cameron	**2**			
Blencoe	**2**			
Smoko	**3**			
Waterfall	**1**			
Herkies	**3**			
Yamanie	**4**			
Sword	**5**			
Longtail	**4**			
Gowrie	**3**			
Pinnacles	**5**			
Garrawalt	**3**			
Stony	**4**			
Henrietta	**1**			
Broadwater	**1**			
Dalrymple	**2**			
Stone West branch	**2**			
Upper Stone	**1**			
Tinkle	**1**			
Seymour	**1**			
Seaforth	**2**			
Seaforth Channel	**5**			

INFORMATION SOURCES

1. Records of the Queensland Herbarium
2. Hellquist,C.B. and Jacobs,S.W.L. 1998. Aponogetonaceae of Australia, with descriptions of six new taxa. *Telopea* 8: 7-19.
3. B.J.Pusey, unpublished observations undertaken as part of extensive field surveys of freshwater fishes.
4. A.Small, *personal communication* to G.Werren

DIVERSITY- FRESHWATER INVERTEBRATES

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**	1	Very limited extent in WTWHA	1 for all
Picaninny	**2**	3		
West Spencer	**3**	3		
Spencer	**2**	3		
East Spencer	**1**	3		
Reedy	**2**	3		
Half Ton	**2**	4	Several waterfalls present	
Mary	**3**	3		
Bushy	**3**	3		
Luster	**2**	3		
Little Sandy	**1**	3		
Spear	**1**	3		
Garioch	**3**	3		
Lagoon	**2**	3		
Wattle	**4**	3		
Camp	**5**	3		
Upper Rifle	**5**	3		
Rooty	**5**	3		
Little Mitchell	**1**	3		
unnamed south of Wattle	**5**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Normanby

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Yard	**1**	2	Limited extent of waterways in WTWHA	1 for all
Sporing	**1**	1	Very limited extent of waterways in WTWHA	
Boolbun North	**4**	3		
Poverty South	**2**	3		
East Normanby North Branch	**1**	3		
Diggers	**1**	2	Limited extent of waterways in WTWHA	
Upper Granite	**1**	2	Limited extent of waterways in WTWHA	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. The upstream reaches of the catchments have numerous medium-sized waterfalls..

MAJOR CATCHMENT Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**	4	Numerous waterfalls present	1 for all
Parrot	**5**	4	Numerous waterfalls present	
Adams	**2**	3		
Banana	**2**	2	Limited extent of waterways in WTWHA	
Wallaby	**4**	4	Numerous waterfalls present	
Mungumby	**2**	3		
Trevethan	**2**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**	3		
McAdam	**5**	3		
Ashwell	**5**	3		
Gap	**2**	3		
Cowie	**5**	3		
Melissa	**5**	3		
Bind	**5**	3		
Tachalbadga	**5**	3		
Emmagen	**5**	3		
Mason	**4**	3		
Myall	**4**	3		
Noah	**5**	3		
Cooper	**5**	3		
Hutchinson	**5**	3		
Alexandra	**5**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**	3		1 for all
Baird	**5**	3		
Roaring Meg	**5**	4	Large waterfall present (Roaring Meg Falls)	
Watermelon	**5**	3		
Unnamed north of Watermelon	**4**	3		
Ayton	**2**	3		
Woobadda	**4**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**	3		1 for all
Smith	**5**	3		
Dagmar East	**5**	3		
Dagmar West	**5**	3		
Timbi	**5**	3		
Bargoo	**5**	3		
Bargoo North	**5**	3		
Paterson	**5**	3		
Adeline	**4**	4	Large waterfall present (Adeline)	
Rodoni	**5**	3		
Boolbun	**3**	3		
Adastra	**5**	3		
Moase	**5**	3		
Kobi	**5**	3		
Lewin	**5**	3		
Ronald	**5**	3		
Lucas	**5**	3		
Duncan	**5**	3		
unnamed est of Duncan	**5**	3		
Hilda	**5**	3		
Gold	**4**	3		
Landers	**4**	3		
Niau	**4**	3		
Little Naiu	**2**	3		
Kiely	**4**	3		
Allanton	**2**	3		
Luttra	**2**	3		
Stewart	**4**	3		
Barratt	**4**	3		
Forest	**2**	3		
Daintree	**5**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE

Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. Large waterfalls are common in the Mowbray and Mossman catchments.

MAJOR CATCHMENT Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**	3		1 for all
Whyanbeel	**3**	3		
unnamed south of Whyanbeel	**3**	3		
Coop		3		
Carson	**1**	2		
Platypus	**4**	4	Large waterfalls present (incl. Mossman Falls)	
Marr	**2**	3		
South Mossman	**3**	3		
Cassowary	**2**	3		
Crees	**1**	2	Limited extent of waterways in WTWHA	
Lower Mowbray	**3**	3		
Collard	**4**	3		
unnamed south of Collard	**2**	4	Waterfalls present (incl. Mowbray Falls)	
unnamed south of Lower Mowbray	**3**	4	Waterfalls present (incl. Mowbray Falls)	
Oak	**3**	3		
Robbins	**4**	4	Waterfalls present (incl. Mowbray Falls)	
Spring	**3**	4	Waterfalls present on Spring Creek	
Upper Mowbray	**2**	3		
Turtle	**5**	3		
Hartley	**5**	3		
Tin	**4**	3		
Moore's	**1**	1	Very limited extent of waterways in WTWHA	
Finn		1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**	3		1 for all
Morans	**4**	3		
Peterson (lakes)	**1**	3		
Mobo	**2**	3		
Robson	**3**	3		
Varch	**4**	3		
Oaky	**1**	3		
Big Rooty	**4**	3		
Track	**2**	3		
Pearce	**1**	2	Limited extent in WTWHA	
Davies	**2**	3		
Brindle	**3**	3		
Shoteel	**5**	3		
Reid	**2**	3		
Kauri	**3**	3		
unnamed east of Pearce	**4**	3		
Myola	**2**	3		
Barron Falls	**4**	4	Large waterfall present (Barron Falls)	
Surprise	**3**	4	Large waterfall present (Barron Falls)	
Stoney	**4**	4	Large waterfall present (Stoney Creek Falls)	
Thomatis	**1**	3		
Freshwater	**3**	4	Several waterfalls present	
Tinaroo	**1**	3		
Rainy	**3**	3		
Emerald	**1**	3		
Jumrun	**3**	4		
Carrington	**1**	1	Very limited extent in WTWHA	
Upper Barron	**1**	1	Very limited extent in WTWHA	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**	1	Very limited extent of waterways in WTWHA	1 for all
Mick	**4**	3		
Kweto	**2**	3		
Skeleton	**1**	1	Very limited extent of waterways in WTWHA	
Chinaman	**1**	1	Very limited extent of waterways in WTWHA	
Blackfellow	**2**	2	Limited extent of waterways in WTWHA	
Wright	**2**	3		
Maskey	**1**	2	Limited extent of waterways in WTWHA	
unnamed east of Maskey	**2**	2	Limited extent of waterways in WTWHA	
Buddabadoo	**4**	3		
Bells Peak	**5**	3		
Josey	**5**	3		
Wyvuri	**3**	3		
Worth	**2**	3		
unnamed south of Worth	**2**	3		
Ella	**2**	3		
Mutchero Inlet	**5**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	3		1 for all
Kiandra	**3**	3		
Bartle Frere	**5**	3		
Wankaroo	**5**	3		
Tewon	**5**	3		
Josephine	**3**	3		
Woopen	**2**	3		
Norries	**2**	3		
Unnamed east of Norries	**2**	3		
Pughs	**2**	3		
Babinda	**3**	4	Several waterfalls on Babinda Creek	
Harvey	**3**	3		
Meringulah	**3**	3		
Niringa	**1**	1	Very limited extent of waterways in WTWHA	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	4	Several large waterfalls present	1 for all
Luscombe	**5**	3		
Upper Mulgrave	**5**	3		
Kearneys Falls	**5**	4	Large waterfall present	
Butcher	**4**	4	Large waterfall present	
Toohey	**4**	3		
Stallion	**5**	3		
Uhr	**5**	3		
Huntsbrook	**4**	3		
Fisheries	**3**	3		
Little Mulgrave	**4**	3		
Blackwell	**3**	3		
Pyramid	**2**	3		
Behana	**4**	4	Several large waterfalls present	
Malbon Thompson	**4**	3		
Fishery Falls	**3**	4	Several waterfalls present	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE

Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. Numerous large waterfalls are present in the escarpment area near the Palmerston Highway.

MAJOR CATCHMENT Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**	3		1 for all
Topaz	**4**	3		
Topaz south	**5**	3		
Five Mile	**3**	3		
Coolamon	**5**	3		
Elinjaa	**2**	4	Several waterfalls present	
Mugalli	**3**	3		
Mystery	**5**	3		
Dirran	**1**	3		
Badgery	**5**	3		
Lower Badgery	**5**	3		
Poorka	**3**	3		
Rankin	**1**	2	***Very limited extent in WTWHA***	
Fishers	**1**	2	***Very limited extent in WTWHA***	
Unnamed (Henrietta Ck?)	**5**	4	***Several waterfalls present***	
Beatrice	**3**	3		
Waraker	**4**	3		
Tregothanan	**1**	3		
Mourilyan	**1**	2	Limited extent of waterways in WTWHA	
Clancys Overflow	**3**	3		
Karangaree	**5**	3		
Kaarru	**5**	3		
Charappa	**5**	3		
Maple	**5**	3		
Downey	**5**	3		
Lower Downey	**5**	3		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
McNamee	**5**	3		
Lower McNamee	**5**	3		
Utchee West	**5**	3		
Utchee	**1**	3		
Mitcha	**5**	3		
Egan	**5**	3		
River	**4**	3		
Mena	**1**	3		
Meingan	**1**	2	Limited extent of waterways in WTWHA	
Theresa	**1**	3		
Rankin	**1**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Liverpool, Moresby, Big Maria & Hull

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Liverpool	**5**	3		1 for all
Scindah	**5**	3		
South Liverpool	**4**	3		
Meuribal	**3**	3		
Jingu	**4**	3		
Taringbah	**3**	3		
Bombeta	**2**	3		
Little Liverpool	**3**	3		
Silkwood	**2**	3		
Brown	**1**			
Kittabah	**3**	3		
Moresby	**2**	3		
Big Maria	**2**	3		
Hull	**3**	3		
North Hull	**4**	3		
Wongaling	**1**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. Numerous large waterfalls are present in the upper Tully River area. Tully Falls gorge is bordered by several sub-catchments.

MAJOR CATCHMENT Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**	4	Includes Cannabullen, Cochable and Carter Falls	1 for all
Coochimbeerum	**5**	4	Includes Elizabeth Grant Falls	
Cheetah	**5**	4	Includes Tully Falls area	
Boundary	**5**	3		
Theodore	**4**	3		
Nitchaga	**3**	3		
Campbell	**5**	4	Includes Tully Falls area	
Carpenter	**5**	3		
Niblet	**5**	3		
Koombooloomba	**5**	3		
Sylvania	**5**	3		
Kooroomool	**5**	3		
Goddard	**5**	3		
Costigan	**5**	3		
Luff	**5**	3		
O'Leary	**5**	3		
Culpa	**5**	3		
Barbed Wire	**3**	3		
Echo North	**1**	3		
Echo	**4**	3		
Table Top	**3**	3		
Timberoonie	**2**	3		
Jarra	**4**	3		
Davidson	**3**	3		
Banyan	**2**	3		
Tyson	**1**	3		
Silky Oak	**2**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. Murray Falls is the major waterfall in this catchment.

MAJOR CATCHMENT Murray

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
North Murray	**4**	3		1 for all
King Ranch	**1**	3		
Deep	**1**	3		
Upper Murray	**4**	4	Includes Murray Falls	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna.

MAJOR CATCHMENT Dallachy, Meunga & Conn

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Dallachy	**3**	3		1 for all
Whitfield	**3**	3		
Wreck	**3**	3		
Alma	**3**	3		
Kennedy	**4**	3		
Hinkler	**4**	3		
Boggy Camp	**2**	3		
Meunga	**3**	3		
Scrubby	**2**	3		
Five Mile	**2**	3		
Damper	**3**	3		
Porter	**5**	3		
Unnamed south of Porter	**2**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE

Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. Yuccabine Creek is of special importance as a site where much scientific research has been undertaken. Many large waterfalls flow to the Herbert River.

MAJOR CATCHMENT Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**	3		1 for all
Nigger	**2**	3		
Cedar	**1**	1	Very limited extent of waterways in WTWHA	
Blunder	**2**	3		
Unnamed sth of Vine	**2**	3		
Cameron	**2**	3		
Blencoe	**2**	3		
Smoko	**3**	5	Scientific importance of Yuccabine and nearby creeks	
Waterfall	**1**	1	Very limited extent of waterways in WTWHA	
Herkies	**3**	4	Large waterfall present	
Yamanie	**4**	4	Large waterfall present (Yamanie)	
Sword	**5**	4	Large waterfall present (Sword)	
Longtail	**4**	3		
Gowrie	**3**	4	Several waterfalls present	
Pinnacles	**5**	3		
Garrawalt	**3**	4	Large waterfall present (Garrawalt)	
Stony	**4**	4	Several large waterfalls present (including Wallaman)	
Henrietta	**1**	2	Limited extent of waterways in WTWHA	
Broadwater	**1**	3		
Dalrymple	**2**	3		
Stone West branch	**2**	4	Several large waterfalls present	
Upper Stone	**1**	3		
Tinkle	**1**	3		
Seymour	**1**	3		
Seaforth	**2**	3		
Seaforth Channel	**5**	3		
Vine	**1**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE

Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. Jourama Falls is a major waterfall in the area.

MAJOR CATCHMENT Trebonne Halifax

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Frances	**1**	3		1 for all
Waterview	**2**	4	Large waterfall present (Jourama)	
Crystal	**3**	3		
Ollera	**2**	3		
Hencamp	**2**	3		
Rollingstone	**3**	3		
Saltwater	**2**	3		
Leichhardt	**2**	3		
Sleeper Log	**2**	3		
Bluewater	**2**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Diversity - Invertebrates

RATIONALE

Invertebrate diversity is high in all WTWHA catchments. Insufficient information is available for further geographical discrimination at this stage. Sub-catchments with waterfalls have been ranked higher as they are habitats of limited extent that are known to harbour specialised invertebrate fauna. Birthday Creek and Camp Creek are sites of significant ongoing scientific research.

MAJOR CATCHMENT Burdekin

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Black Burdekin	**3**	3		1 for all
Michael	**1**	1	Very limited extent of waterways in WTWHA	
Paluma	**3**	5	Birthday Creek and Camp Creek are sites of considerable importance for scientific research due to the long term nature of the research underatken in these streams	
Running	**3**	3		
Puzzle	**1**	1	Very limited extent of waterways in WTWHA	
Blue Gum	**2**	3		
Blue Gum South	**2**	3		
Arnott	**1**	3		
Little Star	**2**	3		
Keelbottom West	**2**	3		
Keelbottom East	**1**	3		

INFORMATION SOURCE

1. Prof. R. Pearson, JCU *unpubl. data*

TAXA OF SPECIFIC CONSERVATION INTEREST- FRESHWATER CRUSTACEA

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest - Crustacea

RATIONALE

Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. *Euastacus fleckeri* is known from the Carbine Tableland and Mt. Lewis area.

MAJOR CATCHMENT

Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**			
Picaninny	**2**			
West Spencer	**3**			
Spencer	**2**			
East Spencer	**1**			
Reedy	**2**	4	Potential habitat for *Euastacus fleckeri*	1,2
Half Ton	**2**	4	Potential habitat for *E.fleckeri*	1,2
Mary	**3**	5	E. fleckeri known from here	1,2
Bushy	**3**	5	E. fleckeri known from here	1,2
Luster	**2**			
Little Sandy	**1**			
Spear	**1**			
Garioch	**3**			
Lagoon	**2**			
Wattle	**4**			
Camp	**5**			
Upper Rifle	**5**			
Rooty	**5**			
Little Mitchell	**1**			
unnamed south of Wattle	**5**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. *Euastacus robertsi* is known from the Mt. Finnigan area of the Parrot sub-catchment

MAJOR CATCHMENT Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**			
Parrot	**5**	5	*Euastacus robertsi* known from here	1,2
Adams	**2**			
Banana	**2**			
Wallaby	**4**			
Mungumby	**2**			
Trevethan	**2**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest - Crustacea

RATIONALE

Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. Though not yet recorded from Noah and Cooper, these sub-catchments drain Thornton Peak, from which *Euastacus robertsi* is known.

MAJOR CATCHMENT

Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**			
McAdam	**5**			
Ashwell	**5**			
Gap	**2**			
Cowie	**5**			
Melissa	**5**			
Bind	**5**			
Tachalbadga	**5**			
Emmagen	**5**			
Mason	**4**			
Myall	**4**			
Noah	**5**	4	Potentially habitat for *E. robertsi*	1,2
Cooper	**5**	4	Potentially habitat for *E. robertsi*	1,2
Hutchinson	**5**			
Alexandra	**5**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest - Crustacea

RATIONALE

Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. Though not yet recorded from Roaring Meg, this sub-catchment drains Thornton Peak, from which *Euastacus robertsi* is known.

MAJOR CATCHMENT

Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**			
Baird	**5**			
Roaring Meg	**5**	4	Potential habitat for *E. robertsi*	1,2
Watermelon	**5**			
Unnamed north of Watermelon	**4**			
Ayton	**2**			
Woobadda	**4**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE

Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. *Euastacus robertsi* is known from Hilda Creek. Other *Euastacus* species may also be present in various sub-catchments.

MAJOR CATCHMENT Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**	4	Potential habitat for *E. fleckeri*	1,2
Smith	**5**			
Dagmar East	**5**			
Dagmar West	**5**			
Timbi	**5**			
Bargoo	**5**			
Bargoo North	**5**			
Paterson	**5**			
Adeline	**4**			
Rodoni	**5**			
Boolbun	**3**			
Adastra	**5**			
Moase	**5**			
Kobi	**5**			
Lewin	**5**			
Ronald	**5**			
Lucas	**5**			
Duncan	**5**			
unnamed west of Duncan	**5**	4	Potential habitat for *E. robertsi*	1,2
Hilda	**5**	5	*E. robertsi* known from here	1,2
Gold	**4**			
Landers	**4**			
Niau	**4**			
Little Naiu	**2**			
Kiely	**4**			
Allanton	**2**			
Luttra	**2**			
Stewart	**4**	4	Potential habitat for *E. fleckeri*	1,2
Barratt	**4**			
Forest	**2**			
Daintree	**5**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. *Euastacus fleckeri* has been recorded from upstream areas of the Mossman catchment.

MAJOR CATCHMENT Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**			
Whyanbeel	**3**			
unnamed south of Whyanbeel	**3**			
Carson	**1**			
Platypus	**4**	5	*E. fleckeri* known from here	1,2
Marr	**2**			
South Mossman	**3**	4	Potential habitat for *E. fleckeri*	1,2
Cassowary	**2**			
Crees	**1**			
Lower Mowbray	**3**			
Collard	**4**			
unnamed south of Collard	**2**			
unnamed south of Lower Mowbray	**3**			
Oak	**3**			
Robbins	**4**			
Spring	**3**			
Upper Mowbray	**2**			
Turtle	**5**			
Hartley	**5**			
Tin	**4**			
Moore's	**1**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE

Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. Caridina zebra is known from the Tablelands area and *Euastacus balanensis* from the Lamb Range area.

MAJOR CATCHMENT Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**			
Morans	**4**			
Peterson (lakes)	**1**	4	*Caridina zebra* known from here	1-4
Mobo	**2**	4	Potential habitat of *E. balanensis*	1-4
Robson	**3**	5	*E. balanensis* and *C. zebra* known from here	1-4
Tinaroo	**1**	4	*Caridina zebra* known from here	1-4
Varch	**4**	5	*E. balanensis* known from here	1-4
Oaky	**1**			
Big Rooty	**4**			
Track	**2**			
Emerald	**3**			
Rainy	**3**			
Carrington	**3**			
Upper Barron	**3**			
Pearce	**1**			
Davies	**2**	5	*E. balanensis* known from here	1-4
Brindle	**3**			
Shoteel	**5**			
Reid	**2**			
Kauri	**3**			
unnamed east of Pearce	**4**			
Myola	**2**			
Barron Falls	**4**			
Surprise	**3**			
Stoney	**4**			
Thomatis	**1**			
Emerald	**1**	4	Potential habitat of *E. balanensis*	1-4
Freshwater	**3**	4	Potential habitat of *E. balanensis*	1-4

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest - Crustacea

RATIONALE

Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. *Euastacus balanensis* is known from the Mt. Bartle Frere area.

MAJOR CATCHMENT

Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**			
Kiandra	**3**			
Bartle Frere	**5**	5	*E. balanensis* known from here	1,2
Wankaroo	**5**	5	*E. balanensis* known from here	1,2
Tewon	**5**			
Josephine	**3**	5	*E. balanensis* known from here	1,2
Woopen	**2**			
Norries	**2**			
Unnamed east of Norries	**2**			
Pughs	**2**	4	Potential habitat of *E. balanensis*	1,2
Niringa	**1**			
Babinda	**3**	4	Potential habitat of *E. balanensis*	1,2
Harvey	**3**	5	*E. balanensis* known from here	1,2
Meringulah	**3**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. *Euastacus balanensis* is known from the Mt. Bartle Frere and Mt. Bellenden Ker areas.

MAJOR CATCHMENT Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	4	Potential habitat of *E. balanensis*	1,2,5
Luscombe	**5**	5	*E. balanensis* occurs here	1,2,5
Upper Mulgrave	**5**	4	Potential habitat of *E. balanensis*	1,2,5
Kearneys Falls	**5**	4	Potential habitat of *E. balanensis*	1,2,5
Butcher	**4**			
Toohey	**4**			
Stallion	**5**			
Uhr	**5**			
Huntsbrook	**4**			
Fisheries	**3**			
Little Mulgrave	**4**			
Blackwell	**3**			
Pyramid	**2**			
Behana	**4**	5	*E. balanensis* occurs here	1,2,5
Malbon Thompson	**4**			
Fishery Falls	**3**	4	Potential habitat of *E. balanensis*	1,2,5

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. *Caridina zebra* is known from the upper North Johnstone area.

MAJOR CATCHMENT Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**			
Topaz	**4**			
Topaz south	**5**			
Five Mile	**3**			
Coolamon	**5**			
Elinjaa	**2**			
Mungalli	**3**			
Mystery	**5**			
Dirran	**1**	3	Potential habitat for *Caridina zebra*	3,4
Badgery	**5**			
Lower Badgery	**5**			
Rankin	**1**			
Fisher	**1**			
Poorka	**3**			
Unnamed (Henrietta Ck?)	**5**	4	*Caridina zebra* known from here	3,4
Beatrice	**3**	3	Potentially habitat for *Caridina zebra*	3,4
Waraker	**4**			
Tregothanan	**1**			
Mourilyan	**1**			
Clancys Overflow	**3**			
Karangaree	**5**			
Kaarru	**5**			
Charappa	**5**			
Maple	**5**			
Downey	**5**			
Lower Downey	**5**			
McNamee	**5**			
Lower McNamee	**5**			
Utchee West	**5**			
Utchee	**1**			
Mitcha	**5**			
Egan	**5**			
River	**4**			
Mena	**1**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE

Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. The area around Koombooloomba Dam is of particular importance for several Crustacea species of conservation interest.

MAJOR CATCHMENT Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**	3	Potential habitat for *Caridina zebra*	4-7
Coochimbeerum	**5**	4	*Caridina zebra* known from here	4-7
Cheetah	**5**	3	Potential habitat for *Caridina zebra*	4-7
Boundary	**5**			
Theodore	**4**			
Nitchaga	**3**	4	Important for several species of interest	4-7
Campbell	**5**	4	Important for several species of interest	4-7
Carpenter	**5**	4	Important for several species of interest	4-7
Niblet	**5**	4	Important for several species of interest	4-7
Koombooloomba	**5**	4	Important for several species of interest	4-7
Sylvania	**5**	4	Important for several species of interest	4-7
Kooroomool	**5**			
Goddard	**5**	4	Important for several species of interest	4-7
Costigan	**5**	4	Important for several species of interest	4-7
Luff	**5**	4	Important for several species of interest	4-7
O'Leary	**5**	5	Known habitat of *Euastacus yigara*, *C.zebra*, *Cherax parvus* and an undescribed *Macrobrachium*	4-7
Culpa	**5**	4	Important for several species of interest	4-7
Barbed Wire	**3**			
Echo North	**1**			
Echo	**4**	4	Important for several species of interest	4-7
Table Top	**3**			
Timberoonie	**2**			
Jarra	**4**			
Davidson	**3**	4	Important for several species of interest	4-7
Banyan	**2**			
Tyson	**1**			
Silky Oak	**2**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Crustacea

RATIONALE Several species of limited distribution are known to occur in the WTWHA. The sub-catchments in which they are known to occur have been given high rankings. Adjacent sub-catchments with similar habitats are also ranked high due to the potential of their also being present but not yet detected because of limited survey. The upper Herbert catchment, near Koombooloomba Dam is an area of particular importance to Crustacea of conservation interest.

MAJOR CATCHMENT Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**			
Nigger	**2**			
Cedar	**1**			
Blunder	**2**	4	*Caridina zebra* known from here	7
Unnamed sth of Vine	**2**			
Cameron	**2**	4	Important for several species of interest	4-7
Blencoe	**2**	4	Important for several species of interest	4-7
Smoko	**3**			
Waterfall	**1**			
Herkies	**3**			
Yamanie	**4**			
Sword	**5**			
Longtail	**4**			
Gowrie	**3**			
Pinnacles	**5**			
Garrawalt	**3**			
Stony	**4**			
Henrietta	**1**			
Broadwater	**1**			
Dalrymple	**2**			
Stone West branch	**2**			
Upper Stone	**1**			
Tinkle	**1**			
Seymour	**1**			
Seaforth	**2**			
Seaforth Channel	**5**			

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TAXA OF SPECIFIC CONSERVATION INTEREST- FRESHWATER FISH INCLUDING IMPORTANT FISH HABITAT AND AREAS OF HIGH DIVERSITY

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare and Endemic Fishes and Areas of High Fish Diversity

RATIONALE

Significant occurrences of rare and endemic fishes, those species for which the WTWHA represents the Australian limit of distribution and widespread species currently under recreational fishing pressure and those areas which contain high diversity of freshwater fishes. Maintenance of flow quantity and regime necessary for habitat maintenance and continued survival.

MAJOR CATCHMENT

Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**	1	Intermittent streams, unlikely to contain either high diversity or any species of conservation significance	1
Picaninny	**2**	2	No R&T species or species of conservation significance, however Herbert *et al.* (1995) suggest that streams in these subcatchments are of importance as spawning habitat for *Hepahaestus fuliginosus.*	1
West Spencer	**3**	2		
Spencer	**2**	2		
East Spencer	**1**	2	Not known to contain species of conservation significance. However, maintenance of flow regime needs to be considered given that streams within these subcatchments have perennial stream flow in contrast to similarly sized streams elsewhere within this drainage. Moreover, maintenance of flow regime and habitat is necessary for maintenance of the fish fauna which are of a distinctly different zoogeography to those fishes occurring in easterly flowing rivers of the WT region. Therefore important for the maintenance of overall fish diversity within the WTWHA.	2
Reedy	**2**	2		
Half Ton	**2**	2		
Mary	**3**	2		
Bushy	**3**	2		
Luster	**2**	2		
Little Sandy	**1**	2		
Spear	**1**	2		
Garioch	**3**	2		
Lagoon	**2**	2		
Wattle	**4**	2		
Camp	**5**	2		
Upper Rifle	**5**	2		
Rooty	**5**	2		
Little Mitchell	**1**	2		
unnamed south of Wattle	**5**	2		

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MAJOR CATCHMENT

Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**	1	Not known to contain species of high conservation significance	33
Parrot	**5**	1		
Adams	**2**	1		
Banana	**2**	1		
Wallaby	**4**	4	Contains probably the most southerly distributed population of *Melanotaenia trifasciata.*	5
Mungumby	**2**	?		
Trevethan	**2**	?		

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MAJOR CATCHMENT

Normanby

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Yard	**1**	1	Contains no known R&T species or species of special conservation significance although such species are present downstream. Flow needs of these subcatchments need protection however given that they are distinguished by perennial flow in contrast to most other subcatchments within this river system. Likely to contain more diverse assemblages on account of perennial flow	3,4
Sporing	**1**	1		
Boolbun North	**4**	1		
Poverty South	**2**	1		
East Normanby North Branch	**1**	1		
Diggers	**1**	1		
Upper Granite	**1**	1		

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MAJOR CATCHMENT

Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**	2	Important fish habitat necessary for maintenance of continuity of habitat.	
McAdam	**5**	3		
Ashwell	**5**	3		
Gap	**2**	4	Contains *M. trifasciata*. Area needs further study, likely to contain species of conservation significance, particularly those streams draining into Cedar Bay	6,7
Cowie	**5**	4	Important fish habitat, contains highly diverse assemblages with high degree of heterogeneity between neighbouring drainages, assemblages distinctive by virtue of domination by estuarine species and species not normally encountered in Australia. Important habitat for the highly restricted spotted flagtail *Kuhlia marginata*	8
Melissa	**5**	4		
Bind	**5**	4		
Tachalbadga	**5**	4		
Emmagen	**5**	4		
Mason	**4**	4		
Myall	**4**	4		
Noah	**5**	4		
Cooper	**5**	4		
Hutchinson	**5**	4		
Alexandra	**5**	4		

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MAJOR CATCHMENT

Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**	5	Only known habitat of the paleoendemic percichthyid "Bloomfield Cod". Species of very high evolutionary, biogeographic and conservation significance. Further research on the rainbowfish of this part of the system highly likely to reveal them to be genetically distinct.	8,9
Baird	**5**	5		
Roaring Meg	**5**	5		
Watermelon	**5**	3	Not known to contain Bloomfield Cod but within drainage and may therefore be of significance. Much greater research effort required to document the distribution, ecology and flow requirements of this species needed.	
Unnamed north of Watermelon	**4**	4	Contains streams upstream of the Bloomfield River Falls and therefore potential habitat for Bloomfield Cod. Lowland streams only known habitat for *Sicyopterus micrurus* (referred to as *S.* cf. *macrostetholepis* in 10. Lowland estuarine reaches contain a high diversity of gobiid species.	10,11
Ayton	**2**	4		
Woobadda	**4**	4		

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MAJOR CATCHMENT

Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**	2	Fish diversity low but may contain important genetic variants of *Melanotaenia splendida splendida* or perhaps contains *M. eachamensis* as proposed by Pusey *et al.* (1997)	8,22
Smith	**5**	2		
Dagmar East	**5**	2		
Dagmar West	**5**	2		
Timbi	**5**	2		
Bargoo	**5**	2		
Bargoo North	**5**	2		
Paterson	**5**	2		
Adeline	**4**	2		
Rodoni	**5**	3	Important habitat for *Kuhlia rupestris* and the WT endemic *Hephaestus* sp. (Khaki Grunter). This river system represent one of the few rivers into which its congener *H. fuliginosus* has not naturally dispersed or been translocated.	8,12
Boolbun	**3**	3		
Adastra	**5**	3		
Moase	**5**	3		
Kobi	**5**	3		
Lewin	**5**	3		
Ronald	**5**	3		
Lucas	**5**	3		
Duncan	**5**	3		
unnamed est of Duncan	**5**	3		
Hilda	**5**	3		
Gold	**4**	2	Substantially degraded but otherwise important representatives of tributaries of the middle reaches of the Daintree.	8,10
Landers	**4**	2		
Niau	**4**	2		
Little Naiu	**2**	2		
Kiely	**4**	2		
Allanton	**2**	3	Tributaries rise steeply into WTWHA and streams of this catchment are distinctive in containing *K. rupestris* in headwaters and *K.marginata* in more lowland reaches	13
Luttra	**2**	4	Retain some connectivity between lowland reaches and headwaters completely within high integrity forest. Douglas Creek contains high diversity of gudgeons within the genera *Oxyeleotris* and *Eleotris*. Only known locality for the New Guinean eel species *Anguilla macrostoma*	8,10
Stewart	**4**	4		
Barratt	**4**	4		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forest	**2**	2	Lowland floodplain partially intact, contains population of *M.maccullochi*	14,17
Daintree	**5**	4	Lowland floodplain extensively intact and of high fish habitat value	14

WET TROPICS SUBCATCHMENT RANKING PROFORMA

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MAJOR CATCHMENT

Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**		Needs survey work	
Whyanbeel	**3**	2		
unnamed south of Whyanbeel	**3**	2		
Carson	**1**	1		
Platypus	**4**	5	Contains *K. marginata* and good populations of *K. rupestris.*	8,10
Marr	**2**	1		
South Mossman	**3**	4	Lowland habitat, high diversity	8,10
Cassowary	**2**	4		
Crees	**1**			
Lower Mowbray	**3**			
Collard	**4**			
unnamed south of Collard	**2**			
unnamed south of Lower Mowbray	**3**			
Oak	**3**			
Robbins	**4**			
Spring	**3**			
Upper Mowbray	**2**			
Turtle	**5**			
Hartley	**5**			
Tin	**4**			
Moore's	**1**			

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MAJOR CATCHMENT

Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**	4	Contains populations of *M. eachamensis*	15
Morans	**4**	1		
Peterson (lakes)	**1**	4	Type locality of *M. eachamensis*, also contains(ed) other isolated populations of fish species	
Mobo	**2**	4	Contains pure lake dwelling population of *M. eachamensis*	15
Tinaroo	**1**	5	Contains unique haplotype of rainbowfish otherwise restricted to Johnstone River drainage	15
Emerald	**2**	5		
Robson	**3**	1		
Varch	**4**	1		
Oaky	**1**	1		
Big Rooty	**4**	1		
Track	**2**	1		
Rainy	**1**	1		
Carrington	**1**	1		
Upper Barron	**1**	1		
Pearce	**1**	1		
Unnamed east of Pearce	**4**	1		
Rainy		1		
Brindle	**3**	1		
Shoteel	**5**	1		
Reid	**2**	1		
Kauri	**3**	1		
unnamed east of Pearce	**4**	1		
Myola	**2**	1		
Barron Falls	**4**	1		
Surprise	**3**	2	Contains *M. eachamensis/M. s. splendida* hybrids	16
Stoney	**4**	1		
Thomatis	**1**	1		
Freshwater	**3**	2	Previously contained very high diversity of freshwater fishes but now heavily infested with *Oreochromis mossambicus*	8,17

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MAJOR CATCHMENT

Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**	?	Needs additional survey work	
Mick	**4**	?		
Kweto	**2**	?		
Skeleton	**1**	1		
Chinaman	**1**	1		
Blackfellow	**2**	2		
Wright	**2**	4	Contains only known population of *Glossogobius* sp. B. outside of the Mulgrave/ Russell system	18
Maskey	**1**	1	Possibly as for Wright but only small area within WTWHA	
unnamed east of Maskey	**2**	4	Highly likely to contain *Glossogobius* sp. B.	
Buddabadoo	**4**	3	Highly likely to contain a high diversity of freshwater fishes plus populations of *K. rupestris.* Needs survey work	20
Bells Peak	**5**	3		
Josey	**5**	5	Highly likely to contain species of high conservation significance or those with disjunct distribution - ie. *M. maccullochi, Pseudimugil gertrudae* and *Denariusa bandata.* Important coastal lowland wetlands. High need for additional survey information.	20
Wyvuri	**3**	5		
Worth	**2**	?		
unnamed south of Worth	**2**	?		

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MAJOR CATCHMENT

Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	3	Upland areas of low diversity but important habitat for *Glossogobius* sp. B and *Cairnsichthys rhombosomoides*	8,19
Kiandra	**3**	3		
Bartle Frere	**5**	4		
Wankaroo	**5**	4		
Tewon	**5**	4		
Josephine	**3**	4		
Woopen	**2**	1		
Norries	**2**	1		
Unnamed east of Norries	**2**	3	As for Coopooroo	8,19
Pughs	**2**	4		
Niringa	**1**	1		
Babinda	**3**	4	High habitat value, lowland creek contains high diversity and good population of sparsely distributed gudgeon *Oxyeleotris aruensis*	8,19
Harvey	**3**	5	Very important fish habitat, contains morphologically distinctive population of *Pseudomugil signifer* plus is the only known location for the rare recently described goby *Stiphodon allen.*	20
Meringulah	**3**	5	Only lowland area within this catchment that is protected by inclusion within WTWHA	

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MAJOR CATCHMENT

Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	4	Upland areas of low diversity however contains endemic species plus those of conservation significance	21
Luscombe	**5**	4		
Upper Mulgrave	**5**	4		
Kearneys Falls	**5**	5	Very high habitat value and diversity, contains the WT tropics endemic *Schismatogobius* sp.	19,21
Butcher	**4**	4	Upper reaches of very low diversity (2 spp.) but lower reaches important spawning areas for WT endemic grunter *Hephaestus* sp.	19,21
Toohey	**4**	4		
Stallion	**5**	5	Contains a long reach of the middle section of the river - very high habitat value and high diversity	19,21
Uhr	**5**	4	High habitat value, contains endemic species	19
Huntsbrook	**4**	4		
Fisheries	**3**	1		
Little Mulgrave	**4**	4	High habitat value, contains endemic goby plus other WT endemics	19
Blackwell	**3**	1		
Pyramid	**2**	1		
Behana	**4**	5	High habitat value, contains species of conservation interest, rich in goby species, maintenance of flow important for maintenance of the integrity of downstream reaches which contain small populations of *Pseudomugil gertrudae* and *Melanotaenia maccullochi*	19,21
Malbon Thompson	**4**	4	Rich in goby and Eleotrid species plus endemic species and WT endemic species. Important lowland tributary habitat	19,21
Fishery Falls	**3**	4		

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MAJOR CATCHMENT

Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**	4	Contains undescribed subspecies or species of *Craterocephalus* aff. *st. stercusmuscarum*	23
Topaz	**4**	3	Highly likely to contain species listed above	
Topaz south	**5**	3		
Theresa	**1**	3		
Five Mile	**3**	5	Contains pure form of *Melanotaenia eachamensis* - no hybridisation with *M.s.splendida*	24
Dirran	**1**	5	AS for South - high quality catchment	22,24
Coolamon	**5**	?	Needs further field and genetics survey	
Elinjaa	**2**	?		
Mungalli	**3**	?		
Mystery	**5**	?		
Badgery	**5**	5	Important fish habitat for spawning of *Hephaestus fuliginosus*. Johnstone River represents northern extent of natural range. Important fish habitat for a range of other riverine species as both contain a long reaches of the river proper	25
Lower Badgery	**5**	5		
Rankin	**1**	4	Contains most upstream populations of "Utchee Creek" Rainbow, endemic to the Johnstone River and phylogenetically important.	12, 24
Fisher	**1**	4		
Unnamed (Henrietta Ck?)	**5**	?		
Poorka	**3**	?		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Beatrice	**3**	4	Contains population of genetically distinct hardyhead	23
Waraker	**4**	4	Contains populations of the paleoendemic rainbowfish *Cairnsichthys rhombosomoides*	25
Tregothanan	**1**	4		
Polly	**1**	3	High diversity assemblages present	25
Mourilyan	**1**	5	Contains remnants of lowland floodplain ecosystems, contains high diversity, important ecosystem function role, contains paleoendemic *C.rhombosomoides* plus disjunct populations of *M. maccullochi* and *Pseudomugil gertrudae*	25
Clancys Overflow	**3**	4	Contains pure populations of *M. eachamensis,* high value habitat	8,22
Karangaree	**5**	5		
Kaarru	**5**	5		
Charappa	**5**	5		
Maple	**5**	5		
Downey	**5**	4	Highly likely to also contain *M. eachamensis* although possibility of hybridisation with *M. s. splendida*	
Lower Downey	**5**	4		
McNamee	**5**	4	Contains long reaches of middle section of South Johnstone River; high value fish habitat, contains the endemic goby *Schismatogobius* sp.	25
Lower McNamee	**5**	4		
Utchee West	**5**	4	Contains population of Utchee Creek rainbow fish.	22
Utchee	**1**	5	Contains population of Utchee Creek rainbow fish plus paleoendemic *C. rhombosomoides*	8,22
Mitcha	**5**	4	Contains long reaches of river within WTWHA - excellent fish habitat.	25
Egan	**5**	4		
River	**4**	4		
Mena	**1**	1	Does however contain *C. rhombosomoides*	25

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare and Endemic Fishes and Areas of High Fish Diversity

RATIONALE

Significant occurrences of rare and endemic fishes, those species for which the WTWHA represents the Australian limit of distribution and widespread species currently under recreational fishing pressure and those areas which contain high diversity of freshwater fishes. Maintenance of flow quantity and regime necessary for habitat maintenance and continued survival.

MAJOR CATCHMENT

Liverpool, Moresby, Big Maria & Hull

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Liverpool	**5**	3	Headwaters relatively well protected, quality fish habitat.	26
Scindah	**5**	3		
South Liverpool	**4**	3		
Meuribal	**3**	3		
Jingu	**4**	3		
Kittabah	**3**	3		
Taringbah	**3**	3		
Bombeta	**2**	3		
Little Liverpool	**3**	3		
Silkwood	**2**	4	Significant remnant of previously much more widespread lowland floodplain ecosystem	26
Brown	**1**	1		26
Moresby	**2**	5	WTWHA contains river mouth and immediate environs - very important fish habitat	
Big Maria	**2**	2		
Hull	**3**	3	Contains isolated lowland populations of paleoendemic *C. rhombsomoides*	8
North Hull	**4**	2		
Wongaling	**1**	1		

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MAJOR CATCHMENT

Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**	4	Upland catchment of the Tully River contained within these subcatchments. Contains genetically distinct populations of rainbowfishes plus *Mogurnda adspersa* and *M. mogurnda.* These latter two species very rarely found in the same drainage. Entire area important from an evolutionary perspective due to complicated drainage rearrangement in recent geological past	22, 27
Coochimbeerum	**5**	4		
Cheetah	**5**	4		
Boundary	**5**	4		
Theodore	**4**	4		
Nitchaga	**3**	4		
Campbell	**5**	4		
Carpenter	**5**	4		
Niblet	**5**	4		
Koombooloomba	**5**	4		
Sylvania	**5**	4		
Kooroomool	**5**	4		
Goddard	**5**	4		
Costigan	**5**	4		
Luff	**5**	4		
O'Leary	**5**	4		
Culpa	**5**	4		
Barbed Wire	**3**	1		
Echo North	**1**	1		
Echo	**4**	1		
Table Top	**3**	1		
Timberoonie	**2**	1		
Jarra	**4**	5	Very important fish habitat, one of very few representatives of major lowland tributaries of high integrity due to protection of catchment and pig control	28
Davidson	**3**	3	Important fish habitat and critical for maintenance of flows in downstream reaches	25
Banyan	**2**	1		
Tyson	**1**	1		
Silky Oak	**2**	1		

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MAJOR CATCHMENT

Murray

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Murray	**4**	4	Very little of this catchment is contained within the WTWHA except for these subcatchment which therefore assume increased significance as fish habitat and the maintenance of diversity within the entire river system	
North Murray	**4**	4		
King Ranch	**1**	1		
Deep	**1**	3	Subcatchment contains a small amount of high integrity land near the river mouth - important fish habitat. Lowland floodplain remnants contain populations of the disjunctly distributed *Pseudomugil gertrudae* and *Denariusa bandata*	25

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MAJOR CATCHMENT

Dallachy, Meunga & Conn

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Dallachy	**3**	3	Lowland wetlands likely to contain high diversity and populations of disjunctly distributed wetland species. Needs survey work to confirm	
Whitfield	**3**	3		
Wreck	**3**	3		
Alma	**3**	?	Needs survey work to document fauna	
Kennedy	**4**	?		
Hinkler	**4**	?		
Boggy Camp	**2**	?		
Meunga	**3**	?		
Scrubby	**2**	?		
Five Mile	**2**	2	Valuable fish habitat as some streams of the area are perennial whereas others more episodic - diverse range of flow environments.	25
Damper	**3**	2		
Porter	**5**	4	Lowland wetland systems - very poorly represented in the WTWHA; important fish habitat and important for maintenance of connectivity between lowland wetlands	25

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MAJOR CATCHMENT

Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**	1		
Nigger	**2**	1		
Cedar	**1**	1		
Blunder	**2**	4	Contains fish populations of high genetic diversity and of evolutionary significance - see comments for the upper Tully	27
Unnamed sth of Vine	**2**			
Cameron	**2**	1		
Blencoe	**2**	1		
Smoko	**3**	1		
Waterfall	**1**	1		
Herkies	**3**	4	Contains long reaches of middle reaches of the river plus many mid-level tributaries of high integrity. Important fish habitat for a wide range of species including those of recreational significance.	29
Yamanie	**4**	4		
Sword	**5**	4		
Longtail	**4**	4		
Gowrie	**3**	4		
Pinnacles	**5**	4		
Garrawalt	**3**	4		
Stony	**4**	5	Contains a major tributary of the Herbert River Which is almost completely within the WTWHA. Important fish habitat as it is the only one of its kind in the Herbert drainage and one of very few within the region	
Henrietta	**1**	1		
Broadwater	**1**	1		
Dalrymple	**2**	1		
Stone West branch	**2**	3	Contains forested headwaters for the Sone River.	
Upper Stone	**1**	3		
Tinkle	**1**	3		
Seymour	**1**	4	Contains lowland section of the Seymour River and lowland wetland habitat - very restricted habitat type within the region and important fish habitat.	
Seaforth	**2**	3		
Seaforth Channel	**5**	3		

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MAJOR CATCHMENT

Trebonne Halifax

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Frances	**1**	1		
Waterview	**2**	1		
Crystal	**3**	4	Very important fish habitat for declining species *Kuhlia rupestris* and other species endemic to the WT region such as *Tandanus* sp. and *Hephaestus* sp. Value of Saltwater, Leichhardt, Sleeper Log and Bluewater reduced because of progressively less WTWHA within catchments. Maintenance of flows important for maintenance of downstream reaches.	30,31
Ollera	**2**	4		
Hencamp	**2**	4		
Rollingstone	**3**	4		
Saltwater	**2**	3		
Leichhardt	**2**	3		
Sleeper Log	**2**	2		
Bluewater	**2**	1		

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MAJOR CATCHMENT

Burdekin

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Black Burdekin	**3**	3	Important spawning habitat for *Hephaestus fuliginusus* and *Neosilurus* sp.	32
Michael	**1**	1		
Paluma	**3**	4	Important for supply of water downstream for the maintenance of morphologically and phenotypically distinct rainbowfish	33
Unnamed	**3**	4		
Puzzle	**1**	1		
Blue Gum	**2**	4	Important spawning habitat for *Hephaestus fuliginusus* and *Neosilurus* sp.	32
Blue Gum South	**2**	1		
Arnott	**1**	1		
Little Star	**2**	1		
Keelbottom West	**2**	1		
Keelbottom East	**1**	1		

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TAXA OF SPECIFIC CONSERVATION INTEREST- FROGS

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare and Threatened Frogs

RATIONALE

Significant occurrences of rare and threatened species of frogs, those species for which the WTWHA represents the limits of distribution and those subcatchments which originally contained such species but for which populations likely to have become extinct. Maintenance of flows necessary for habitat maintenance and continued survival.

MAJOR CATCHMENT

Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**	1		
Picaninny	**2**	5	Contains all five species of R&T species expected for the Windsor Tablelands	1-4,7
West Spencer	**3**	5		
Spencer	**2**	5		
East Spencer	**1**	1		
Reedy	**2**	4	Contains 4/5 R&T species (lacking *L. lorica*) plus also contains *T. rheophilus*	1-4,7
Half Ton	**2**	4		
Mary	**3**	5	Contains all of the R&T Wet Tropics endemic frog species	7
Bushy	**3**	5		
Luster	**2**	?	Status uncertain, further work needed	7
Little Sandy	**1**	?		
Spear	**1**	?		
Garioch	**3**	?		
Lagoon	**2**	?		
Wattle	**4**	?		
Camp	**5**	?		
Upper Rifle	**5**	2	Connectivity value high	7
Rooty	**5**	?		
Little Mitchell	**1**	1		
unnamed south of Wattle	**5**	2	As for Upper Rifle	7

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MAJOR CATCHMENT

Normanby

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Yard	**1**	2	Previously known to contain *L. rheocola* and *T. acutirostris.* Particularly strong population of *T. acutirostris* in East Normanby North Branch	1-4, 7
Sporing	**1**	2		
Boolbun North	**4**	2		
Poverty South	**2**	2		
East Normanby North Branch	**1**	3		
Diggers	**1**	2	Contains only small amount of rainforest but likely to contain same species as Adeline subcatchment in Daintree (see Daintree sheet)	7
Upper Granite	**1**	2		

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MAJOR CATCHMENT

Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**	4	Previously known to contain R&T species but populations have recently declined	1-7
Parrot	**5**	4		
Adams	**2**	2	Probably still contains population of *L. rheocola*	7
Banana	**2**	1		
Wallaby	**4**	5	Contains full complement of R&T species	1-7
Mungumby	**2**	5		
Trevethan	**2**	?		

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MAJOR CATCHMENT

Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**	?		
McAdam	**5**	2	Lowland population of *L.rheocoloa*	7
Ashwell	**5**	4	Full complement of lowland R&T species still present	1-4,7
Gap	**2**	4		
Cowie	**5**	1	Lowland open forest unlikely to contain rainforest R&T species	7
Melissa	**5**	1		
Bind	**5**	1		
Tachalbadga	**5**	3	Lowland species still present, upland areas drain high quality rainforest and may contain R&T species	1-4,7
Emmagen	**5**	3		
Mason	**4**	1	Lowland open forest	7
Myall	**4**	3	As for Tachalbadga and Emmagen	
Noah	**5**	5	Seven species of R&T frogs, including *L. lorica* present in these drainages; very high value	7
Cooper	**5**	5		
Hutchinson	**5**	5		
Alexandra	**5**	3	Previously known to contain *T. acutirostris*	7

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MAJOR CATCHMENT

Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**	?	Needs further survey work	
Baird	**5**	5	Contains upland populations of 5 spp of R&T frogs whereas Roaring Meg known to contain all 7 species	1-4,7
Roaring Meg	**5**	5		
Watermelon	**5**	?	Needs further survey work	
Unnamed north of Watermelon	**4**	?		
Ayton	**2**	1		1-4
Woobadda	**4**	5		7

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MAJOR CATCHMENT

Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**	4	Contains 4 of 5 R&T species expected for the region	1-4,7
Smith	**5**	?	Further survey work urgently needed for these and many other subcatchments of the Daintree drainage	7
Dagmar East	**5**	?		
Dagmar West	**5**	?		
Timbi	**5**	?		
Bargoo	**5**	4	Highly likely to contain all those R&T species expected for the Mt Windsor area	1-4,7
Bargoo North	**5**	4		
Paterson	**5**	?	Needs survey work	7
Adeline	**4**	4	As for Bargoo	7
Rodoni	**5**	1	Open forest	
Boolbun	**3**	3	Likely to contain high diversity of frogs plus species of R&T frogs	7
Adastra	**5**	?	Very high need for specimen based survey work.	7
Moase	**5**	?		
Kobi	**5**	?		
Lewin	**5**	?		
Ronald	**5**	?		
Lucas	**5**	?		
Duncan	**5**	?		
unnamed (Osborne?)	**5**	3	High diversity likely to be similar to Hilda Creek and contain R&T species	7
Hilda	**5**	5	As for Roaring Meg	7
Gold	**4**	?		
Landers	**4**	?		
Niau	**4**	?		
Little Naiu	**2**	?		
Kiely	**4**	?		
Allanton	**2**	1	Highly unlikely to contain R&T species	7
Luttra	**2**	1		
Stewart	**4**	4	Headwaters in upland regions highly likely to contain R&T species	7
Barratt	**4**	2	Lowland contains high diversity of frog species	1-4,7
Forest	**2**	1	Highly unlikely to contain R&T species	7
Daintree	**5**	1		

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MAJOR CATCHMENT

Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Whyanbeel	**3**	3	Highland areas contain R&T species typical of Mt Carbine region	7
unnamed south of Whyanbeel	**3**	3		
Carson	**1**	1		
Platypus	**4**	5	Highland areas contain 6 spp. of R&T frogs. Only species absent is *L. lorica*	1-4,7
Marr	**2**	1		
South Mossman	**3**	5	Highland areas contain 6 spp. of R&T frogs. Only species absent is *L. lorica*	1-4,7
Cassowary	**2**	1	Not known to contain species of high conservation interest but important for maintaining connectivity between Mossman drainage and that of the Mowbray	7
Crees	**1**	1	As for Cassowary	7
Lower Mowbray	**3**	1		
Collard	**4**	1		
unnamed south of Collard	**2**	1	Open forest, extensively cleared - unlikely to contain R&T species	7
unnamed south of Lower Mowbray	**3**	1		
Oak	**3**	1		
Robbins	**4**	1		
Spring	**3**	4	Centred on Black Mountain Corridor; contains very high diversity of frogs	1-4,7
Upper Mowbray	**2**	3	As for Spring, but slightly less diversity	7
Turtle	**5**	1		
Hartley	**5**	1		
Tin	**4**	1		
Moore's	**1**	1		

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MAJOR CATCHMENT

Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**	5	Contains full complement of upland species of R&T species expected for region (*L. nyakalensis, L. rheocola, L. nannotis, N. dayi* and *T. acutirostris*)	1-4,7
Morans	**4**	4	Highly likely to be similar to Poona	7
Peterson (lakes)	**1**	4	Contains all R&T species expected of the region except for *T. acutirostris*	7
Mobo	**2**	2		
Robson	**3**	5	As for Poona	1-4, 7
Varch	**4**	5		
Oaky	**1**	?		
Tinaroo	**1**	5	Contains full complement of upland species of R&T species expected for region (*L. nyakalensis, L. rheocola, L. nannotis, N. dayi* and *T. acutirostris*)	1-4, 7
Emerald	**2**	5		
Big Rooty	**4**	?		
Track	**2**	?		
Rainy	**1**	?		
Carrington	**1**	?		
Upper Barron	**1**	?		
Pearce	**1**	?		
Davies	**2**	5	As for Robson	1-4,7
Brindle	**3**	5		
Shoteel	**5**	2	Dry open forest unlikely to contain rainforest R&T species	7
Reid	**2**	2		
Kauri	**3**	2		
unnamed east of Pearce	**4**	4	Contains *T. acutirostris, L. rheocola* and *N. dayi* - high connectivity value	7
Myola	**2**	3	Likely to contain same species as above	7
Barron Falls	**4**	4	Contains full complement of lowland species expected for the area - *N. dayi, L. nannotis* and *L. rheocola*	7
Surprise	**3**	4		
Stoney	**4**	4		
Thomatis	**1**	1		
Freshwater	**3**	5	Contains very good populations of all expected lowland populations of lowland R&T species	1-4, 7

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare and Threatened Frogs

RATIONALE

Significant occurrences of rare and threatened species of frogs, those species for which the WTWHA represents the limits of distribution and those subcatchments which originally contained such species but for which populations likely to have become extinct. Maintenance of flows necessary for habitat maintenance and continued survival.

MAJOR CATCHMENT

Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**	1	Unlikely to contain R&T species of rainforest frog	1-4,7
Mick	**4**	1		
Kweto	**2**	1		
Skeleton	**1**	1		
Chinaman	**1**	1		
Blackfellow	**2**	1		
Wright	**2**	2	Previously known to contain *T. acutirostris* and possibly *L. nannotis* (latter based on tadpole only)	7
Maskey	**1**	1		
unnamed east of Maskey	**2**	2	Mostly open forest but contains areas of rainforest on north-western flanks of the Malbon Thompson Range	
Buddabadoo	**4**	2	Likely to contain high diversity of frogs	7
Bells Peak	**5**	4	Upland areas contain *T. acutirostris* plus high diversity of microhylid frogs	1-4, 7
Josey	**5**	?	Survey work needed	7
Wyvuri	**3**	?		
Worth	**2**	?		
Mutchero Inlet	**3**	?		
Ella	**2**	?		
unnamed south of Worth	**2**	?		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

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MAJOR CATCHMENT

Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	5	Contains full complement of highland populations of R&T frogs expected for the part of the WTWHA (*L. nannotis*, *L. rheocola, L. nyakalensis, N. dayi, T. acutirostris* and *T. rheophilus*)	1-4,7
Kiandra	**3**	5		
Bartle Frere	**5**	5		
Wankaroo	**5**	5		
Tewon	**5**	4		
Josephine	**3**	5		
Woopen	**2**	4		
Norries	**2**	?		
Unnamed east of Norries	**2**	?		
Pughs	**2**	3	Contains some but not all R&T species	7
Niringa	**1**	?		
Babinda	**3**	5	Contains full complement of R&T species	1-4,7
Harvey	**3**	5		
Meringulah	**3**	?	Survey work needed	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

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MAJOR CATCHMENT

Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	5	Contains full complement of highland populations of R&T frogs expected for the part of the WTWHA (*L. nannotis*, *L. rheocola, L. nyakalensis, N. dayi, T. acutirostris* and *T. rheophilus*)	1-4,7
Luscombe	**5**	5		
Upper Mulgrave	**5**	5		
Kearneys Falls	**5**	5		
Butcher	**4**	3	Contains some, but not all, R&T species	7
Toohey	**4**	3		
Stallion	**5**	3		
Uhr	**5**	?		
Huntsbrook	**4**	?		
Fisheries	**3**	4	Contains some, but not all, R&T species	7
Little Mulgrave	**4**	3	Contains some, but not all, R&T species	7
Blackwell	**3**	1	Open forest, unlikely to contain rainforest R&T species	
Pyramid	**2**	1		
Behana	**4**	5	Contains full complement of highland populations of R&T frogs expected for the part of the WTWHA (*L. nannotis*, *L. rheocola, L. nyakalensis, N. dayi, T. acutirostris* and *T. rheophilus*	1-4,7
Malbon Thompson	**4**	4	Contains some, but not all, R&T species. Important area for genetic differentiation within populations	7
Fishery Falls	**3**	?		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

Taxa of Specific Conservation Interest
Rare and Threatened Frogs

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MAJOR CATCHMENT

Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**	3	Known to have contained upland populations of R&T species *Taudactylus acutirostris, Litoria nyakalensis* and *L. rheocola* but populations have seriously declined	1, 2, 3, 4, 5, 6, & 7
Topaz	**4**	4		
Topaz south	**5**	4		
South	**3**	4		
Coolamon	**5**	?		
Elinjaa	**2**	?		
Mungalli	**3**	4	Known to have contained populations of *L. nannotis*	
Mystery	**5**	3	Highly probable that these subcatchments contained or still contained populations of R&T frogs. These areas are in need of further study.	
Dirran	**1**	3		
Badgery	**5**	3		
Lower Badgery	**5**	3		
Rankin	**1**	?		
Fisher	**1**	?		
Poorka	**3**	3		
Beatrice	**3**	5	Known to have contained all five species of R&T stream dwelling frogs found on the Atherton Tablelands - *Litoria rheophilus, L. nannotis, L. nyakalensis, Nyctimystes dayi* and *T. acutirostris.* Populations have declined.	
Waraker	**4**	?		
Tregothanan	**1**	?		
Mourilyan	**1**	1	Contains no R&T species	
Clancys Overflow	**3**	4	Known to have contained four of the five species of R&T frogs found on the Atherton Tablelands. Suspected to also contain fifth species also	
Karangaree	**5**	4		
Kaarru	**5**	4		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Charappa	**5**	4		
Maple	**5**	4		
Downey	**5**	4		
Lower Downey	**5**	4		
McNamee	**5**	4		
Lower McNamee	**5**	4		
Henrietta creek subcatchment unnamed on map	**5**	5	Full complement of species as found in the Beatrice	
Utchee West	**5**	4	Contains four R&T species plus is important habitat for microhylid frogs	
Utchee	**1**	4	As above	
Mitcha	**5**	5	Full complement of species as in Beatrice	
Egan	**5**	4	As for Utchee	
River	**4**	3	Known to contain *N. dayi* and *L. rheocola*	
Mena	**1**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

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MAJOR CATCHMENT

Liverpool, Moresby, Maria & Hull

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Liverpool	**5**	?	Region poorly studied, needs further survey and specimen collection.	7
Scindah	**5**	?		
South Liverpool	**4**	?		
Meuribal	**3**	?		
Jingu	**4**	?		
Kittabah	**3**	?		
Taringbah	**3**	?		
Bombeta	**2**	?		
Little Liverpool	**3**	?		
Silkwood	**2**	?		
Brown	**1**	?		
Moresby	**2**	?		
Maria	**2**	3	One of the few remaining lowland populations of *L. rheocola*	7
Hull	**3**	3	As above	7
North Hull	**4**	3		
Wongaling	**1**	1	Surveyed and not known to support R&T species	7

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST

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MAJOR CATCHMENT

Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**	5	Known to have contained all five species of R&T frogs present of the Atherton Tablelands	1-7
Coochimbeerum	**5**	5		
Cheetah	**5**	5		
Boundary	**5**	4	Known to have contained four of the fiver R&T frogs	
Theodore	**4**	5	Contains full complement of R&T lowland species: *L. nannotis*, *L. rheocola* and *N. dayi*. Type locality of *L. nannotis*. Important hybrid zone for northern and southern populations of *L. nannotis*	7,8
Nitchaga	**3**	?	Area poorly surveyed, status and nature of frog populations unknown.	7
Campbell	**5**	?		
Carpenter	**5**	?		
Niblet	**5**	?		
Koombooloomba	**5**	?		
Sylvania	**5**	?		
Kooroomool	**5**	?		
Goddard	**5**	?		
Costigan	**5**	?		
Luff	**5**	?		
O'Leary	**5**	?		
Culpa	**5**	?		
Barbed Wire	**3**	?		
Echo North	**1**	?		
Echo	**4**	?		
Table Top	**3**	?		
Timberoonie	**2**	?		
Jarra	**4**	5	Contains full complement of lowland R&T frogs. High value rainforest habitat with effective feral pig control in place.	1-4, 7
Davidson	**3**	4	Full complement of lowland R&T species plus *T. acutirostris* in upland areas.	7
Banyan	**2**	4		
Tyson	**1**	?		
Silky Oak	**2**	1	Mostly open forest and unlikely to contain R&T species.	7

WET TROPICS SUBCATCHMENT RANKING PROFORMA

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MAJOR CATCHMENT

Murray

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
King Ranch	**1**	1	Open woodland unlikely to contain R&T rainforest frogs	
Deep	**1**	1		
North Murray	**4**	4	Contains upland and lowland population of *T.acutirostris, L. nyakalensis, L. rheocola* and *L.nannotus*	1-4, 7
Upper Murray	**?**	5	As above but also known to be southern limit of the distribution of *L. nyakalensis*	1-4, 7

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MAJOR CATCHMENT

Dallachy, Meunga & Conn

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Dallachy	**3**	3	Good complement of lowland frogs in general and forming important remnant of coastal lowland habitat	7
Whitfield	**3**	3		
Wreck	**3**	3		
Alma	**3**	5	Contains lowland populations of *L. nyaka-lensis* (southern limit of distribution), *N.dayi, T. acutirostris* and *L. nannotis*	1-4, 7
Kennedy	**4**	5		
Hinkler	**4**	5		
Boggy Camp	**2**	3	Known to contain one or two of the species present in Kennedy	7
Meunga	**3**	4		
Scrubby	**2**	1	Lowland open forest	
Five Mile	**2**	1	Lowland open forest, unlikely to contain R&T rainforest species.	7
Damper	**3**	1		
Porter	**5**	1		

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MAJOR CATCHMENT

Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**	3	Important connection between Herbert River drainage and the Johnstone River drainage	7
Nigger	**2**	3	Tall open forest with rainforest gullies may contain R&T species	7
Cedar	**1**	3	High conservation value wet sclerophyll forest and may contain R&T frogs at the western limit of their distribution	1-4,7
Vine	**?**	5	Known to have contained *L. nannotis, L.rheocola* and *N. dayi.* Catchment also contains the Magnificent Brood Frog (*Pseudophryne covacevichi*).	1-4,7
Blunder	**2**	3	Good diversity of frogs in general but no R&T species	7
Unnamed sth of Vine	**2**	?		
Cameron	**2**	?		
Blencoe	**2**	4	Known to contain *L. nanotis* and *L. rheocola* and probably would contain *T. acutirostris* and *N. dayi*	1-4,7
Smoko	**3**	4		
Waterfall	**1**	1		
Herkies	**3**	3	Highly probable that these subcatchments contain the full complement of R&T species characteristic of the Seaview Range (ie. species present in Vine). South of the southern limit of *T.acutirostris* and *L.nyaka-lensis.*	1-4,7
Yamanie	**4**	3		
Sword	**5**	3		
Longtail	**4**	?		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Gowrie	**3**	5	Contains species present in Herkies plus *T. acutirostris.*	1-4, 7
Pinnacles	**5**	3	Highly probable that these subcatchments contain the full complement of R&T species characteristic of the Seaview Range (ie. species present in Vine). South of the limit of *T.acutirostris* and *L.nyakalensislensis.*	1-4,7
Garrawalt	**3**	3		
Stony	**4**	4	Same as above but also contains *L. rheocola.*	1-4,7
Henrietta	**1**	1	Dry open forest	
Broadwater	**1**	5	Full complement of R&T species for Seaview Range area	1-4,7
Dalrymple	**2**	3	Unsurveyed but likely to be similar to Broadwater	7
Stone West branch	**2**	?		
Upper Stone	**1**	?		
Tinkle	**1**	1	Open forest	
Seymour	**1**	1	Mangrove does not contain R&T frog species	7
Seaforth	**2**	1		
Seaforth Channel	**5**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

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MAJOR CATCHMENT

Trebonne Halifax

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Frances	**1**	1		
Waterview	**2**	3	Contains *L. nyakalensis* & *N. dayi*	7
Crystal	**3**	3	Contains *L. nannotis*	7
Ollera	**2**	?	Needs survey work and specimen collection	7
Hencamp	**2**	?		
Rollingstone	**3**	3	Contains *L. nyakalensis* and probably *N. dayi*	1-4,7
Saltwater	**2**	?	Needs survey work and specimen collection	7
Leichhardt	**2**	?		
Sleeper Log	**2**	?		
Bluewater	**2**	?		

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MAJOR CATCHMENT

Burdekin

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Black Burdekin	**3**	?		
Michael	**1**	?		
Paluma	**3**	5	Previously known to contain *N. dayi* and *L. nyakalensis*	1-4,7
Running	**3**	?		
Puzzle	**1**	?		
Blue Gum	**2**	?		
Blue Gum South	**2**	?		
Arnott	**1**	?		
Little Star	**2**	?		
Keelbottom West	**2**	?		
Keelbottom East	**1**	?		

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TAXA OF SPECIFIC CONSERVATION INTEREST- FRESHWATER TURTLES

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Taxa of Specific Conservation Interest - Freshwater Turtles

RATIONALE | Significant occurrences of rare and threatened species, those of special conservation concern or those for which the Wet Tropics World Heritage Area represents the limits of distribution. Flows required for the maintenance of habitat and the maintenance of food supply.

MAJOR CATCHMENT | Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Mary	**3**	2	Only subcatchments of the Mitchell River contained within the WTWHA likely to contain *Emydura tanybaraga* which is endemic to the Mitchell and the Daly rivers.	1
Bushy	**3**	2		
Luster	**2**	2		
Boggy	**1**	1	Unlikely to contain *E. tanybaraga* as this species prefers low gradient streams, further research is warranted however to determine how widespread this interesting endemic is within the WTWHA	1
Picaninny	**2**	1		
West Spencer	**3**	1		
Spencer	**2**	1		
East Spencer	**1**	1		
Reedy	**2**	1		
Half Ton	**2**	1		
Little Sandy	**1**	1		
Spear	**1**	1		
Garioch	**3**	1		
Lagoon	**2**	1		
Wattle	**4**	1		
Camp	**5**	1		
Upper Rifle	**5**	1		
Rooty	**5**	1		
Little Mitchell	**1**	1		
unnamed south of Wattle	**5**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Taxa of Specific Conservation Interest - Freshwater Turtles

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MAJOR CATCHMENT | Normanby

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Yard	**1**	3	Normanby River is the southern limit for the longnecked turtle *Chelodina rugosa*. Also northern limit for the shortnecked turtle *Emydura krefftii* . This population represents a distinctive morphological form. *E. krefftii* dependent on the availability of permanent water as no member of this genus is capable of aestivation	1
Sporing	**1**	3		
Boolbun North	**4**	3		
Poverty South	**2**	3		1,2
East Normanby North Branch	**1**	3		
Diggers	**1**	3		1
Upper Granite	**1**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Freshwater Turtles

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MAJOR CATCHMENT Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**	?		
McAdam	**5**	?		
Ashwell	**5**	?		
Gap	**2**	?		
Cowie	**5**	1	*Emydura krefftii* and *Elseya* sp. known to occur in streams of this area but unknown whether the forms of either are distinctive. Situation warrants further investigation.	1
Melissa	**5**	1		
Bind	**5**	1		
Tachalbadga	**5**	1		
Emmagen	**5**	1		
Mason	**4**	1		
Myall	**4**	1		
Noah	**5**	1		
Cooper	**5**	1		
Hutchinson	**5**	1		
Alexandra	**5**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Taxa of Specific Conservation Interest - Freshwater Turtles

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MAJOR CATCHMENT | Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**	?		
Whyanbeel	**3**	?		
unnamed south of Whyanbeel	**3**	?		
Carson	**1**	?		
Platypus	**4**	?		
Marr	**2**	?		
South Mossman	**3**	?		
Cassowary	**2**	?		
Crees	**1**	4	Hartley Creek drainage known to contain a distinctive morphological form of *E.* aff. *dentata* allied to the Johnstone River form and is the northern limit for the *E. dentata* species complex. Highly probable that all of the streams in this catchment group contain this distinctive morphological form.	1
Lower Mowbray	**3**	4		
Collard	**4**	4		
unnamed south of Collard	**2**	4		
unnamed south of Lower Mowbray	**3**	4		
Oak	**3**	4		
Robbins	**4**	4		
Spring	**3**	4		
Upper Mowbray	**2**	4		
Turtle	**5**	4		
Hartley	**5**	4		
Tin	**4**	4		
Moore's	**1**	4		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

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MAJOR CATCHMENT | Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Peterson (lakes)	**1**	4	Known to contain two species of turtle; *E.latisternum* and *E.* aff. *dentata*	6
Mobo	**2**	3	As above	6
Robson	**3**	3		
Poona	**2**	?		
Tinaroo	**2**	?		
Emerald	**3**	?		
Rainy	**1**	?		
Carrington	**1**	?		
Upper Barron	**1**	?		
Morans	**4**	?		
Varch	**4**	?		
Oaky	**1**	?		
Big Rooty	**4**	?		
Track	**2**	?		
Pearce	**1**	?		
Davies	**2**	?		
Brindle	**3**	?		
Shoteel	**5**	?		
Reid	**2**	?		
Kauri	**3**	?		
unnamed east of Pearce	**4**	?		
Myola	**2**	?		
Barron Falls	**4**	?		
Surprise	**3**	?		
Stoney	**4**	?		
Thomatis	**1**	?		
Freshwater	**3**	?		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Taxa of Specific Conservation Interest - Freshwater Turtles

RATIONALE | Significant occurrences of rare and threatened species, those of special conservation concern or those for which the Wet Tropics World Heritage Area represents the limits of distribution. Flows required for the maintenance of habitat and the maintenance of food supply.

MAJOR CATCHMENT | Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	3	Highly probable that this system would contain its own morphological variant of *E.* aff. *dentata* given the distinctiveness of it fish fauna and the distributional pattern indicated in Cann (1998). Further investigation warranted	
Kiandra	**3**	3		
Bartle Frere	**5**	3		
Wankaroo	**5**	3		
Tewon	**5**	3		
Josephine	**3**	3		
Woopen	**2**	3		
Norries	**2**	3		
Unnamed east of Norries	**2**	3		
Pughs	**2**	3		
Niringa	**1**			
Babinda	**3**	3		
Harvey	**3**	3		
Meringulah	**3**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Taxa of Specific Conservation Interest - Freshwater Turtles

RATIONALE | Significant occurrences of rare and threatened species, those of special conservation concern or those for which the Wet Tropics World Heritage Area represents the limits of distribution. Flows required for the maintenance of habitat and the maintenance of food supply.

MAJOR CATCHMENT | Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	3	Highly probable that this system would contain its own morphological variant of *E.* aff. *dentata* given the distinctiveness of it fish fauna and the distributional pattern indicated in Cann (1998). Further investigation warranted	
Luscombe	**5**	3		
Upper Mulgrave	**5**	3		
Kearneys Falls	**5**	3		
Butcher	**4**	3		
Toohey	**4**	3		
Stallion	**5**	3		
Uhr	**5**	3		
Huntsbrook	**4**	3		
Fisheries	**3**	3		
Little Mulgrave	**4**	3		
Blackwell	**3**	3		
Pyramid	**2**	3		
Behana	**4**	3		
Malbon Thompson	**4**	3		
Fishery Falls	**3**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Taxa of Specific Conservation Interest - Freshwater Turtles

RATIONALE Significant occurrences of rare and threatened species, those of special conservation concern or those for which the Wet Tropics World Heritage Area represents the limits of distribution. Flows required for the maintenance of habitat and the maintenance of food supply.

MAJOR CATCHMENT Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**	5	***Known locality of the undescribed endemic Johnstone River form of*** **Elseya** ***currently referred to as*** **E. *aff.* dentata**	1,3,5
Topaz	**4**	5		
Topaz south	**5**	5		
Five Mile	**3**	5		
Coolamon	**5**	4	Probable distribution of Johnstone River *Elseya* aff. *dentata*	5
Elinjaa	**2**	4		
Mungalli	**3**	4		
Mystery	**5**	4		
Dirran	**1**	5	Known locality for *Elseya* aff. *dentata*	5
Badgery	**5**	4	Probable distribution of *E.* aff. *dentata*	1
Lower Badgery	**5**	4		
Poorka	**3**	4		
Rankin	**1**	?		
Fisher	**1**	?		
Beatrice	**3**	5	Known locality for *Elseya* aff. *dentata*	5
Waraker	**4**	5		
Unnamed (Henrietta Ck?)	**5**	?		
Tregothanan	**1**	?	unknown	
Mourilyan	**1**	?	unknown	
Clancys Overflow	**3**	4	Probable distribution of *E.* aff. *dentata* in the upstream reaches of the South Johnstone River	1
Karangaree	**5**	4		
Kaarru	**5**	4		
Charappa	**5**	4		
Maple	**5**	5	Known locality for *Elseya* aff. *dentata*	5
Downey	**5**	4	Probable distribution of *E.* aff. *dentata* in the middle and lowland reaches of the South Johnstone River	5
Lower Downey	**5**	4		
McNamee	**5**	4		
Lower McNamee	**5**	4		
Utchee West	**5**	5	Known locality for *Elseya* aff. *dentata*	5
Utchee	**1**	5	Known locality for *Elseya* aff. *dentata*	5
Mitcha	**5**	4	Probable distribution of *E.* aff. *dentata* in the middle and lowland reaches of the South Johnstone River	5
Egan	**5**	4		
River	**4**	5	Probable distribution but importantly this is the only truly lowland reach of the river bordered by the WTWHA	5
Mena	**1**	4	Probable distribution	5

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Taxa of Specific Conservation Interest - Freshwater Turtles

RATIONALE | Significant occurrences of rare and threatened species, those of special conservation concern or those for which the Wet Tropics World Heritage Area represents the limits of distribution. Flows required for the maintenance of habitat and the maintenance of food supply.

MAJOR CATCHMENT | Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**	3	Probable that these drainages also contain the Johnstone River form of *E.* aff. *dentata* given the extent of drainage rearrangement between the upper reaches of these two river systems	
Nigger	**2**	3		
Cedar	**1**	3		
Blunder	**2**	3		
Cameron	**2**	3		
Blencoe	**2**	?		
Smoko	**3**	?		
Waterfall	**1**	?		
Herkies	**3**	?		
Yamanie	**4**	?		
Sword	**5**	?		
Longtail	**4**	?		
Gowrie	**3**	?		
Pinnacles	**5**	?		
Garrawalt	**3**	?		
Stony	**4**	?		
Henrietta	**1**	?		
Broadwater	**1**	?		
Dalrymple	**2**	?		
Stone West branch	**2**	?		
Upper Stone	**1**	?		
Tinkle	**1**	?		
Seymour	**1**	?		
Seaforth	**2**	?		
Seaforth Channel	**5**	?		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Taxa of Specific Conservation Interest - Freshwater Turtles

RATIONALE | Significant occurrences of rare and threatened species, those of special conservation concern or those for which the Wet Tropics World Heritage Area represents the limits of distribution. Flows required for the maintenance of habitat and the maintenance of food supply.

MAJOR CATCHMENT | Burdekin

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Black Burdekin	**3**	4	Burdekin River drainage is the northernmost limit of the distribution of the long-necked turtle *Chelodina longicollis* and within this system it is restricted to the upper reaches and tributaries	1
Michael	**1**	4		
Paluma	**3**	4		
Running	**3**	4		
Puzzle	**1**	4		
Blue Gum	**2**	4		
Blue Gum South	**2**	4		
Arnott	**1**	4		
Little Star	**2**	4		
Keelbottom West	**2**	4		
Keelbottom East	**1**	4		

INFORMATION SOURCES

1. Cann,J. 1998. *Australian Freshwater Turtles*. Beaumont Publications, Singapore. 292 pp.
2. B.J.Pusey unpublished observations undertaken during field research concerning freshwater fishes in the Normanby River 1990.
3. Tom Ryan, DNR. *Personal communcication*
4. B.J.Pusey unpublished observations undertaken during extensive field work throughout the WTWHA in 1993.
5. B.J.Pusey unpublished observations undertaken during extensive field research within the Johnstone river drainage 1993-1998.

RARE AND THREATENED REGIONAL ECOSYSTEMS

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**			
Picaninny	**2**			
West Spencer	**3**			
Spencer	**2**			
East Spencer	**1**			
Reedy	**2**			
Half Ton	**2**			
Mary	**3**	2	contributes to sustenance of variants of RE 7.3.22	
Bushy	**3**	2	as above	
Luster	**2**	2	as above	
Little Sandy	**1**			
Spear	**1**			
Garioch	**3**			
Lagoon	**2**			
Wattle	**4**			
Camp	**5**			
Upper Rifle	**5**			
Rooty	**5**			
Little Mitchell	**1**			
unnamed south of Wattle	**5**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST	Rare and Threatened Regional Ecosystems
RATIONALE	see text Note - may sustain extra-regional systems of importance - info not available to inform the present assessment
MAJOR CATCHMENT	Normanby

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Yard	**1**			
Sporing	**1**			
Boolbun North	**4**			
Poverty South	**2**			
East Normanby North Branch	**1**			
Diggers	**1**			
Upper Granite	**1**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST	Rare and Threatened Regional Ecosystems
RATIONALE	see text
MAJOR CATCHMENT	Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**	2	streams sustain some minor RE 7.3.22	
Parrot	**5**	2	as above	
Adams	**2**			
Banana	**2**	2	as for Romeo, Parrot	
Wallaby	**4**	2	as above	
Mungumby	**2**	2	as above	
Trevethan	**2**	4	sustains important endangered RE 7.3.22 (1c)	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**			
McAdam	**5**			
Ashwell	**5**			
Gap	**2**			
Cowie	**5**			
Melissa	**5**			
Bind	**5**			
Tachalbadga	**5**			
Emmagen	**5**			
Mason	**4**	2	streams sustain floristically significant variants of important regional ecosystems	
Myall	**4**	2	as above	
Noah	**5**	2	as above	
Cooper	**5**	2	as above	
Hutchinson	**5**	2	as above	
Alexandra	**5**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**	2	streams assist in sustaining endangered RE 7.3.22	
Baird	**5**	2	as above	
Roaring Meg	**5**	2	as above	
Watermelon	**5**	2	as above	
Unnamed north of Watermelon	**4**	2	as above	
Ayton	**2**	2	as above	
Woobadda	**4**	2	as above	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**	1	contributes to the sustenance of endangered REs 7.3.4 (3b) & 7.3.7 (19) & of concern RE 7.3.5 (15a) downstream	
Smith	**5**	1	as above	
Dagmar East	**5**	1	as above	
Dagmar West	**5**	1	as above	
Timbi	**5**	1	as above	
Bargoo	**5**	1	as above	
Bargoo North	**5**	1	as above	
Paterson	**5**	1	as above	
Adeline	**4**	1	as above	
Rodoni	**5**	1	as above	
Boolbun	**3**	1	as above	
Adastra	**5**	1	as above	
Moase	**5**	1	as above	
Kobi	**5**	1	as above	
Lewin	**5**	1	as above	
Ronald	**5**	1	as above	
Lucas	**5**	1	as above	
Duncan	**5**	1	as above	
unnamed east of Duncan	**5**	1	as above	
Hilda	**5**	2	as above but more closely associated with those communities	
Gold	**4**	2	as above	
Landers	**4**	2	as above	
Niau	**4**	2	as above	
Little Naiu	**2**	2	as above	
Kiely	**4**	3	contributes directly to the sustenance of endangered REs 7.3.4 (3b) & 7.3.7 (19) & of concern RE 7.3.5 (15a)	
Allanton	**2**	3	as above	
Luttra	**2**	3	as above	
Stewart	**4**	3	as above	
Barratt	**4**	3	as above	
Forest	**2**	4	as above with significant presence of same within subcatchment	
Daintree	**5**	5	as above with major presence of 7.3.7 & 7.3.5 + occurrence of unusual wetlands dominated by *Melaleuc cajaputi*	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**	4	directly sustains endangered RE 7.3.7 (19) & of concern RE 7.3.5 (15a)	
Whyanbeel	**3**	3	sustains endangered RE 7.3.7 & of concern RE 7.3.5	
unnamed south of Whyanbeel	**3**	3	as above	
Coop		3		
Carson	**1**	1	contributes to sustaining RE 7.3.5	
Platypus	**4**	1	as above	
Marr	**2**	1	as above	
South Mossman	**3**	1	as above	
Cassowary	**2**	1	as above	
Crees	**1**	2	directly sustains RE 7.3.5	
Lower Mowbray	**3**	2	as above	
Collard	**4**	2	as above	
unnamed south of Collard	**2**	2	as above	
unnamed south of Lower Mowbray	**3**	2	as above	
Oak	**3**	1	contributes to the sustainance of RE 7.3.5	
Robbins	**4**	1	as above	
Spring	**3**	1	as above	
Upper Mowbray	**2**	1	as above	
Turtle	**5**	1	as above	
Hartley	**5**	2	delivers water into general area supporting endangered RE 7.2.1	
Tin	**4**	3	sustains RE of concern 7.3.23 SDNVF on alluvial levees	
Moore's	**1**	1	sustains remnants of 7.3.5	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**			
Morans	**4**			
Peterson (lakes)	**1**	4	sustains rare & endangered RE7.3.2 (sedgeland/grassland freshwater peat swamps of volcanic craters)	
Mobo	**2**	4	as above	
Robson	**3**	4	as above	
Varch	**4**			
Oaky	**1**			
Big Rooty	**4**			
Emerald	**3**			
Rainy	**1**			
Carrington	**1**			
Upper Barron	**1**			
Track	**2**			
Pearce	**1**			
Davies	**2**	2	sustains variant of endangered RE 7.3.22	
Brindle	**3**	2	as above	
Shoteel	**5**	2	as above	
Reid	**2**			
Kauri	**3**	2	as for Davies, Brindle, Shoteel	
unnamed east of Pearce	**4**			
Myola	**2**			
Barron Falls	**4**			
Surprise	**3**			
Stoney	**4**			
Thomatis	**1**	2	sustains variants of 7.3.22 & remnants of 7.3.4	
Freshwater	**3**	2	as above	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**			
Mick	**4**			
Kweto	**2**			
Skeleton	**1**			
Chinaman	**1**			
Blackfellow	**2**			
Wright	**2**			
Maskey	**1**			
unnamed east of Maskey	**2**			
Buddabadoo	**4**			
Bells Peak	**5**			
Josey	**5**			
Wyvuri	**3**	5	streams sustain endangered REs 7.3.1 & 7.3.6 + RE of concern 7.3.5 (NB - instrumented catchment to determine hydrological balance of Mike Bonnell)	
Worth	**2**	5	streams sustain endangered REs 7.3.1 & 7.3.6 + RE of concern 7.3.5	
unnamed south of Worth	**2**	5	as above	
Ella	**3**	5	as above, of very high significance	
Mutchero Inlet		5	as above, of very high significance	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	1	assists in the maintenance of a range of REs of significance (7.3.3, 7.3.6 & 7.3.5) downstream	
Kiandra	**3**	1	as above	
Bartle Frere	**5**	1	as above	
Wankaroo	**5**	1	as above	
Tewon	**5**	1	as above	
Josephine	**3**	2	as above but more influential	
Woopen	**2**	2	as above	
Norries	**2**	2	as above	
Unnamed east of Norries	**2**	5	contains major tributary streams of Eubenangee Swamp which contains endangered RE 7.3.3 & RE of concern 7.3.5	
Pughs	**2**	5	sustains Babinda Swamp remnants of endangered RE 7.3.3 & RE of concern 7.3.5	
Niringa	**?**	5	as above	
Babinda	**3**	4	sustains Russell River wetlands that contain endangered RE 7.3.3 & RE of concern 7.3.5	
Harvey	**3**	5	major feeder of Russell River wetland containing endangered REs 7.3.3, 7.3.6 & RE of concern 7.3.5 (also **type locality of Tracey type 3a**)	
Meringulah	**3**	3	assists in the sustenance of important wetland systems supporting the above REs	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	1	contribute to the sustenance of significant REs downstream	
Luscombe	**5**	1	as above	
Upper Mulgrave	**5**	1	as above	
Kearneys Falls	**5**	1	as above	
Butcher	**4**	1	as above	
Toohey	**4**	1	as above	
Stallion	**5**	1	as above	
Uhr	**5**	1	as above	
Huntsbrook	**4**	3	contains highly significant isolate of *Araucaria cunninghamii* etc. in close proximity to creek - of evolutionary significance	
Fisheries	**3**	4	sustains endangered RE7.3.22	
Little Mulgrave	**4**	2	contributes to the sustenance of significant REs downstream	
Blackwell	**3**	4	sustains endangered RE7.3.22 & **type locality of Tracey type 1c**	
Pyramid	**2**	4	as above	
Behana	**4**	4	assists in the sustenance of RE7.3.22 & significant lagoonal wetlands including endangered 7.3.6	
Malbon Thompson	**4**	4	as above	
Fishery Falls	**3**	5	as above but more directly so	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST	Rare and Threatened Regional Ecosystems
RATIONALE	see text
MAJOR CATCHMENT	Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**			
Topaz	**4**			
Topaz south	**5**			
Five Mile	**3**			
Coolamon	**5**			
Elinjaa	**2**			
Mugalli	**3**			
Mystery	**5**			
Dirran	**1**			
Badgery	**5**			
Lower Badgery	**5**			
Unnamed (Henrietta Ck?)	**5**			
Poorka	**3**			
Rankin				
Fisher				
Beatrice	**3**			
Waraker	**4**			
Tregothanan	**1**			
Mourilyan	**1**	3	streams sustain RE of concern 7.3.5 (15a)	
Clancys Overflow	**3**			
Karangaree	**5**			
Kaarru	**5**			
Charappa	**5**			
Maple	**5**			
Downey	**5**			
Lower Downey	**5**			
McNamee	**5**			
Lower McNamee	**5**			
Utchee West	**5**			
Utchee	**1**			
Mitcha	**5**			
Egan	**5**			
River	**4**			
Mena	**1**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Liverpool, Moresby, Big Maria & Hull

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Liverpool	**5**			
Scindah	**5**			
South Liverpool	**4**			
Meuribal	**3**			
Jingu	**4**			
Taringbah	**3**			
Bombeta	**2**			
Little Liverpool	**3**			
Silkwood	**2**	5	with streams sustaining endangered RE 7.3.4 (3b) & RE of concern 7.3.5 (15a)	
Brown	**1**			
Moresby	**2**	4	contains streams sustaining RE of concern - type 7.3.5 (15a) in very good condition + others (non-stream related) - eg type 7.2.1 (2b), 7.2.2	
Big Maria	**2**	4	with streams sustaining endangered RE 7.3.6 (18)	
Hull	**3**	5	with streams sustaining endangered REs7.3.6 (18), 7.3.4 (3b) + many fragments of others in a mosaic	
North Hull	**4**	5	as above	
Wongaling	**1**	5	as above + endangered RE 7.3.4 (3b) & a very significant remnant patch of lowland CMVF on basalt - Clump Pt	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**			
Coochimbeerum	**5**			
Cheetah	**5**			
Boundary	**5**			
Theodore	**4**			
Nitchaga	**3**			
Campbell	**5**			
Carpenter	**5**			
Niblet	**5**			
Koombooloomba	**5**			
Sylvania	**5**			
Kooroomool	**5**			
Goddard	**5**			
Costigan	**5**			
Luff	**5**			
O'Leary	**5**			
Culpa	**5**			
Barbed Wire	**3**			
Echo North	**1**			
Echo	**4**			
Table Top	**3**			
Timberoonie	**2**			
Jarra	**4**	3	streamflow sustains remnant of endangered RE 7.3.6 (18) - Djilgarin	
Davidson	**3**			
Banyan	**2**	2	maintains feeder streams to remnant of important REs - 7.3.5 & 7.3.4 (15a, 3b)	
Tyson	**1**			
Silky Oak	**2**	2	as for Banyan	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST	Rare and Threatened Regional Ecosystems
RATIONALE	see text
MAJOR CATCHMENT	Murray

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
North Murray	**4**	3	sustains streams feeding remnants of endangered REs (7.3.6, 7.3.2)	
King Ranch	**1**	3	as above	
Deep	**1**	4	as above + RE of concern 7.3.5 (15a)	
Upper Murray	**4**			

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Dallachy, Meunga & Conn

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Dallachy	**3**	3	streams sustain a mosaic containing remnants of several important REs	
Whitfield	**3**	5	streams sustain one of 2 remaining major occurrences of endangered RE 7.3.6 + RE 7.3.7	
Wreck	**3**	3	streams sustain a mosaic containing remnants of several important REs	
Alma	**3**	3	streams sustain minor occurrences of endangered RE 7.3.6, 7.3.7	
Kennedy	**4**	3	as above	
Hinkler	**4**	3	as above	
Boggy Camp	**2**	3	as above	
Meunga	**3**	5	streams sustain one of 2 remaining major occurrences of endangered RE 7.3.6 + RE 7.3.7	
Scrubby	**2**	3	streams sustain minor occurrences of endangered RE 7.3.6, 7.3.7	
Five Mile	**2**	3	sustain coastal communities with important elements of endangered REs (also significant terrestrial orchids & ant plants)	
Damper	**3**	3	as above	
Porter	**5**	3	as above	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**	2	headwaters of feeder streams sustaining endangered RE 7.3.26 & 7.3.22	
Nigger	**2**	2	as above	
Cedar	**1**	2	as above	
Vine	**?**	2	as above	
unnamed sth of Vine	**?**	2	as above	
Blunder	**2**	2	as above	
Cameron	**2**	2	as above	
Blencoe	**2**	2	as above	
Smoko	**3**	2	as above	
Waterfall	**1**	2	as above	
Herkies	**3**	2	as above	
Yamanie	**4**	2	as above	
Sword	**5**	2	as above	
Longtail	**4**	2	as above	
Gowrie	**3**	2	as above	
Pinnacles	**5**	2	as above	
Garrawalt	**3**	2	as above	
Stony	**4**	2	as above	
Henrietta	**1**	2	feeder streams sustain endangered RE 7.3.24 & of concern REs 7.3.5 & 7.3.27	
Broadwater	**1**	3	as above but more important as water source	
Dalrymple	**2**	3	as above	
Stone West branch	**2**	3	major feeder streams sustaining endangered RE 7.3.26	
Upper Stone	**1**	3	as above	
Tinkle	**1**	1	streams sustain a coastal mosaic containing minor elements of REs of importance	
Seymour	**1**	1	as above	
Seaforth	**2**	1	as above	
Seaforth Channel	**5**	1	as above	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST Rare and Threatened Regional Ecosystems

RATIONALE see text

MAJOR CATCHMENT Trebonne Halifax

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Frances	**1**	2	streams sustain a coastal mosaic containing minor elements of REs of importance	
Waterview	**2**	2	as above	
Crystal	**3**	4	as above + streams sustain endangered REs 7.3.26 & 7.3.28	
Ollera	**2**	2	streams sustain a coastal mosaic containing minor elements of REs of importance	
Hencamp	**2**	2		
Rollingstone	**3**	1		
Saltwater	**2**	1		
Leichhardt	**2**	1		
Sleeper Log	**2**	1		
Bluewater	**2**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST	Rare and Threatened Regional Ecosystems
RATIONALE	see text - BUT NOTE these streams probably are importance for sustaining regional ecosystems for the Dry Tropics Region - these not available to inform the present exercise save for those applying to Lumholtz NP - may be of higher value.
MAJOR CATCHMENT	Burdekin

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Black Burdekin	**3**			
Michael	**1**			
Paluma	**3**			
Running	**3**			
Puzzle	**1**			
Blue Gum	**2**			
Blue Gum South	**2**			
Arnott	**1**			
Little Star	**2**			
Keelbottom West	**2**			
Keelbottom East	**1**			

INFORMATION SOURCES

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DISTINCTIVE FLOW REGIME TYPES AND FLOW NEEDS

WORKSHEETS

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Mitchell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Boggy	**1**	1		
Picaninny	**2**	1		
West Spencer	**3**	3	Perennial flow regimes more typical of systems east of the Great Dividing Range and essential for the continued survival of R&T frogs. Flow management must consider this important distinction.	
Spencer	**2**	3		
East Spencer	**1**	3		
Reedy	**2**	3		
Half Ton	**2**	3		
Mary	**3**	3		
Bushy	**3**	3		
Luster	**2**	3		
Little Sandy	**1**	3		
Spear	**1**	3		
Garioch	**3**	3		
Lagoon	**2**	3		
Wattle	**4**	3		
Camp	**5**	3		
Upper Rifle	**5**	3		
Rooty	**5**	3		
Little Mitchell	**1**	3		
unnamed south of Wattle	**5**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Normanby

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Yard	**1**	2	Perennial flow in upstream sections of utmost importance to habitat integrity and therefore to fauna given that downstream reaches within this drainage are characterised by greater seasonality in flow and often prolonged periods of zero flow.	
Sporing	**1**	2		
Boolbun North	**4**	2		
Poverty South	**2**	2		
East Normanby North Branch	**1**	3		
Diggers	**1**	1		
Upper Granite	**1**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Annan

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Romeo	**5**	2	Perennial flow but with a stronger seasonal monsoonal signal than is found in other WTWHA streams to the south. Maintenance of this temporal distinction must be given high priority as is the maintenance of perennial nature.	
Parrot	**5**	2		
Adams	**2**	2		
Banana	**2**	2		
Wallaby	**4**	2		
Mungumby	**2**	2		
Trevethan	**2**	2		
Sampson	**2**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Amos - Cape Tribulation

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Forsberg	**1**	2	Maintenance of high constancy essential for maintenance of high diversity of fishes.	
McAdam	**5**	2		
Ashwell	**5**	2		
Gap	**2**	2		
Cowie	**5**	2	Maintenance of high constancy essential for maintenance of high diversity of fishes and for maintenance of populations of fishes rarely observed on the Australian continent.	
Melissa	**5**	2		
Bind	**5**	2		
Tachalbadga	**5**	2		
Emmagen	**5**	2		
Mason	**4**	2		
Myall	**4**	2		
Noah	**5**	2		
Cooper	**5**	2		
Hutchinson	**5**	2		
Alexandra	**5**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Bloomfield

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Keating	**5**	1	Although maintenance of flows necessary for the maintenance of habitat suitable for rare and endemic fish fauna, these subcatchments are afforded high value for other attributes	
Baird	**5**	1		
Roaring Meg	**5**	1		
Watermelon	**5**	1		
Unnamed north of Watermelon	**4**	1		
Ayton	**2**	3	Maintenance of constancy and overall flow regime required to maintain habitat integrity particularly the provision of high flows and riffle habitats suitable for rare goby species.	
Woobadda	**4**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Daintree

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Upper Daintree	**5**	2	Maintenance of habitat integrity reliant on the provision of adequate flows during the dry season. Although more seasonal than many other WTWHA systems to the immediate south, most streams of the region do not dry out completely or only do so rarely.	Abstraction must **not** increase the frequency of spells of low or zero flow above levels indicated by the historical record.
Smith	**5**	2		
Dagmar East	**5**	2		
Dagmar West	**5**	2		
Timbi	**5**	2		
Bargoo	**5**	2		
Bargoo North	**5**	2		
Paterson	**5**	2		
Adeline	**4**	2		
Rodoni	**5**	2		
Boolbun	**3**	2		
Adastra	**5**	2		
Moase	**5**	2		
Kobi	**5**	2		
Lewin	**5**	2		
Ronald	**5**	2		
Lucas	**5**	2		
Duncan	**5**	2		
unnamed est of Duncan	**5**	2		
Hilda	**5**	2		
Gold	**4**	2		
Landers	**4**	2		
Niau	**4**	2		
Little Naiu	**2**	2		
Kiely	**4**	2		
Allanton	**2**	2		
Luttra	**2**	2		
Stewart	**4**	2		
Barratt	**4**	2		
Forest	**2**	2		
Wonga	**3**	2		
Daintree	**5**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Newell, Mossman & Cook

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wonga	**3**	2	Maintenance of habitat integrity during the dry season must be given high priority. Management of low flows must be given careful consideration.	
Whyanbeel	**3**	2		
unnamed south of Whyanbeel	**3**	2		
Carson	**1**	2	Maintenance of habitat integrity during the dry season must be given high priority. Management of low flows must be given careful consideration.	
Platypus	**4**	2		
Marr	**2**	2		
South Mossman	**3**	2		
Cassowary	**2**	2		
Crees	**1**	2	Maintenance of habitat integrity during the dry season must be given high priority. Management of low flows must be given careful consideration.	
Lower Mowbray	**3**	2		
Collard	**4**	2		
unnamed south of Collard	**2**	2		
unnamed south of Lower Mowbray	**3**	2		
Oak	**3**	2		
Robbins	**4**	2		
Spring	**3**	2		
Upper Mowbray	**2**	2		
Turtle	**5**	3	Tending towards greater ephemerality than is indicated for other short coastal streams to the north as indicated by vegetation type and frog distribution (see sheet dealing with frogs). Regulation must not result in periods of zero flow for periods longer than are indicated by historical record.	
Hartley	**5**	3		
Tin	**4**	3		
Moore's	**1**	3		
Finn		2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Barron

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Poona	**2**	1	Highly regulated system with considerable alteration to natural flow regime due to transfer of water from Lake Tinaroo into streams for use by downstream users. Although the flow regimes of many of the streams of the region are unlikely to be distinctive and therefore can only be accorded a value of 1, significant consideration must be given to the maintenance of the natural flow regime in order to maintain habitat integrity. Specifically, there should be no trend towards greater seasonality than is apparent in the historical record whilst maintenance of the historical differences between wet and dry season flows must be given high priority. The use of natural stream channels for the delivery of water to downstream users during periods of peak demand (ie. the dry season) is to be discouraged. High flows during historically low flow periods must not occur.	
Morans	**4**	1		
Peterson (lakes)	**1**	1		
Mobo	**2**	1		
Robson	**3**	1		
Varch	**4**	1		
Tinaroo	**1**	1		
Emerald	**2**	1		
Oaky	**1**	1		
Big Rooty	**4**	1		
Rainy	**1**	1		
Carrington	**1**	1		
Upper Barron	**1**	1		
Track	**2**	1		
Pearce	**1**	1		
Davies	**2**	1		
Brindle	**3**	1		
Shoteel	**5**	1		
Reid	**2**	1		
Kauri	**3**	1		
unnamed east of Pearce	**4**	1		
Myola	**2**	1		
Barron Falls	**4**	1		
Surprise	**3**	1		
Stoney	**4**	1		
Thomatis	**1**	1		
Freshwater	**3**	2	Maintenance of high wet season flows and constant dry season flows must be given priority to sustain habitat integrity and to discourage noxious pest species.	

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Trinity, Yarrabah & Bramston

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
False	**1**	1	Unlikely to be highly distinctive but careful consideration to maintenance of the flow regime sufficient to result in maintenance of habitat integrity - should be no trend towards greater ephemerality than is already present.	
Mick	**4**	1		
Kweto	**2**	1		
Skeleton	**1**	1		
Chinaman	**1**	1		
Blackfellow	**2**	1		
Wright	**2**	2	Essential to maintain habitat integrity for R&T frog species and rare fish species (*Glossogobius* sp. B.). Stream flow must be maintained to ensure that extensive habitat desiccation does not occur.	
Maskey	**1**	2		
unnamed east of Maskey	**2**	2		
Buddabadoo	**4**	1		
Bells Peak	**5**	1		
Josey	**5**	1		
Wyvuri	**3**	1		
Worth	**2**	1		
unnamed south of Worth	**2**	1		
Ella	**2**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Russell

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Coopooroo	**3**	4	As for the Mulgrave River subcatchments accorded a value of 4.	
Kiandra	**3**	4		
Bartle Frere	**5**	4		
Wankaroo	**5**	4		
Tewon	**5**	4		
Josephine	**3**	4		
Woopen	**2**	4		
Norries	**2**	4		
Unnamed east of Norries	**2**	4		
Pughs	**2**	4		
Niringa	**1**	4		
Babinda	**3**	4		
Harvey	**3**	4		
Meringulah	**3**	4		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Mulgrave

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Mulgrave	**5**	4	Constancy and magnitude of dry season flows needs to be maintained. Stream flow within this catchment is the most predictable and constant of flow regimes in Queensland, if not Australia. Regulation of any sort should not alter this pattern towards greater difference between wet and dry season flows	
Luscombe	**5**	4		
Upper Mulgrave	**5**	4		
Kearneys Falls	**5**	4		
Butcher	**4**	4		
Toohey	**4**	4		
Stallion	**5**	4		
Uhr	**5**	4		
Huntsbrook	**4**	4		
Fisheries	**3**	4		
Little Mulgrave	**4**	4		
Blackwell	**3**	4	Streams of these two subcatchments are the most ephemeral of any in the basin and therefore any regulation should not reduce the distinction between wet and dry season flow. Maintenance of the flow regimes of these subcatchments is necessary to maintain the diversity of flow regimes within the basin.	
Pyramid	**2**	4		
Behana	**4**	4	As for the West Mulgrave to Little Mulgrave subcatchments.	
Malbon Thompson	**4**	4		
Fishery Falls	**3**	4		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Johnstone

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Glen Allyn	**1**	4	Constancy of dry season flows necessary for distinctive fish fauna and turtle species and for the maintenance of downstream habitat integrity	1
Topaz	**4**	4		
Topaz south	**5**	4		
Five Mile	**3**	4		
Dirran	**1**	4		
Coolamon	**5**	4		
Elinjaa	**2**	1		
Mugalli	**3**	1		
Mystery	**5**	1		
Badgery	**5**	1		
Lower Badgery	**5**	1		
Rankin	**1**	1		
Fisher	**1**	4	Very limited catchment area within WTWHA, protection needed to ensure maintenance of downstream habitat integrity	
Poorka	**3**	1		
Beatrice	**3**	4	As for other Tablelands subcatchment	
Waraker	**4**	3	Maintenance of habitat integrity	
Tregothanan	**1**	3		
Mourilyan	**1**	3		
Clancys Overflow	**3**	4	Maintenance of habitat integrity within subcatchments and for downstream reaches of the river	
Karangaree	**5**	4		
Kaarru	**5**	4		
Charappa	**5**	4		
Maple	**5**	4		
Downey	**5**	4		
Theresa		4		
Lower Downey	**5**	1		

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
McNamee	**5**	1		
Lower McNamee	**5**	1		
Meingan	**5**	1		
Utchee West	**5**	2		
Utchee	**1**	4	Maintenance of habitat integrity and relatively high flows necessary for maintenance of “Utchee Creek” rainbowfish	
Mitcha	**5**	2		
Egan	**5**	1		
River	**4**	1		
Mena	**1**	2		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

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MAJOR CATCHMENT | Liverpool, Moresby, Big Maria & Hull

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
West Liverpool	**5**	3	Maintenance of habitat integrity in subcatchments and in downstream reaches	
Scindah	**5**	3		
South Liverpool	**4**	3		
Meuribal	**3**	3		
Jingu	**4**	3		
Taringbah	**3**	3		
Kittabah	**3**	3		
South Liverpool	**5**	3		
Bombeta	**2**	3		
Little Liverpool	**3**	3		
Silkwood	**2**	3		
Brown	**1**	1		
Moresby	**2**	4	Maintenance of habitat integrity and proper estuarine processes	
Big Maria	**2**	1		
Hull	**3**	4	Maintenance of habitat integrity	
North Hull	**4**	4		
Wongaling	**1**	4		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

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MAJOR CATCHMENT | Tully

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Cochable	**5**	2	Maintenance of habitat integrity. Great care needs to be taken in this catchment to ensure that water is not transferred from one subcatchment to another.	
Coochimbeerum	**5**	2		
Cheetah	**5**	2		
Boundary	**5**	2		
Theodore	**4**	2		
Nitchaga	**3**	2		
Campbell	**5**	2		
Carpenter	**5**	2		
Niblet	**5**	2		
Koombooloomba	**5**	2		
Sylvania	**5**	2		
Kooroomool	**5**	2		
Goddard	**5**	2		
Costigan	**5**	2		
Luff	**5**	2		
O'Leary	**5**	2		
Culpa	**5**	2		
Barbed Wire	**3**	2		
Echo North	**1**	2		
Echo	**4**	2		
Table Top	**3**	2		
Timberoonie	**2**	2		
Jarra	**4**	4	Maintenance of habitat integrity essential in such a high quality stream	
Davidson	**3**	4	Integrity of upstream and downstream habitat essential especially given the parcity of lowland tributary streams of high quality.	
Banyan	**2**	4		
Tyson	**1**	4		
Silky Oak	**2**	4		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

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MAJOR CATCHMENT | Murray

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
North Murray	**4**	3	Flow regime in this river tending towards less constancy than is apparent in other rivers of the WTWHA. Seasonal difference in flows need to be maintained by dry season flows should not be allowed to fall below that indicated in the historical record.	
King Ranch	**1**	3		
Deep	**1**	3		
Upper Murray	**5**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

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MAJOR CATCHMENT | Dallacy, Meunga & Conn

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Dallachy	**3**	?	Data unavailable, difficult to ascertain what natural pattern of flow might be or if any distinctive flow requirements.	
Whitfield	**3**	?		
Wreck	**3**	?		
Alma	**3**	?		
Kennedy	**4**	?		
Hinkler	**4**	?		
Boggy Camp	**2**	?		
Meunga	**3**	?		
Scrubby	**2**	?		
Five Mile	**2**	?		
Damper	**3**	?		
Porter	**5**	?		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

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MAJOR CATCHMENT | Herbert

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Wild	**2**	1	Although given low value rating, alterations to flow regime must ensure that maintenance of habitat integrity is accorded high priority. Upstream reaches within this drainage contribute a very great proportion of the flow in downstream reaches and therefore the maintenance of habitat integrity in these downstream is reliant on upstream areas. Although distinctive in having a flow regime that is the least predictable and least constant of the drainages of the southern part of the WTWHA, alterations to flow regime should not exceed what is indicated by the historical flow record	
Nigger	**2**	1		
Cedar	**1**	1		
Vine	**2**	1		
Blunder	**2**	1		
Unnamed south of Vine	**2**	1		
Cameron	**2**	1		
Blencoe	**2**	1		
Smoko	**3**	1		
Waterfall	**1**	1		
Herkies	**3**	1		
Yamanie	**4**	1		
Sword	**5**	1		
Longtail	**4**	1		
Gowrie	**3**	1		
Pinnacles	**5**	1		
Garrawalt	**3**	1		
Stony	**4**	1		
Henrietta	**1**	1		
Broadwater	**1**	1		
Dalrymple	**2**	1		
Stone West branch	**2**	1		
Upper Stone	**1**	1		
Tinkle	**1**	1		
Seymour	**1**	1		
Seaforth	**2**	1		
Seaforth Channel	**5**	1		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Trebonne Halifax

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Frances	**1**	?		
Waterview	**2**	?		
Crystal	**3**	3	Maintenance of habitat integrity essential for the maintenance of fish populations and flow regime should not be altered towards greater ephemerality than is already indicated. Downstream environmental needs must be considered.	
Ollera	**2**	3		
Hencamp	**2**	3		
Rollingstone	**3**	3		
Saltwater	**2**	3		
Leichhardt	**2**	3		
Sleeper Log	**2**	3		
Bluewater	**2**	3		

WET TROPICS SUBCATCHMENT RANKING PROFORMA

ATTRIBUTE OF INTEREST | Distinctive Flow Regime Types and Flow Needs

RATIONALE

The maintenance of the flow regime typical of the catchment must occur in order to ensure that the diversity of flow regime types within the WTWHA is maintained as are flow related processes important in regulating natural communities. The downstream flow needs of river reaches not within the WTWHA need to be considered also.

MAJOR CATCHMENT | Burdekin

SUBCATCHMENT	WTWHA extent	SCORE	JUSTIFICATION & COMMENTS	DATA SOURCE
Black Burdekin	**3**	3	Natural flow regime must be maintained. High summer flows needed for the provision of downstream spawning habitat for a range of species of fish.	
Michael	**1**	3		
Paluma	**3**	3		
Running	**3**	3		
Puzzle	**1**	3		
Blue Gum	**2**	3		
Blue Gum South	**2**	3		
Arnott	**1**	3		
Little Star	**2**	3		
Keelbottom West	**2**	3		
Keelbottom East	**1**	3		

INFORMATION SOURCE

Information concerning distinctive flow regimes presented in individual sheets for each river basin is derived from Appendix 1 in *Conservation Values of Waterways in the Wet Tropics World Heritage Area.* Information concerning distinctive flow needs is drawn from the individual sheets for each river and attribute of interest.

APPENDIX 3

ATTRIBUTES OF INTEREST
SCORES AND VALUE

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Mitchell	Boggy	2			1		1	1	1	1	1	**1.14**	**2**	1.50	Moderate
Mitchell	Picaninny	2			3		2	5	1	1	1	**2.14**	**5**	5	Very High
Mitchell	West Spencer	2			3		2	5	1	1	3	**2.43**	**5**	5	Very High
Mitchell	Spencer	2			3		2	5	1	1	3	**2.43**	**5**	5	Very High
Mitchell	East Spencer	2			3		2	1	1	1	3	**1.86**	**3**	1.88	Moderate
Mitchell	Reedy	2			3	4	2	4	1	1	3	**2.50**	**4**	2.44	High
Mitchell	Half Ton	2	2		4	4	2	4	1	1	3	**2.56**	**4**	2.50	High
Mitchell	Mary	2	3		3	5	2	5	2	2	3	**3**	**5**	5	Very High
Mitchell	Bushy	3	3		3	5	2	5	2	2	3	**3.11**	**5**	5	Very High
Mitchell	Luster	2			3		2		2	2	3	**2.33**	**3**	2.14	High
Mitchell	Little Sandy	2			3		2		1	1	3	**2**	**3**	2	Moderate
Mitchell	Spear	2			3		2		1	1	3	**2**	**3**	2	Moderate
Mitchell	Garioch	2			3		2		1	1	3	**2**	**3**	2	Moderate
Mitchell	Lagoon	2			3		2		1	1	3	**2**	**3**	2	Moderate
Mitchell	Wattle	2			3		2		1	1	3	**2**	**3**	2	Moderate
Mitchell	Camp	2			3		2		1	1	3	**2**	**3**	2	Moderate
Mitchell	Upper Rifle	2			3		2	2	4	1	3	**2.43**	**4**	2.38	High
Mitchell	Rooty	2			3		2		1	1	3	**2**	**3**	2	Moderate
Mitchell	Little Mitchell	2			3		2	1	1	1	3	**1.86**	**3**	1.88	Moderate
Mitchell	unnamed sth of Wattle	2			3		2	2	1	1	3	**2**	**3**	2	Moderate
Mitchell		**2.05**	**2.67**	**---**	**2.95**	**4.50**	**1.95**	**3.33**	**1.30**	**1.15**	**2.80**	**2.19**			
Normanby	Yard	2			2		1	2	3		2	**2**	**3**	2	Moderate
Normanby	Sporing	2			1		1	2	3		2	**1.83**	**3**	1.86	Moderate
Normanby	Boolbun North	2			3		1	2	3		2	**2.17**	**3**	2.14	High
Normanby	Poverty South	2			3		1	2	3		2	**2.17**	**3**	2.14	High
Normanby	East Normanby North Branch	2			3		1	3	3		3	**2.50**	**3**	2.43	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Normanby	Diggers	2			2		1	2	3		1	**1.83**	**3**	1.86	Moderate
Normanby	Upper Granite	2			2		1	2	3		1	**1.83**	**3**	1.86	Moderate
Normanby		**2**	**---**	**---**	**2.29**	**---**	**1**	**2.14**	**3**	**---**	**1.86**	**2.05**			
Annan	Romeo	2			4		1	4		2	2	**2.50**	**4**	2.43	High
Annan	Parrot	2	2		4	5	1	4		2	2	**2.75**	**5**	5	Very High
Annan	Adams	2			3		1	2		2		**2**	**3**	2	Moderate
Annan	Sampson	2			3		1	2		2	2	**2**	**3**		Moderate
Annan	Banana	2			2		1	1		2	2	**1.67**	**2**	1.71	Moderate
Annan	Wallaby	2			4		4	5		2	2	**3.17**	**5**	5	Very High
Annan	Mungumby	2			3			5		2	2	**2.80**	**5**	5	Very High
Annan	Trevethan	2			3					4	2	**2.75**	**4**	2.60	High
Annan		**2**	**2**	**---**	**3.25**	**5**	**1.50**	**3.29**	**---**	**2.25**	**2**	**2.45**			
Amos - Cape Tribulation	Forsberg	2			3		2			1	2	**2**	**3**	2	Moderate
Amos - Cape Tribulation	McAdam	1			3		3	2		1	2	**2**	**3**	1.86	Moderate
Amos - Cape Tribulation	Ashwell	1	2		3		3	4		1	2	**2.29**	**4**	2.13	High
Amos - Cape Tribulation	Gap	3	5		3		4	4		1	2	**3.14**	**5**	5	Very High
Amos - Cape Tribulation	Cowie	2			3		4	1	1	1	2	**2**	**4**	2	Moderate
Amos - Cape Tribulation	Melissa	2			3		4	1	1	1	2	**2**	**4**	2	Moderate
Amos - Cape Tribulation	Bind	2			3		4	1	1	1	2	**2**	**4**	2	Moderate
Amos - Cape Tribulation	Tachalbadga	2			3		4	3	1	1	2	**2.29**	**4**	2.25	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Amos - Cape Tribulation	Emmagen	2			3		4	3	1	1	2	**2.29**	**4**	2.25	High
Amos - Cape Tribulation	Mason	3	5		3		4	1	1	2	2	**2.63**	**5**	5	Very High
Amos - Cape Tribulation	Myall	3	5		3		4	3	1	2	2	**2.88**	**5**	5	Very High
Amos - Cape Tribulation	Noah	1	5		3	4	4	5	1	2	2	**3**	**5**	5	Very High
Amos - Cape Tribulation	Cooper	1	5		3	4	4	5	1	2	2	**3**	**5**	5	Very High
Amos - Cape Tribulation	Hutchinson	1	3		3		4	5	1	2	2	**2.63**	**5**	5	Very High
Amos - Cape Tribulation	Alexandra	3	2		3		4	3	1	2		**2.57**	**4**	2.56	High
Amos - Cape Tribulation		**1.93**	**4**	**---**	**3**	**4**	**3.73**	**2.93**	**1**	**1.40**	**2**	**2.45**			
Bloomfield	Keating	1	1		3		5			2	1	**2.17**	**5**	5	Very High
Bloomfield	Baird	1	2		3		5	5		2	1	**2.71**	**5**	5	Very High
Bloomfield	Roaring Meg	1	5		4	4	5	5		2	1	**3.38**	**5**	5	Very High
Bloomfield	Watermelon	1	1		3		3			2	1	**1.83**	**3**	1.71	Moderate
Bloomfield	unnamed nth of Watermelon	2	2		3		4			2	1	**2.33**	**4**	2.29	High
Bloomfield	Ayton	2	1		3		4	1		2	3	**2.29**	**4**	2.25	High
Bloomfield	Woobadda	2	2		3		4	5		2	3	**3**	**5**	5	Very High
Bloomfield		**1.43**	**2**	**---**	**3.14**	**4**	**4.29**	**4**	**---**	**2**	**1.57**	**2.53**			
Daintree	Upper Daintree	1			3	4	2	4		1	2	**2.43**	**4**	2.25	High
Daintree	Smith	1			3		2			1	2	**1.80**	**3**	1.67	Moderate
Daintree	Dagmar East	1			3		2			1	2	**1.80**	**3**	1.67	Moderate

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Daintree	Dagmar West	1			3		2			1	2	**1.80**	**3**	1.67	Moderate
Daintree	Timbi	1			3		2			1	2	**1.80**	**3**	1.67	Moderate
Daintree	Bargoo	1			3		2	4		1	2	**2.17**	**4**	2	Moderate
Daintree	Bargoo North	1			3		2	4		1	2	**2.17**	**4**	2	Moderate
Daintree	Paterson	1			3		2			1	2	**1.80**	**3**	1.67	Moderate
Daintree	Adeline	1	2		4		2	4		1	2	**2.29**	**4**	2.13	High
Daintree	Rodoni	1			3		3	1		1	2	**1.83**	**3**	1.71	Moderate
Daintree	Boolbun	3			3		3	3		1	2	**2.50**	**3**	2.57	High
Daintree	Adastra	1			3		3			1	2	**2**	**3**	1.83	Moderate
Daintree	Moase	1			3		3			1	2	**2**	**3**	1.83	Moderate
Daintree	Kobi	1			3		3			1	2	**2**	**3**	1.83	Moderate
Daintree	Lewin	1			3		3			1	2	**2**	**3**	1.83	Moderate
Daintree	Ronald	1			3		3			1	2	**2**	**3**	1.83	Moderate
Daintree	Lucas	1			3		3			1	2	**2**	**3**	1.83	Moderate
Daintree	Duncan	1			3		3			1	2	**2**	**3**	1.83	Moderate
Daintree	unnamed east of Duncan	1	1		3	4	3	3		1	2	**2.25**	**4**	2.11	High
Daintree	Hilda	1	3		3	5	3	5		2	2	**3**	**5**	5	Very High
Daintree	Gold	1			3		2			2	2	**2**	**3**	1.83	Moderate
Daintree	Landers	1			3		2			2	2	**2**	**3**	1.83	Moderate
Daintree	Niau	2			3		2			2	2	**2.20**	**3**	2.17	High
Daintree	Little Niau	2			3		2			2	2	**2.20**	**3**	2.17	High
Daintree	Martin	2			3		2			2	2	**2.20**	**3**		High
Daintree	Kiely	2	1		3		2			3	2	**2.17**	**3**	2.14	High
Daintree	Allanton	2			3		3	1		3	2	**2.33**	**3**	2.29	High
Daintree	Luttra	2			3		4	1		3	2	**2.50**	**4**	2.43	High
Daintree	Stewart	3			3	4	4	4		3	2	**3.29**	**4**	3.25	High
Daintree	Barratt	1			3		4	2		3	2	**2.50**	**4**	2.29	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Daintree	Forest	2			3		2	1		4	2	**2.33**	**4**	2.29	High
Daintree	Daintree	4			3		4	1		5	2	**3.17**	**5**	5	Very High
Daintree		**1.44**	**1.75**	**---**	**3.03**	**4.25**	**2.63**	**2.71**	**---**	**1.72**	**2**	**2.20**		2.09	
Newell, Mossman & Cook	Wonga	2			3					4	2	**2.75**	**4**		High
Newell, Mossman & Cook	Whyanbeel	2	2		3		2	3		3	2	**2.43**	**3**	2.50	High
Newell, Mossman & Cook	unnamed sth of Whyanbeel	2	1		3		2	3		3	2	**2.29**	**3**	2.38	High
Newell, Mossman & Cook	Coop	1			3		4	2		3	2	**2.50**	**4**		High
Newell, Mossman & Cook	Carson	2			2		1	1		1	2	**1.50**	**2**	2.25	Moderate
Newell, Mossman & Cook	Platypus	3	5		4	5	5	5		1	2	**3.75**	**5**	5	Very High
Newell, Mossman & Cook	Marr	2			3		1	1		1	2	**1.67**	**3**	3.67	Moderate
Newell, Mossman & Cook	South Mossman	2	4		3	4	4	5		1	2	**3.13**	**5**	5	Very High
Newell, Mossman & Cook	Cassowary	2			3		4	1		1	2	**2.17**	**4**	3	High
Newell, Mossman & Cook	Crees	3			2			1	4	2	2	**2.33**	**4**	2.14	High
Newell, Mossman & Cook	Lower Mowbray	3		3	3			1	4	2	2	**2.57**	**4**	2.38	High
Newell, Mossman & Cook	Collard	3		3	3			1	4	2	2	**2.57**	**4**	2.50	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Newell, Mossman & Cook	unnamed sth of Collard	3		3	4			1	4	2	2	**2.71**	**4**	2.50	High
Newell, Mossman & Cook	unnamed sth of lower Mowbray	3			4			1	4	2	2	**2.67**	**4**	2.63	High
Newell, Mossman & Cook	Oak	3			3			1	4	1	2	**2.33**	**4**	2.63	High
Newell, Mossman & Cook	Robbins	3			4			1	4	1	2	**2.50**	**4**	2.43	High
Newell, Mossman & Cook	Spring	2			3			4	4	1	2	**2.67**	**4**	2.57	High
Newell, Mossman & Cook	Upper Mowbray	2			3			3	4	1	2	**2.50**	**4**	2.57	High
Newell, Mossman & Cook	Turtle	2			3			1	4	1	3	**2.33**	**4**	2.43	High
Newell, Mossman & Cook	Hartley	2			3			1	4	2	3	**2.50**	**4**	2.14	High
Newell, Mossman & Cook	Tin	2			3			1	4	3	3	**2.67**	**4**	2.29	High
Newell, Mossman & Cook	Finn	2			1			1	4	1	2	**1.83**	**4**	2.43	Moderate
Newell, Mossman & Cook	Moore's	3			1			1	4	1	3	**2.17**	**4**	1.86	High
Newell, Mossman & Cook		**2.35**	**3**	**3**	**2.91**	**4.50**	**2.88**	**1.82**	**4**	**1.74**	**2.17**	**2.46**			
Barron	Poona	4			3		4	5		1	1	**3**	**5**	5	Very High
Barron	Morans	4			3		1	4		1	1	**2.33**	**4**	2.57	High
Barron	Peterson	1			3	4	4	4	4	4	1	**3.13**	**4**	2.89	High
Barron	Mobo	2	1		3	4	4	2	3	4	1	**2.67**	**4**	2.60	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Barron	Robson	2	2		3	5	5	5	3	4	1	**3.33**	**5**	5	Very High
Barron	Varch	1	2		3	5	5	5		1	1	**2.88**	**5**	5	Very High
Barron	Tinaroo	1	1		3	4	1	5		1	1	**2.13**	**5**	5	Very High
Barron	Kambul	1			3		1			1	1	**1.40**	**3**	1.33	Moderate
Barron	Emerald	1	1		3	4	1	5		1	1	**2.13**	**5**	5	Very High
Barron	Rainy	1			3		1			1	1	**1.40**	**3**	1.50	Moderate
Barron	Carrington	1			1		1			1	1	**1**	**1**	1	Moderate
Barron	Upper Barron	1			1		1			1	1	**1**	**1**	1	Moderate
Barron	Oaky	1			3		1			1	1	**1.40**	**3**	1.33	Moderate
Barron	Big Rooty	1			3		1			1	1	**1.40**	**3**	1.33	Moderate
Barron	Track	1			3		1			1	1	**1.40**	**3**	1.33	Moderate
Barron	Pearce	1			2		1			1	1	**1.20**	**2**	1.17	Moderate
Barron	Davies	1			3	5	1	5		2	1	**2.57**	**5**	5	Very High
Barron	Brindle	1			3		1	5		2	1	**2.17**	**5**	5	Very High
Barron	Shoteel	1			3		1	2		2	1	**1.67**	**3**	1.57	Moderate
Barron	Reid	1			3		1	2		1	1	**1.50**	**3**	1.43	Moderate
Barron	Kauri	2			3		1	2		2	1	**1.83**	**3**	1.86	Moderate
Barron	unnamed east of Pearce	2			3		1	4		1	1	**2**	**4**	2	Moderate
Barron	Myola	3			3		1	3		1	1	**2**	**3**	2.14	Moderate
Barron	Barron Falls	2			4		1	4		1	1	**2.17**	**4**	2.14	High
Barron	Surprise	2			4		2	4		1	1	**2.33**	**4**	2.29	High
Barron	Jumrum	2			4		1	4		1	1	**2.17**	**4**		High
Barron	Stoney	2			4		1	4		1	1	**2.17**	**4**	2.14	High
Barron	Thomatis	2			3		1	1		2	1	**1.67**	**3**	1.71	Moderate
Barron	Freshwater	3			4	4	2	5		2	2	**3.14**	**5**	5	Very High
Barron		**1.66**	**1.40**	**---**	**3**	**4.38**	**1.66**	**3.81**	**3.33**	**1.52**	**1.03**	**2.04**			

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Trinity, Yarrabah, Bramston	False	1			1			1		1	1	**1**	**1**	1	Moderate
Trinity, Yarrabah, Bramston	Mick	1			3			1		1	1	**1.40**	**3**	1.33	Moderate
Trinity, Yarrabah, Bramston	Kweto	1			3			1		1	1	**1.40**	**3**	1.33	Moderate
Trinity, Yarrabah, Bramston	Skeleton	2		3	1		1	1		1	1	**1.43**	**3**	1.43	Moderate
Trinity, Yarrabah, Bramston	Chinaman	2		3	1		1	1		1	1	**1.43**	**3**	1.43	Moderate
Trinity, Yarrabah, Bramston	Blackfellow	2		3	2		2	1		1	1	**1.71**	**3**	1.71	Moderate
Trinity, Yarrabah, Bramston	Wright	2		3	3		4	2		1	2	**2.43**	**4**	2.43	High
Trinity, Yarrabah, Bramston	Maskey	2			2		1	1		1	2	**1.50**	**2**	1.57	Moderate
Trinity, Yarrabah, Bramston	unnamed east of Maskey	2	1		2		4	2		1	2	**2**	**4**	2	Moderate
Trinity, Yarrabah, Bramston	Buddabadoo	2			3		3	2		1	1	**2**	**3**	2	Moderate
Trinity, Yarrabah, Bramston	Bells Peak	3			3		3	4		1	1	**2.50**	**4**	2.57	High
Trinity, Yarrabah, Bramston	Josey	1			3		5			1	1	**2.20**	**5**	5	Very High
Trinity, Yarrabah, Bramston	Wyvuri	3			3		5			5	1	**3.40**	**5**	5	Very High
Trinity, Yarrabah, Bramston	Worth	3			3					5	1	**3**	**5**	5	Very High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Trinity, Yarrabah, Bramston	unnamed south of Worth	3			3					5	1	**3**	**5**	5	Very High
Trinity, Yarrabah, Bramston	Mutchero Inlet	3			3					5	1	**3**	**5**	5	Very High
Trinity, Yarrabah, Bramston	Ella	1	1		3					5	1	**2.20**	**5**	1.33	Very High
Trinity, Yarrabah, Bramston		**2**	**1**	**3**	**2.47**	**---**	**2.90**	**1.55**	**---**	**2.18**	**1.18**	**2.09**			
Mulgrave	West Mulgrave	2	1		4	4	4	5	3	1	4	**3.11**	**5**	5	Very High
Mulgrave	Luscombe	2	1		3	5	4	5	3	1	4	**3.11**	**5**	5	Very High
Mulgrave	Upper Mulgrave	2	1	2	3	4	4	5	3	1	4	**2.90**	**5**	5	Very High
Mulgrave	Kearneys Falls	2	1	2	4	4	5	5	3	1	4	**3.10**	**5**	5	Very High
Mulgrave	Butcher	2	2		4		4	3	3	1	4	**2.88**	**4**	2.78	High
Mulgrave	Toohey	2	2		3		4	3	3	1	4	**2.75**	**4**	2.67	High
Mulgrave	Stallion	2	3		3		5	3	3	1	4	**3**	**5**	5	Very High
Mulgrave	Uhr	2	2		3		4		3	1	4	**2.71**	**4**	2.63	High
Mulgrave	Huntsbrook	2	2		3		4		3	3	4	**3**	**4**	2.88	High
Mulgrave	Fisheries	2	3	1	3		1	4	3	4	4	**2.78**	**4**	2.89	High
Mulgrave	Little Mulgrave	2	4	2	3		4	3	3	2	4	**3**	**4**	3	High
Mulgrave	Blackwell	3	2		3		1	1	3	4	4	**2.63**	**4**	2.67	High
Mulgrave	Pyramid	3			3		1	1	3	4	4	**2.71**	**4**	2.75	High
Mulgrave	Behana	3	3	1	4	5	5	5	3	4	4	**3.70**	**5**	5	Very High
Mulgrave	Malbon Thompson	3	2		3		4	4	3	4	4	**3.38**	**4**	3.33	High
Mulgrave	Fishery Falls	3	2		4	4	4		3	5	4	**3.63**	**5**	5	Very High
Mulgrave		**2.31**	**2.07**	**1.60**	**3.31**	**4.33**	**3.63**	**3.62**	**3**	**2.38**	**4**	**3.02**			
Russell	Coopooroo	2	3	2	3		3	5	3	1	4	**2.89**	**5**	5	Very High
Russell	Kiandra	3	1	2	3		3	5	3	1	4	**2.78**	**5**	5	Very High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Russell	Bartle Frere	2	3	2	3	5	4	5	3	1	4	**3.20**	**5**	5	Very High
Russell	Wankaroo	2	3	4	3	5	4	5	3	1	4	**3.40**	**5**	5	Very High
Russell	Tewon	2	2	4	3		4	4	3	1	4	**3**	**4**	2.78	High
Russell	Josephine	2	2	4	3	5	4	5	3	2	4	**3.40**	**5**	5	Very High
Russell	Woopen	3	2	4	3		1	4	3	2	4	**2.89**	**4**	2.78	High
Russell	Norries	3	1	5	3		1		3	2	4	**2.75**	**5**	2.50	Very High
Russell	unnamed east of Norries	2	1	3	3		3		3	5	4	**3**	**5**	5	Very High
Russell	Pughs	2	2		3	4	4	3	3	5	4	**3.33**	**5**	5	Very High
Russell	Niringa	2			1		1			5	4	**2.60**	**5**	5	Very High
Russell	Babinda	2	5	2	4	4	4	5	3	4	4	**3.70**	**5**	5	Very High
Russell	Harvey	3	3	1	3	5	5	5	3	5	4	**3.70**	**5**	5	Very High
Russell	Meringulah	3			3		5		3	3	4	**3.50**	**5**	5	Very High
Russell		**2.36**	**2.33**	**3**	**2.93**	**4.67**	**3.29**	**4.60**	**3**	**2.71**	**4**	**3.15**			
Johnstone	Glen Allyn	3			3		4	3	5	1	4	**3.29**	**5**	5	Very High
Johnstone	Topaz	2			3		3	4	5	1	4	**3.14**	**5**	5	Very High
Johnstone	Topaz South	2			3		3	4	5	1	4	**3.14**	**5**	5	Very High
Johnstone	Theresa	2		4	3		3		5	1	4	**3.14**	**5**	5	Very High
Johnstone	South	2		2	3		5	4	5	1	4	**3.25**	**5**	5	Very High
Johnstone	Dirran	4			3	3	5	3	4	1	4	**3.38**	**5**	5	Very High
Johnstone	Coolamon	2		2	3				4	1	4	**2.67**	**4**	2.67	High
Johnstone	Elinjaa	2		2	4				4	1	1	**2.33**	**4**	2.33	High
Johnstone	Mungalli	2			3			4	4	1	1	**2.50**	**4**	2.43	High
Johnstone	Mystery	2		2	3			3	4	1	1	**2.29**	**4**	2.29	High
Johnstone	Badgery	2	2	4	3		5	3	4	1	1	**2.78**	**5**	5	Very High
Johnstone	Lower Badgery	2	1		3		5	3	4	1	1	**2.50**	**5**	5	Very High
Johnstone	Rankin	2			3		4			1	1	**2.20**	**4**	2.17	High
Johnstone	Fisher	2			3					1	4	**2.50**	**4**	2.40	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Johnstone	Poorka	1	1		3			3	4	1	1	**2**	**4**	1.88	Moderate
Johnstone	Beatrice	4		4	3	3	4	5	5	1	4	**3.67**	**5**	5	Very High
Johnstone	Waraker	1			3		4		5	1	3	**2.83**	**5**	5	Very High
Johnstone	Tregothanan	2			3		4			1	3	**2.60**	**4**	2.50	High
Johnstone	Polly	2			2		3			1	3	**2.20**	**3**	2.17	High
Johnstone	Mourilyan	2			2		5	1		3	4	**2.83**	**5**	5	Very High
Johnstone	Clancys Overflow	2			3		4	4	4	1	4	**3.14**	**4**	3	High
Johnstone	Karangaree	2			3		5	4	4	1	4	**3.29**	**5**	5	Very High
Johnstone	Kaarru	2			3		5	4	4	1	4	**3.29**	**5**	5	Very High
Johnstone	Charappa	2			3		5	4	4	1	4	**3.29**	**5**	5	Very High
Johnstone	Maple	2	2		3		5	4	5	1	4	**3.25**	**5**	5	Very High
Johnstone	Downey	2	2		3		4	4	4	1	1	**2.63**	**4**	2.56	High
Johnstone	Lower Downey	2	2		3		4	4	4	1	1	**2.63**	**4**	2.56	High
Johnstone	McNamee	2	2		3		4	4	4	1	1	**2.63**	**4**	2.56	High
Johnstone	Lower McNamee	2	2		3		4	4	4	1	1	**2.63**	**4**	2.56	High
Johnstone	unnamed (Henrietta Ck)	2			4	4		5		1	1	**2.83**	**5**	5	Very High
Johnstone	Meingan	2			2					1	1	**1.50**	**2**	1.60	Moderate
Johnstone	Utchee West	2			3		4	4	5	1	2	**3**	**5**	5	Very High
Johnstone	Utchee	4			3		5	4	5	1	4	**3.71**	**5**	5	Very High
Johnstone	Mitcha	2			3		4	5	4	1	2	**3**	**5**	5	Very High
Johnstone	Egan	2			3		4	4	4	1	1	**2.71**	**4**	2.63	High
Johnstone	River	2			3		4	3	5	1	1	**2.71**	**5**	5	Very High
Johnstone	Mena	3			3		1	1	4	1	2	**2.14**	**4**	2.25	High
Johnstone		**2.16**	**1.75**	**2.86**	**2.97**	**3.33**	**4.10**	**3.64**	**4.37**	**1.05**	**2.54**	**2.80**			
Liverpool to Hull	West Liverpool	1			3		3			1	3	**2.20**	**3**	2	High
Liverpool to Hull	Kittabah	2	1		3					1		**1.75**	**3**	1.80	Moderate
Liverpool to Hull	Scindah	1			3		3			1	3	**2.20**	**3**	2	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Liverpool to Hull	South Liverpool	2			3		3			1	3	**2.40**	**3**	2.33	High
Liverpool to Hull	Meuribal	2			3		3			1	3	**2.40**	**3**	2.33	High
Liverpool to Hull	Jingu	2			3		3			1	3	**2.40**	**3**	2.33	High
Liverpool to Hull	Taringbah	2			3		3			1	3	**2.40**	**3**	2.33	High
Liverpool to Hull	Kittabah	2			3		3			1	3	**2.40**	**3**	2.33	High
Liverpool to Hull	Bombeta	2			3		3			1	3	**2.40**	**3**	2.33	High
Liverpool to Hull	Little Liverpool	2			3		3			1	3	**2.40**	**3**	2.33	High
Liverpool to Hull	Silkwood	3			3		4			5	3	**3.60**	**5**	5	Very High
Liverpool to Hull	Brown	2			3		1			1	1	**1.60**	**3**	1.67	Moderate
Liverpool to Hull	Moresby	3			3		5			4	4	**3.80**	**5**	5	Very High
Liverpool to Hull	Big Maria	3			3		2	3		4	1	**2.67**	**4**	2.71	High
Liverpool to Hull	Hull	4			3		3	3		5	4	**3.67**	**5**	5	Very High
Liverpool to Hull	North Hull	4			3		2	3		5	4	**3.50**	**5**	5	Very High
Liverpool to Hull	Wongaling	4			3		1	1		5	4	**3**	**5**	5	Very High
Liverpool to Hull		**2.41**	**1**	**---**	**3**	**---**	**2.81**	**2.50**	**---**	**2.29**	**3**	**2.63**			
Tully	Cochable	1	3		4	3	4	5		1	2	**2.88**	**5**	5	Very High
Tully	Coochimbeerum	1	3		4	4	4	5		1	2	**3**	**5**	5	Very High
Tully	Cheetah	1	2		4	3	4	5		1	2	**2.75**	**5**	5	Very High
Tully	Boundary	1			3		4	4		1	2	**2.50**	**4**	2.29	High
Tully	Theodore	1			3		4	5		1	2	**2.67**	**5**	5	Very High
Tully	Nitchaga	1	2		3	4	4			1	2	**2.43**	**4**	2.25	High
Tully	Campbell	1	2		4	4	4			1	2	**2.57**	**4**	2.38	High
Tully	Carpenter	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	Niblet	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	Koombooloomba	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	Sylvania	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	Kooroomool	1			3		4			1	2	**2.20**	**4**	2	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Tully	Goddard	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	Costigan	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	Luff	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	O'Leary	1			3	5	4			1	2	**2.67**	**5**	5	Very High
Tully	Culpa	1			3	4	4			1	2	**2.50**	**4**	2.29	High
Tully	Barbed Wire	1			3		1			1	2	**1.60**	**3**	1.50	Moderate
Tully	Echo North	1			3		1			1	2	**1.60**	**3**	1.50	Moderate
Tully	Echo	1			3	4	1			1	2	**2**	**3**	1.50	Moderate
Tully	Table Top	1			3		1			1	2	**1.60**	**3**	1.50	Moderate
Tully	Timberoonie	1			3		1			1	2	**1.60**	**3**	1.50	Moderate
Tully	Jarra	3	2		3		5	5		3	4	**3.57**	**5**	5	Very High
Tully	Davidson	3			3	4	3	4		1	4	**3.14**	**4**	3.13	High
Tully	Banyan	2			3		1	4		2	4	**2.67**	**4**	2.57	High
Tully	Tyson	2			3		1			1	4	**2.20**	**4**	2.17	High
Tully	Silky Oak	3			3		1	1		2	4	**2.33**	**4**	2.43	High
Tully		**1.30**	**2.33**	**---**	**3.15**	**3.94**	**3.11**	**4.22**	**---**	**1.15**	**2.37**	**2.44**			
Murray	North Branch	2			3		4	4		3	3	**3.17**	**4**	3	High
Murray	King Ranch	2			3		1	1		3	3	**2.17**	**3**	2.14	High
Murray	Deep	2			3		3	1		4	3	**2.67**	**4**	2.57	High
Murray	Upper Murray	2			4		4	5		3	3	**3.50**	**5**	5	Very High
Murray		**2**	**---**	**---**	**3.25**	**---**	**3**	**2.75**	**---**	**3.25**	**3**	**2.88**			
Dallachy, Meunga & Conn	Dallachy	3			3		3	3		3		**3**	**3**	3	High
Dallachy, Meunga & Conn	Whitfield	3			3		3	3		5		**3.40**	**5**	5	Very High
Dallachy, Meunga & Conn	Wreck	3			3		3	3		3		**3**	**3**	3	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Dallachy, Meunga & Conn	Alma	2			3			5		3		**3.25**	**5**	5	Very High
Dallachy, Meunga & Conn	Kennedy	2			3			5		3		**3.25**	**5**	5	Very High
Dallachy, Meunga & Conn	Hinkler	2			3			5		3		**3.25**	**5**	5	Very High
Dallachy, Meunga & Conn	Boggy Camp	2			3			3		3		**2.75**	**3**	2.60	High
Dallachy, Meunga & Conn	Meunga	2			3			4		5		**3.50**	**5**	5	Very High
Dallachy, Meunga & Conn	Scrubby	2			3			1		3		**2.25**	**3**	2.20	High
Dallachy, Meunga & Conn	Five Mile	4			3		2	1		3		**2.60**	**4**	2.83	High
Dallachy, Meunga & Conn	Damper	4			3		2	1		3		**2.60**	**4**	2.83	High
Dallachy, Meunga & Conn	Porter	4			3		4	1		3		**3**	**4**	3.17	High
Dallachy, Meunga & Conn		**2.75**	**---**	**---**	**3**	**---**	**2.83**	**2.92**	**---**	**3.33**	**---**	**2.99**			
Herbert	Wild	1			3		1	3	3	2	1	**2**	**3**	1.88	Moderate
Herbert	Nigger	1			3		1	3	3	2	1	**2**	**3**	1.88	Moderate
Herbert	Cedar	1		1	1		1	3	3	2	1	**1.63**	**3**	1.63	Moderate
Herbert	Vine	1		1	3			5	3	2	1	**2.29**	**5**	5	Very High
Herbert	Blunder	3	2		3	4	4	3	3	2	1	**2.78**	**4**	2.80	High
Herbert	unnamed sth of Vine	2		2	3					2	1	**2**	**3**	2.25	High
Herbert	Cameron	2	2		3	4	1		3	2	1	**2.25**	**4**	2.22	High
Herbert	Blencoe	2			3	4	1	4		2	1	**2.43**	**4**	2.38	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Herbert	Smoko	2			5		1	4		2	1	**2.50**	**5**	5	Very High
Herbert	Waterfall	1			1		4	1		2	1	**1.67**	**4**	1.57	Moderate
Herbert	Herkies	1			4		4	3		2	1	**2.50**	**4**	2.29	High
Herbert	Yamanie	1			4		4	3		2	1	**2.50**	**4**	2.29	High
Herbert	Sword	1			4		4	3		2	1	**2.50**	**4**	2.29	High
Herbert	Longtail	1			3		4			2	1	**2.20**	**4**	2	High
Herbert	Gowrie	2			4		4	5		2	1	**3**	**5**	5	Very High
Herbert	Pinnacles	1			3		4	3		2	1	**2.33**	**4**	2.14	High
Herbert	Garrawalt	2			4		4	3		2	1	**2.67**	**4**	2.57	High
Herbert	Stony	3			4		5	4		2	1	**3.17**	**5**	5	Very High
Herbert	Henrietta	1			2		1	1		2	1	**1.33**	**2**	1.29	Moderate
Herbert	Broadwater	2			3		1	5		3	1	**2.50**	**5**	5	Very High
Herbert	Dalrymple	2			3		1	3		3	1	**2.17**	**3**	2.14	High
Herbert	Stone West Branch	3			4		3			3	1	**2.80**	**4**	2.83	High
Herbert	Upper Stone	3			3		3			3	1	**2.60**	**3**	2.67	High
Herbert	Lannercost	2			3		3	1		1	1	**1.83**	**3**		Moderate
Herbert	Tinkle	2			3		3	1		1	1	**1.83**	**3**	1.86	Moderate
Herbert	Seymour	3			3		4	1		1	1	**2.17**	**4**	2.29	High
Herbert	Seaforth	3			3		3	1		1	1	**2**	**3**	2.14	Moderate
Herbert	Seaforth Channel	3			3		3	1		1	1	**2**	**3**	2.14	Moderate
Herbert		**1.86**	**2**	**1.33**	**3.14**	**4**	**2.77**	**2.78**	**3**	**1.96**	**1**	**2.27**			
Trebonne Halifax	Frances	3			3		1	1		2		**2**	**3**	2.17	Moderate
Trebonne Halifax	Waterview	3			4		1	3		2		**2.60**	**4**	2.67	High
Trebonne Halifax	Crystal	3			3		4	3		4	3	**3.33**	**4**	3.29	High
Trebonne Halifax	Ollera	3			3		4			2	3	**3**	**4**	3	High
Trebonne Halifax	Hencamp	3			3		4			2	3	**3**	**4**	3	High
Trebonne Halifax	Rollingstone	3			3		4	3		1	3	**2.83**	**4**	2.86	High

MAJOR DRAINAGE	SUBCATCHMENT	ATTRIBUTES OF INTEREST												OVERALL SCORE	CONSERVATION VALUE
		ECOSYSTEM FUNCTION VALUES	RHEOPHYTIC PLANTS	AQUATIC PLANTS	FRESHWATER INVERTEBRATES	CRUSTACEA	FRESHWTER FISH	FROGS	FRESHWATER TURTLES	REGIONAL ECOSYSTEMS	FLOWREGIME TYPES & NEEDS	MEAN SCORE	HIGHEST SCORE		
Trebonne Halifax	Saltwater	3			3		3			1	3	**2.60**	**3**	2.67	High
Trebonne Halifax	Leichhardt	3			3		3			1	3	**2.60**	**3**	2.67	High
Trebonne Halifax	Sleeper Log	3			3		2			1	3	**2.40**	**3**	2.50	High
Trebonne Halifax	Bluewater	3			3		1			1	3	**2.20**	**3**	2.33	High
Trebonne Halifax		**3**	**---**	**---**	**3.10**	**---**	**2.70**	**2.50**	**---**	**1.70**	**3**	**2.66**			
Burdekin	Arnott	2			3		1		4		3	**2.60**	**4**		High
Burdekin	Black Burdekin	2			3		3		4		3	**3**	**4**	2.83	High
Burdekin	Michael	2			1		1		4		3	**2.20**	**4**	2.17	High
Burdekin	Paluma	2			5		4	5	4		3	**3.83**	**5**	5	Very High
Burdekin	Williams	2			3		4		4		3	**3.20**	**4**	3	High
Burdekin	Puzzle	2			1		1		4		3	**2.20**	**4**	2.17	High
Burdekin	Blue Gum	2			3		4		4		3	**3.20**	**4**	3	High
Burdekin	Blue Gum south	2			3		1		4		3	**2.60**	**4**	2.50	High
Burdekin	Little Star	2			3		1		4		3	**2.60**	**4**	2.50	High
Burdekin	Keelbottom West	2			3		1		4		3	**2.60**	**4**	2.50	High
Burdekin	Keelbottom East	2			3		1		4		3	**2.60**	**4**	2.50	High
Burdekin		**2**	**---**	**---**	**2.82**	**---**	**2**	**5**	**4**	**---**	**3**	**2.78**			

APPENDIX 3

CONSERVATION VALUES

MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value
Mitchell	Boggy	red	**Mitchell**	Reedy	amber	**Mitchell**	Picaninny	green
Mitchell	East Spencer	red	**Mitchell**	Half Ton	amber	**Mitchell**	West Spencer	green
Mitchell	Little Sandy	red	**Mitchell**	Luster	amber	**Mitchell**	Spencer	green
Mitchell	Spear	red	**Mitchell**	Upper rifle	amber	**Mitchell**	Mary	green
Mitchell	Garioch	red				**Mitchell**	Bushy	green
Mitchell	Lagoon	red						
Mitchell	Wattle	red						
Mitchell	Camp	red						
Mitchell	Rooty	red						
Mitchell	Little Mitchell	red						
Mitchell	unnamed south of Wattle	red						
Normanby	Yard	red	**Normanby**	Boolbun North	amber			
Normanby	Sporing	red	**Normanby**	Poverty south	amber			
Normanby	Diggers	red	**Normanby**	East Normanby Nth Branch	amber			
Normanby	Upper Granite	red						
Annan	Adams	red	**Annan**	Romeo	amber	**Annan**	Parrot	green
Annan	Banana	red	**Annan**	Trevathan	amber	**Annan**	Wallaby	green
						Annan	Mungumby	green
Amos - Cape Tribulation	Forsberg	red	**Amos - Cape Tribulation**	Ashwell	amber	**Amos - Cape Tribulation**	Gap	green
Amos - Cape Tribulation	McAdam	red	**Amos - Cape Tribulation**	Tachalbadga	amber	**Amos - Cape Tribulation**	Mason	green
Amos - Cape Tribulation	Cowrie	red	**Amos - Cape Tribulation**	Emmagen	amber	**Amos - Cape Tribulation**	Myall	green
Amos - Cape Tribulation	Melissa	red	**Amos - Cape Tribulation**	Alexandria	amber	**Amos - Cape Tribulation**	Noah	green
Amos - Cape Tribulation	Bind	red				**Amos - Cape Tribulation**	Cooper	green
						Amos - Cape Tribulation	Hutchinson	green
Bloomfield	Watermelon	red	**Bloomfield**	unnamed north of Watermelon	amber	**Bloomfield**	Keating	green
			Bloomfield	Ayton	amber	**Bloomfield**	Baird	green
						Bloomfield	Roaring Meg	green
						Bloomfield	Woobadda	green

MAJOR DRAINAGE	SUB CATCHMENT	conservation value
Daintree	Smith	red
Daintree	Dagmar east	red
Daintree	Dagmar west	red
Daintree	Timbi	red
Daintree	Bargoo	red
Daintree	Bargoo north	red
Daintree	Paterson	red
Daintree	Rodonie	red
Daintree	Adastra	red
Daintree	Moase	red
Daintree	Kobi	red
Daintree	Lewin	red
Daintree	Ronald	red
Daintree	Lucas	red
Daintree	Duncan	red
Daintree	Gold	red
Daintree	Landers	red
Newell, Mossman & Cook	Moore's	red

MAJOR DRAINAGE	SUB CATCHMENT	conservation value
Daintree	Upper Daintree	amber
Daintree	Adeline	amber
Daintree	Boolbun	amber
Daintree	unnamed east of Duncan	amber
Daintree	Niau	amber
Daintree	Little Naiu	amber
Daintree	Kiely	amber
Daintree	Allanton	amber
Daintree	Luttra	amber
Daintree	Stewart	amber
Daintree	Barrat	amber
Daintree	Forest	amber
Newell, Mossman & Cook	Wonga	amber
Newell, Mossman & Cook	Whyanbeel	amber
Newell, Mossman & Cook	unnamed south of Whyanbeel	amber
Newell, Mossman & Cook	Carson	amber
Newell, Mossman & Cook	Marr	amber
Newell, Mossman & Cook	Cassowary	amber
Newell, Mossman & Cook	Crees	amber
Newell, Mossman & Cook	Lower Mowbray	amber
Newell, Mossman & Cook	Collard	amber
Newell, Mossman & Cook	unnamed south of Collard	amber
Newell, Mossman & Cook	unnamed south of Lower Mowbray	amber

MAJOR DRAINAGE	SUB CATCHMENT	conservation value
Daintree	Hilda	green
Daintree	Daintree	green
Newell, Mossman & Cook	Platypus	green
Newell, Mossman & Cook	South Mossman	green

MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value
			Newell, Mossman & Cook	Oak	amber			
			Newell, Mossman & Cook	Robbins	amber			
			Newell, Mossman & Cook	Spring	amber			
			Newell, Mossman & Cook	Upper Mowbray	amber			
			Newell, Mossman & Cook	Turtle	amber			
			Newell, Mossman & Cook	Hartley	amber			
			Newell, Mossman & Cook	Tin	amber			
			Newell, Mossman & Cook	Finn	amber			
Barron	Kambul	red	**Barron**	Morans	amber	**Barron**	Poona	green
Barron	Rainy	red	**Barron**	Peterson	amber	**Barron**	Robson	green
Barron	Carrington	red	**Barron**	Mobo	amber	**Barron**	Varch	green
Barron	Upper Barron	red	**Barron**	Myola	amber	**Barron**	Tinaroo	green
Barron	Oaky	red	**Barron**	Barron Falls	amber	**Barron**	Emerald	green
Barron	Big Rooty	red	**Barron**	Surprise	amber	**Barron**	Davies	green
Barron	Track	red	**Barron**	Stoney	amber	**Barron**	Bridle	green
Barron	Pearce	red				**Barron**	Freshwater	green
Barron	Shoteel	red						
Barron	Reid	red						
Barron	Kauri	red						
Barron	unnamed east of Pearce	red						
Barron	Thomatis	red						
Trinity, Yarrabah, Bramston	FALSE	red	**Trinity, Yarrabah, Bramston**	Wright	amber	**Trinity, Yarrabah, Bramston**	Josey	green
Trinity, Yarrabah, Bramston	Mick	red	**Trinity, Yarrabah, Bramston**	Bells Peak	amber	**Trinity, Yarrabah, Bramston**	Wyvuri	green
Trinity, Yarrabah, Bramston	Kweto	red				**Trinity, Yarrabah, Bramston**	Worth	green
Trinity, Yarrabah, Bramston	Skeleton	red				**Trinity, Yarrabah, Bramston**	unnamed south of Worth	green
Trinity, Yarrabah, Bramston	Chinaman	red				**Trinity, Yarrabah, Bramston**	Mutchero Inlet	green

MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value
Trinity, Yarrabah, Bramston	Blackfellow	red						
Trinity, Yarrabah, Bramston	Maskey	red						
Trinity, Yarrabah, Bramston	unnamed east of Maskey	red						
Trinity, Yarrabah, Bramston	Buddabadoo	red						
Trinity, Yarrabah, Bramston	Ella	red						
			Mulgrave	Butcher	amber	**Mulgrave**	West Mulgrave	green
			Mulgrave	Toohey	amber	**Mulgrave**	Luscombe	green
			Mulgrave	Uhr	amber	**Mulgrave**	Upper Mulgrave	green
			Mulgrave	Huntsbrook	amber	**Mulgrave**	Kearneys Falls	green
			Mulgrave	Fisheries	amber	**Mulgrave**	Stallion	green
			Mulgrave	Little Mulgrave	amber	**Mulgrave**	Behanna	green
			Mulgrave	Blackwell	amber	**Mulgrave**	Fishery Falls	green
			Mulgrave	Pyramid	amber			
			Mulgrave	Malbon Thompson	amber			
			Russell	Tewon	amber	**Russell**	Coopooroo	green
			Russell	Woopen	amber	**Russell**	Kiandra	green
			Russell	Norries	amber	**Russell**	Bartle Frere	green
						Russell	Wankaroo	green
						Russell	Josephine	green
						Russell	Unnamed east of Norries	green
						Russell	Pughs	green
						Russell	Niringa	green
						Russell	Babinda	green
						Russell	Harvey	green
						Russell	Meringulah	green

MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value
Johnstone	Poorka	red	**Johnstone**	Coolamon	amber	**Johnstone**	Glen Allyn	green
Johnstone	Meingan	red	**Johnstone**	Elinjaa	amber	**Johnstone**	Topaz	green
			Johnstone	Mungalli	amber	**Johnstone**	Topaz south	green
			Johnstone	Mystery	amber	**Johnstone**	Theresa	green
			Johnstone	Rankin	amber	**Johnstone**	South	green
			Johnstone	Fisher	amber	**Johnstone**	Dirran	green
			Johnstone	Tregothanan	amber	**Johnstone**	Badgery	green
			Johnstone	Polly	amber	**Johnstone**	Lower Badgery	green
			Johnstone	Clancys Overflow	amber	**Johnstone**	Beatrice	green
			Johnstone	Downey	amber	**Johnstone**	Waraker	green
			Johnstone	Lower Downey	amber	**Johnstone**	Mourilyan	green
			Johnstone	McNamee	amber	**Johnstone**	Karangaree	green
			Johnstone	Lower McNamee	amber	**Johnstone**	Kaarru	green
			Johnstone	Egan	amber	**Johnstone**	Charappa	green
			Johnstone	Mena	amber	**Johnstone**	Maple	green
						Johnstone	unnamed (Henrietta Ck)	green
						Johnstone	Utchee West	green
						Johnstone	Utchee	green
						Johnstone	Mitcha	green
						Johnstone	River	green
Liverpool to Hull	West Liverpool	red	**Liverpool to Hull**	South Liverpool	amber	**Liverpool to Hull**	Silkwood	green
Liverpool to Hull	Kittabah	red	**Liverpool to Hull**	Meuribal	amber	**Liverpool to Hull**	Moresby	green
Liverpool to Hull	Scindah	red	**Liverpool to Hull**	Jingu	amber	**Liverpool to Hull**	Hull	green
Liverpool to Hull	Brown	red	**Liverpool to Hull**	Taringbah	amber	**Liverpool to Hull**	North Hull	green
			Liverpool to Hull	Kittabah	amber	**Liverpool to Hull**	Wongaling	green
			Liverpool to Hull	Bombeta	amber			
			Liverpool to Hull	Little Liverpool	amber			
			Liverpool to Hull	Maria	amber			
Tully	Kooroomool	red	**Tully**	Boundary	amber	**Tully**	Cochable	green
Tully	Barbed Wire	red	**Tully**	Nitchaga	amber	**Tully**	Coochimbeerum	green
Tully	Echo North	red	**Tully**	Campbell	amber	**Tully**	Cheetah	green

MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value
Tully	Echo	red	**Tully**	Carpenter	amber	**Tully**	Theodore	green
Tully	Table Top	red	**Tully**	Niblet	amber	**Tully**	O'Leary	green
Tully	Timberoonie	red	**Tully**	Koombooloomba	amber	**Tully**	Jarra	green
			Tully	Culpa Silvania	amber			
			Tully	Goddard	amber			
			Tully	Costigan	amber			
			Tully	Luff	amber			
			Tully	Culpa	amber			
			Tully	Davidson	amber			
			Tully	Banyan	amber			
			Tully	Tyson	amber			
			Tully	Silky Oak	amber			
			Murray	North Branch	amber	**Murray**	Upper Murray	green
			Murray	King Ranch	amber			
			Murray	Deep	amber			
			Dallachy, Meunga & Conn	Dallachy	amber	**Dallachy, Meunga & Conn**	Whitfield	green
			Dallachy, Meunga & Conn	Wreck	amber	**Dallachy, Meunga & Conn**	Alma	green
			Dallachy, Meunga & Conn	Boggy Camp	amber	**Dallachy, Meunga & Conn**	Kennedy	green
			Dallachy, Meunga & Conn	Scrubby	amber	**Dallachy, Meunga & Conn**	Hinkler	green
			Dallachy, Meunga & Conn	File Mile	amber	**Dallachy, Meunga & Conn**	Meunga	green
			Dallachy, Meunga & Conn	Damper	amber			
			Dallachy, Meunga & Conn	Porter	amber			
Herbert	Wild	red	**Herbert**	Blunder	amber	**Herbert**	Vine	green
Herbert	Nigger	red	**Herbert**	unnamed south of Vine	amber	**Herbert**	Smoko	green
Herbert	Cedar	red	**Herbert**	Cameron	amber	**Herbert**	Gowrie	green
Herbert	Waterfall	red	**Herbert**	Blencoe	amber	**Herbert**	Stony	green
Herbert	Henrietta	red	**Herbert**	Herkies	amber	**Herbert**	Broadwater	green
Herbert	Tinkle	red	**Herbert**	Yamanie	amber			
			Herbert	Sword	amber			
			Herbert	Longtail	amber			

MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value	MAJOR DRAINAGE	SUB CATCHMENT	conservation value
			Herbert	Pinnacles	amber			
			Herbert	Garrawalt	amber			
			Herbert	Dalrymple	amber			
			Herbert	Stone West Branch	amber			
			Herbert	Upper Stone	amber			
			Herbert	Seymour	amber			
			Herbert	Seaforth	amber			
			Herbert	Seaforth Channel	amber			
			Trebonne Halifax	Frances	amber			
			Trebonne Halifax	Waterview	amber			
			Trebonne Halifax	Crystal	amber			
			Trebonne Halifax	Ollera	amber			
			Trebonne Halifax	Hencamp	amber			
			Trebonne Halifax	Rollingstone	amber			
			Trebonne Halifax	Saltwater	amber			
			Trebonne Halifax	Leichhardt	amber			
			Trebonne Halifax	Sleeper Log	amber			
			Trebonne Halifax	Bluewater	amber			
			Burdekin	Black Burdekin	amber	**Burdekin**	Paluma	green
			Burdekin	Michael	amber			
			Burdekin	Running	amber			
			Burdekin	Puzzle	amber			
			Burdekin	Blue Gum	amber			
			Burdekin	Blue Gum south	amber			
			Burdekin	Little Star	amber			
			Burdekin	Keelbottom West	amber			
			Burdekin	Keelbottom East	amber			

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