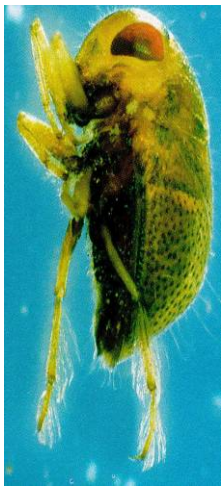
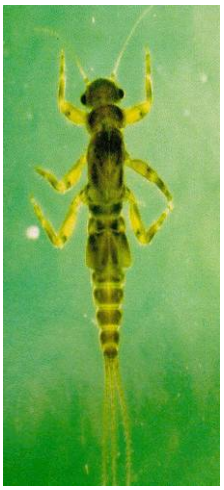
Monitoring for Aquatic Ecosystem Protection in Rapid Creek





Northern Territory Government

Department of Natural Resources, Environment and the Arts

Monitoring for Aquatic Ecosystem Protection in Rapid Creek.

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SUMMARY

Rapid Creek is the largest freshwater system within the Darwin city area and is therefore recognised as an extremely valuable community asset. Whilst a large proportion of the catchment has been cleared and is utilised for a variety of uses (e.g. residential, commercial and semi-rural), the stream corridor itself remains relatively intact and in this context, Rapid Creek is unusual for a capital city. In recognition of the importance of this natural resource, the Rapid Creek Catchment Advisory Committee (RCCAC) was established in 1996 to develop a management plan for the Rapid Creek catchment. One of the key objectives of the management plan is to maintain protection of the aquatic ecosystem of Rapid Creek.

There are a number of factors that affect the quality and quantity of water entering Rapid Creek, which in turn affects the health of the aquatic ecosystem within the creek. Examples of these factors include human developments in the catchment (e.g. suburban areas, sporting grounds, commercial/industrial, small-scale agriculture/horticulture), the condition of streamside vegetation and general land management practices in areas of native vegetation (e.g. weeds, fire). Clearing of native vegetation can increase the flow of water into the creek and combined with stormwater, can increase the amount of sediments transported into the creek and scouring of the stream banks. Human land uses can also potentially increase inputs of nutrients, heavy metals, herbicides/pesticides and other chemicals (e.g. hydrocarbons) into the waterway. While some of these are naturally present in the system (e.g. heavy metals and nutrients), excess concentrations (pollution) in the water can adversely affect the health of the aquatic ecosystem. For example, elevated nutrients can lead to algal blooms, which are not only unsightly but can harm other organisms in the water, such as fish and invertebrates.

An assessment of water quality monitoring data for Rapid Creek freshwater reach suggests that there are elevated levels of some heavy metals and nutrients, which are generally observed during the wet season, particularly early in the season when the first rains flush accumulated pollutants from the catchment into the creek. Once the wet season sets in, water quality generally improves as pollutants are diluted and flushed quickly from the system and out to sea. In such a system, there is very little chance of accumulation of nutrients or metals within the freshwater reaches and given the high flow velocities in the incised channel of the creek, little sediment accumulation.

Different types of monitoring can tell us different things about the aquatic ecosystem. Water quality monitoring (measurement of physical and chemical properties of the water) often involves infrequent collection of water samples which only provide information for a single point in time. In contrast, monitoring of aquatic biota can provide a measure of the ecological health of aquatic systems that is likely to reflect the water quality conditions over several weeks or even months. Since one of the key objectives of the Rapid Creek Management Plan is to maintain aquatic ecosystem protection, it is important that the monitoring program is targeted to make efficient use of available resources and provide a meaningful assessment of the overall health of the ecosystem. It is recommended that the best way to achieve this is through the monitoring of macro-invertebrates, diatoms and fish, supported by an assessment of the riparian condition and water quality observation and limited water sample collection.

INTRODUCTION

Background & Catchment Description

The Rapid Creek Catchment Advisory Committee (RCCAC) was established in 1996 to develop and implement a management plan for the Rapid Creek catchment. In 2000, the beneficial uses of the freshwater reaches of the creek were declared under the Water Act. These uses were ecosystem protection, recreation and aesthetics. This declaration represents a statement of "what we want to mange the creek for". A key objective of the management plan is to maintain the ecological health of Rapid Creek.

Rapid Creek is located within the northern suburbs of Darwin (Figure 1). The creek drains a catchment area of approximately 28 km^2 and originates from Marrara Swamp, at the eastern end of Darwin Airport. It flows for 9.8 km, discharging into the Beagle Gulf at the southern end of Casuarina Beach.

The creek is the largest freshwater system within the Darwin city area and is therefore recognised as an extremely valuable community asset. The creek and its riparian (stream-side) land is a recreation amenity for a range of pursuits including walking, bike riding and swimming. Whilst a large proportion of the catchment has been cleared and is utilised for a variety of activities, the stream corridor itself remains relatively intact and in this context, Rapid Creek is unusual for a capital city.

Plant communities along the creek can be divided into three distinct zones. A paperbark forest surrounds the Marrara Swamp wetland at the headwaters of the system, while a monsoon forest extends along the banks of the middle reaches of the creek. The tidal lower reaches of the creek are lined with mangrove forests.

In recent years, the expansion of urban areas, commercial developments and airport operations has increased the risk of pollutants entering the creek (Figure 1). There is an ongoing need to assess the health of the creek and evaluate whether it's declared beneficial use of ecosystem protection is met.

The objectives of this report are to: (1) provide an overview of the factors potentially influencing water quality and ecological health of the creek, (2) to assess the impact on the creek's ecological health, (3) to assess the adequacy of current monitoring programs, and (4) make recommendations for future monitoring. The report contributes to implementing the water quality strategy of the RCCAC 2004 reporting framework.

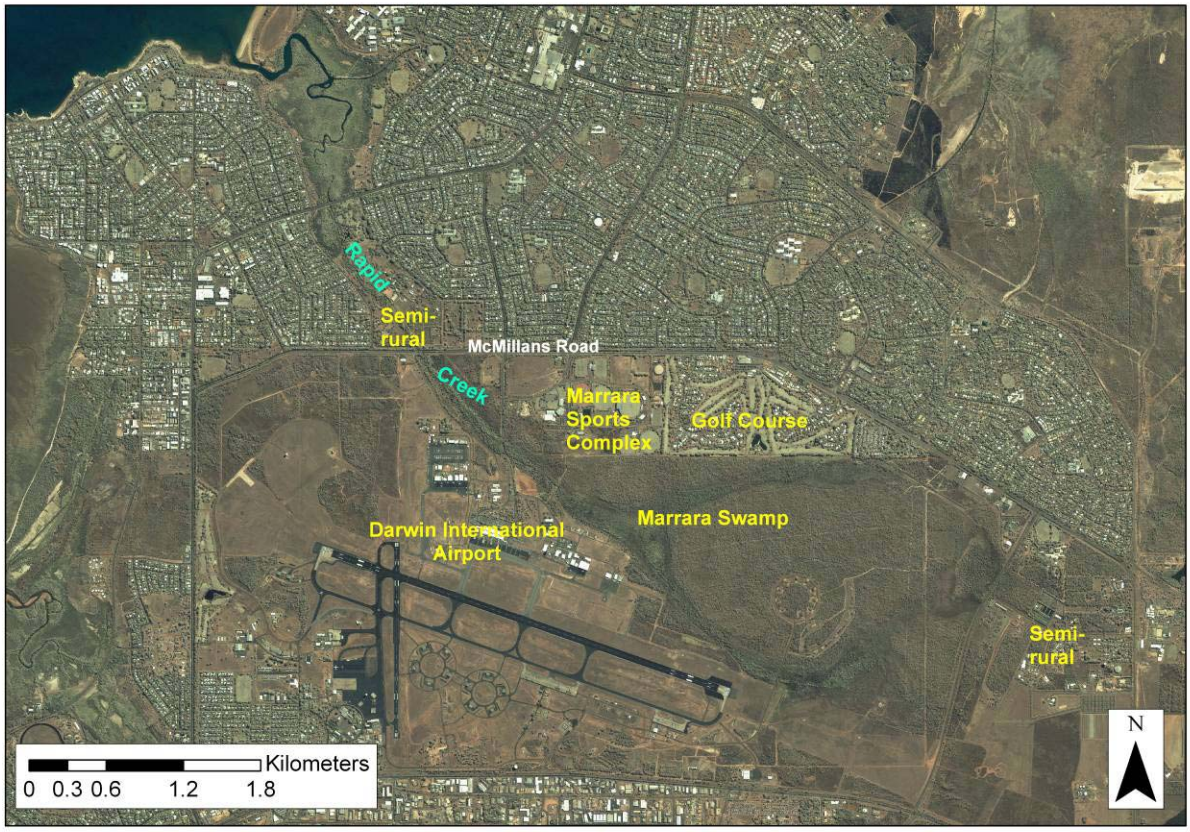

Figure 1. Rapid Creek catchment, showing surrounding land uses.

Hydrology

Originating in Marrara Swamp, the upper reaches of Rapid Creek are divided into two main channels, which meet just before a flood mitigation wall upstream of Yankee's Pool. From this point, a single well-defined channel flows downstream to the v-notched weir (just downstream from Kimmorley Bridge, McMillans Road), where tidal influence begins.

The two sources of freshwater to the creek are rainfall-runoff and groundwater, with the contribution of these to creek flow linked to the seasons. During the wet season, flow is primarily driven by rainfall-runoff whereas in the dry season, flow is almost exclusively groundwater discharge. The groundwater discharge is fed by two springs in the Marrara Swamp, as well as a swamp situated on the Defence estate (Willing & Partners, 1976; Dwyer, 1980). Groundwater recharge maintains flow at a low, though slowly declining levels, over much of the dry season.

Preserving these swamps and surrounding drainage areas is critical in maintaining flood attenuation downstream, in addition to supplying stream flow and groundwater discharge through the dry season. The relatively undisturbed nature of the swamp area and large tracts of the stream corridor has resulted in minimal changes to the creek's hydrology upstream of the airport and urban areas.

As shown in Figure 2, the first flushes of the wet season do not occur until November. Flow remains high from December to the end of April, with numerous high peak flow events associated with storm or monsoonal activity. With the onset of dry season conditions, flow driven by groundwater recharge remains very low between May and the beginning of November, and can even cease flowing.

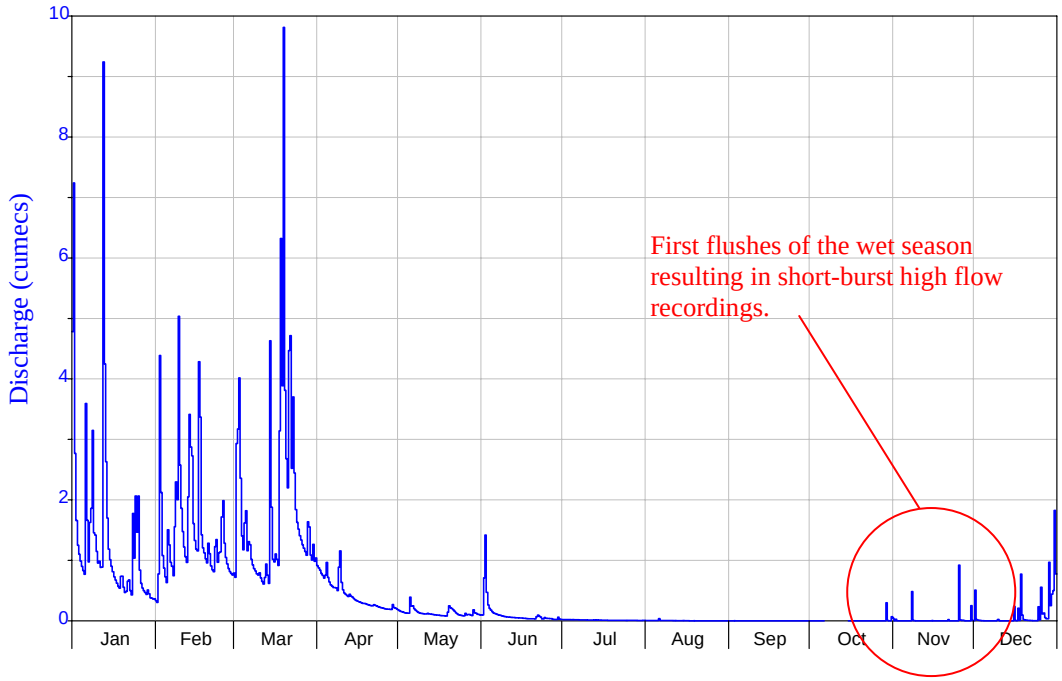

Figure 2: Discharge recorded at the v-notched weir (gauging station – G8150127), Rapid Creek in 2004.

FACTORS AFFECTING WATER QUALITY IN THE RAPID CREEK CATCHMENT

Fire and weeds

The majority of native bushland in the Rapid Creek catchment is managed either by the Department of Defence (Defence) or Darwin International Airport (DIA), with smaller areas managed by Darwin City Council and the Northern Territory Government. Two land management practices that are likely to affect stream water quality and hydrology in the creeks bushland catchment are fire and terrestrial weeds. Fire can affect water quality by changing run-off characteristics (e.g. increased erosion) and increasing nutrient concentrations, which in turn can affect the health of the creek. Terrestrial weeds can affect water quality indirectly by their influence on fires. For example, the additional fuel loads provided by grassy weeds can lead to more intense fires, resulting in damage to riparian vegetation (Figure 3). In addition to terrestrial weeds, there is also the threat of aquatic weeds (e.g. Cabomba), which can out-compete native species and literally choke a water body. Another potential impact of weeds is the application of herbicide for their control, which may influence water quality.

Figure 3. A grass fire fuelled by Gamba grass (*Andropodon gayanus*).

Fire management generally involves the undertaking of wet season or early dry season controlled burns, to reduce fuel loads and the risk of intense fires and associated impacts. Weed management involves annual herbicide spraying of weeds, in conjunction with fuel reduction burning.

Condition of riparian land

Riparian land is the area along the banks of rivers and streams (Figure 4). It is the interface between the terrestrial and aquatic environments and is important to river health. Riparian plants perform a variety of functions that help to improve and maintain the health of streams. Some examples are provided below:

Figure 4. Riparian vegetation in Rapid Creek

- Wood and leaves falling into the stream from riparian plants slow the stream down while the roots of riparian plants bind the soil. This helps to stabilise the stream banks.
- Shade provided by riparian plants regulates the temperature and the amount of light reaching the stream water. This can affect the stream's productivity, the growth of aquatic plants and the animal species that survive.
- Run-off from the catchment passes through the riparian zone before reaching the stream. The riparian vegetation slows its passage, allowing sediments, nutrients and pollutants to be trapped and filtered.

The riparian corridor along Rapid Creek is in reasonable condition, although there have been some impacts of human visitation and weeds, particularly in the lower freshwater reaches. Over recent years, Darwin International Airport (DIA), Greening Australia, Darwin City Council and the Northern Territory Government have put considerable effort into management of disturbed riparian areas by planting trees along the creek.

Human developments

A large proportion of the Rapid Creek catchment has been utilised for a variety of developments, including:

- Urban residential areas
- Semi-rural blocks
- Sporting facilities
- Industrial/commercial developments (DIA & Defence).

These land uses involve the clearing of native vegetation, which effectively removes natural barriers that usually slow runoff. This means that water runs off the land and into the creek more quickly, which can wash sediments into the creek or cause erosion of the creek bed. Higher inputs of sediments to the creek can increase the cloudiness (turbidity) of the water, which means that less light can enter the water for photosynthesis by plants. There is evidence of scouring of the stream banks in several sections of Rapid Creek, which is likely to be the result of increased flows associated

with urban land-use and hydrological changes caused by flow concentration by the flood mitigation weir.

In addition to clearing of vegetation, the above land uses can potentially increase inputs of nutrients, heavy metals, herbicides/pesticides and other chemicals (e.g. hydrocarbons) into the waterway. While some of these are naturally present in the system (e.g. metals and nutrients), excess concentrations in the water can adversely affect the health of the aquatic ecosystem. For example, elevated nutrients can lead to algal blooms, which are not only unsightly but can harm other organisms in the water, such as fish and invertebrates.

Discussion is provided below for specific land uses within the Rapid Creek catchment and their potential impact(s) on water quality.

Urban residential areas

Stormwater from urban areas on the northern side of the catchment (e.g. Karama and Moil) flows into Rapid Creek, mainly via closed drains. The main pollutants potentially entering the stormwater system from urban residential areas include sediment, nutrients, heavy metals, herbicides/pesticides (garden use), hydrocarbons (e.g. oil on roads) and rubbish. The first rain of the wet season is the time when there is the greatest risk of pollutants entering the creek from urban areas, as they are likely to have accumulated in gardens and on roads during the dry season.

Figure 5: Example of a stormwater drain servicing the urban areas that flows into Rapid Creek.

Semi-rural blocks

There are a number of semi-rural blocks located downstream (north) of McMillans Road and upstream (east) of Amy Johnson Avenue. Farming in the area is not intensive, with only a small number of agricultural and horticultural allotments. Stormwater may wash accumulated faecal matter, fertilisers and herbicides/pesticides into the creek during the wet season, particularly during the first rains.

Figure 6: Example of semi-rural land use downstream of McMillans Road.

Sporting Grounds

Two major sporting facilities are located in the catchment. These are the Marrara Sporting Complex, comprising of a number of football ovals and a shooting range, and the Northlakes Golf Course. Both facilities use treated sewage effluent to irrigate grassed areas during the dry season. This generally contains high levels of nutrients, which are likely to be taken up by grass. Overflow from the golf course may occur in the wet season but would be greatly diluted by runoff from the rest of the catchment.

More recently, increased sedimentation has been noted in association with development works at the Marrara Soccer Ground. Measures have been undertaken to reduce run-off from this site.

Industrial/commercial developments

The Darwin International Airport (DIA) occupies an area of 311 hectares of land south of McMillans Road, much of this land being situated within the Rapid Creek catchment.

Examples of potential water contamination sources from DIA that may impact on downstream aquatic ecosystems are leakage from fuel storage tanks, spillage of toxic or hazardous substances (e.g. while refuelling aircraft), aircraft and vehicle wash down or maintenance facilities, pesticides/herbicides and sewage spills.

DIA has developed an environmental management plan and water quality monitoring program, which includes procedures to reduce the risk of pollutants entering the Rapid Creek system. It also outlines a monitoring approach to a number of sites along Rapid Creek within the Airport estate (Darwin International Airport 2004).

The airport has carried out work designed to minimise the potential for pollutants to enter the creek from the airport estate, such as the installation of improved hydrocarbon interception systems.

Figure 7: The Marrara Sporting Complex, which is located within the Rapid Creek catchment, consists of a number of ovals that are irrigated using treated sewage effluent.

Figure 8: Example of plate-separator pollution control system installed by Darwin International Airport.

AQUATIC MONITORING IN RAPID CREEK- HOW HEALTHY IS IT?

Water Quality Monitoring

Data Collected

The Department of Natural Resources, Environment and The Arts (NRETA) and predecessor organisations has collected water quality data from a number of sites on Rapid Creek since 1981, the most comprehensive being from the v-notch weir

downstream of McMillans Road. In 2005, weekly sampling was undertaken at the above site to further investigate seasonal variability in water quality.

DIA has been monitoring water quality from a number of sites since 2000, both in Rapid Creek and in stormwater drains that flow into the creek from land managed by DIA. The frequency of water sample collection was initially monthly but has been reduced recently to quarterly. However, monthly checks are still carried out at all sites for visual indications of any water quality issues, in addition to *in situ* checks with a water quality meter (e.g. turbidity, dissolved oxygen, electrical conductivity).

Water quality monitoring has also been undertaken by the community-based Greening Australia and Waterwatch (e.g. Schenkel 1998) and the Department of Defence.

A review of the following data sets was undertaken:

- NRETA HYDSTRA database: metals and nutrients, 1967 – 2004.
- NRETA 2005 water quality monitoring: monthly samples of nutrients and field measurements during the dry season.
- Darwin International Airport metals, nutrients and other parameters, 2000 – 2005.
- Waterwatch: water quality monitoring, 1995 – 1999.

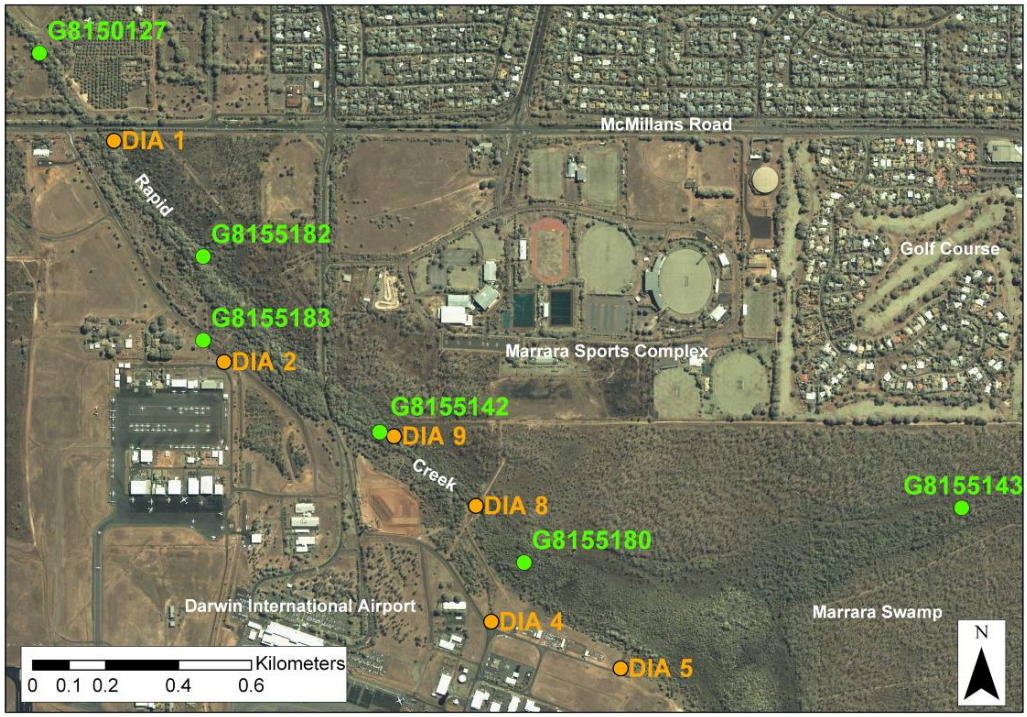

Figure 9. Location of Water Monitoring Branch (green) and Darwin International Airport (orange) sites in the Rapid Creek catchment.

What does it tell us?

In general, the water quality measured in Rapid Creek is good when considered in the context of a highly modified urban catchment. Water quality is generally best in the early to middle part of the dry season but becomes poorer late in the dry season and during the wet season. This is discussed in further detail below and summarised data are presented in Appendix 1. Table 1 provides an overview of water quality variables that are often measured and how they relate to ecosystem health.

Data suggest that there are elevated concentrations of some heavy metals, (e.g. aluminium, iron, copper, cadmium, lead and zinc) which in some cases exceed guidelines for ecosystem protection (ANZECC 2000). It is likely that levels of some of these metals (e.g. aluminium and iron) are naturally high, since they are present in the lateritic soils that characterise the Darwin region.

Concentrations of some nutrients, such as nitrogen and phosphorus, increase late in the dry season and after the first rains in the wet season. Some of these nutrients in stormwater runoff may come from fertilisers. Nutrients also originate from naturally occurring particulate and organic matter that is washed into the creek (e.g. leaves).

Elevated concentrations of metals and nutrients are generally observed during the wet season, particularly early in the season when the first rains flush all the accumulated pollutants from the catchment into the creek. Once the wet season sets in, water quality generally improves as pollutants are diluted and flushed quickly from the system. In such a system, there is very little chance of the accumulation of nutrients or metals within the freshwater reaches and given the high flow velocities in the incised channel of the creek, little sediment accumulation (Lawton 1994).

Electrical conductivity (dissolved salts), turbidity (cloudiness of water) and dissolved oxygen reflect other seasonal patterns in water quality. Towards the end of the dry season, electrical conductivity and turbidity increase, while dissolved oxygen decreases. In most natural systems, this is a time when aquatic biota are under high stress.

One of the major disadvantages of the water quality monitoring that has been undertaken in Rapid Creek is that the data reflect the conditions in the creek at a single point in time, only a few times a year. This means that some pollution events could be 'missed' by sampling, particularly if they are short in duration (e.g. a few days) or conversely, if high pollutant levels are detected in a single sample, there is no indication of the duration of any potential impact on the aquatic ecosystem. The objective of aquatic monitoring in Rapid Creek is to assess the ecosystem health of the creek, it is therefore more appropriate to survey organisms that will show a cumulative impact of any potential pollutants entering the system. The advantages of biological monitoring are discussed further in the following section.

Table 1. Water quality parameters monitored in the Darwin region.

Water Quality Parameter	Importance
Nitrogen	An important plant nutrient. Too much nitrogen in the form of oxidised nitrogen (nitrate and nitrite) and ammonia can lead to excessive plant growth. Total nitrogen is the sum of nitrite, nitrate and Total Kjeldhal Nitrogen, which is mainly organically bound nitrogen.
Phosphorus	An important plant nutrient. Too much phosphorus in soluble can lead to excessive plant growth.
Chlorophyll *a*	The green component of plants used in photosynthesis. Is used as an index of the amount (biomass) of algae.
Dissolved oxygen	Essential for all plant and animal processes. Prolonged periods of oxygen depletion can result in death of fish and other animals, and too much oxygen is a sign of increased plant/algal biomass due to nutrient enrichment.
Metals	Some are required at trace levels by organisms, but can be toxic at high levels. The concentration of metals may vary with local geology or anthropogenic sources (pollution).
Total suspended sediments	This is a measure of the amount of all material suspended in the water. This measure is sensitive to catchment erosion or disturbance of bottom sediments.
pH	The concentration of hydrogen ions, i.e. the acidity or alkalinity of water. A fundamental measure that determines metal solubility and toxicity, and affects an organisms ability to absorb minerals and nutrients.
Turbidity	A measure of the light scattering property of water as a result of material suspended in the water. Turbidity is correlated with suspended solids. It affects the amount of light available for photosynthesis by plants.
Conductivity	A measure of the amount of ionic materials (salts).

Biological Monitoring

Macro-invertebrates

Aquatic macro-invertebrates include a diverse range of freshwater invertebrate animals. Some, such as freshwater shrimps and mussels, are well known to many people, but most are relatively small, obscure animals which live unseen in our streams, rivers and lagoons. Most of the aquatic macro-invertebrates collected in local stream samples are larval stages of aquatic insects. Macro-invertebrates can be highly abundant, and play important ecological roles in streams; for example, by processing nutrients and by providing food for fish and waterbirds. The presence or absence of different types of macro-invertebrates, and their relative numbers, can provide a measure of the ecological health of aquatic systems that is likely to reflect the water quality over several weeks or even months.

Figure 10. Larvae of all damselflies (*Ceriagrion aeruginosum* shown above) and dragon flies are aquatic.

NRETA, with the assistance of the Cooperative Research Centre for Freshwater Ecology, has developed a method of assessing the ecological health of streams, known as the AUSRIVAS method. The method is based on comparing the number of types of macro-invertebrates identified in samples to the number of types predicted to be present and involves a scoring system, based on comparisons between the system being monitored (Observed) and another system that is known to be pristine (Expected). When the Observed/Expected (OE50) score is close to one, this indicates the stream macro-invertebrate fauna sampled is similar to reference streams, and not impacted by human activity.

Consistent trends in OE50 scores over time may indicate changes in the ecological health of streams. For example, Figure 11 shows OE50 scores for Rapid Creek and two other creeks in the Darwin Harbour catchment. Scores for Mitchell Creek indicate deterioration in macro-invertebrate communities, potentially associated with catchment disturbance from residential development, whereas the trend for Rapid Creek indicates an improvement, which may be associated with measures undertaken recently by DIA to intercept pollutants. Peel Creek is close to Darwin River Dam, and has a catchment that is mostly eucalypt woodland. However, it should be noted that this includes only 4 years of data and may not take into account natural cycles that affect aquatic ecosystems.

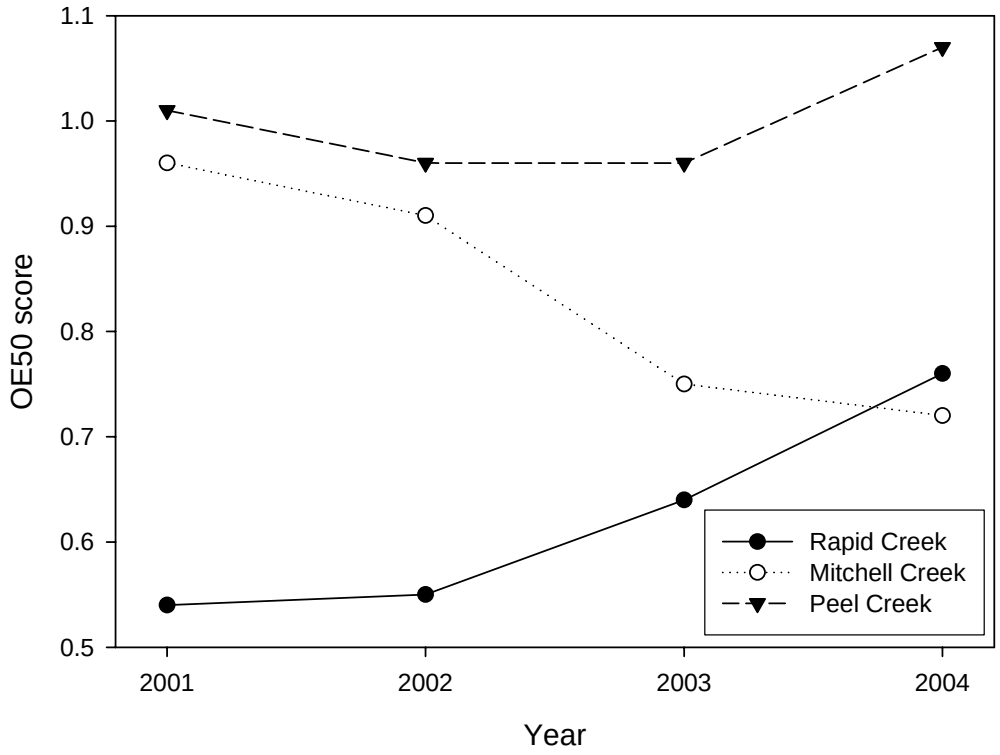

Figure 11. Four year trends in OE50 scores for three stream sites in the Darwin area.

RECOMMENDATIONS FOR FUTURE MONITORING

Since one of the key objectives of the Rapid Creek Management Plan is to maintain the aquatic health of the creek, it is important that the monitoring program is targeted to make efficient use of available resources and provide a meaningful assessment of the overall health of the ecosystem. It is recommended that the best way to achieve this is through an integrated monitoring program with a focus on the biota within the creek (e.g. maco-invertebrates, diatoms and fish) and the factors that affect the value of the creek as habitat for the biota (e.g. water quality, hydrology, geomorphology and riparian health). A proposed monitoring program is detailed in Table 2.

Table 2. Proposed program for future monitoring of aquatic health of Rapid Creek

Monitoring Task	Data provided	Location(s)	Frequency
1. Visual & in-situ checks of water quality	Observations of pollution, photo monitoring & field measurements (pH, EC, Temperature, turbidity, DO)	5 DIA monitoring sites (DIA1, 2, 4, 5 & 8)	Monthly
2. Ecological Monitoring:			
a. Macroinvertebrates	Assessment of aquatic macro-invertebrate community health	3 NRETA sites (G815127, G8155182, G8155142)	Annually (May/June)
b. Diatoms	Monitor species diversity and/or pollution indicators	Pilot study required	Annually
c. Fish	Monitor species present and diversity	Pilot study required	Annually
3. Water Sampling	Metals & nutrients only	3 NRETA sites (G815127, G8155182, G8155142)	Annually (May/June)
4. Riparian Vegetation Monitoring (using TRARC)	Relative Condition Score	Sites in natural and revegetated areas, representing all land tenures.	Annual
5. Hydrology	Stream flows, heights	Existing gauge station at G815127	Ongoing
6. Geomorphology (erosion)	Visual assessment using photo-point monitoring & permanent markers along creek bank	5 DIA monitoring sites (DIA1, 2, 4, 5 & 8)	Photographs: Monthly, Assessment: Annually
7. Reporting	Data and interpretation provided on RACAC, NRETA and other websites	All monitoring locations	Ongoing

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Appendix A.

Weekly monitoring undertaken by NRETA in 2005 at site G8150127 (see Fig. 9 for location)

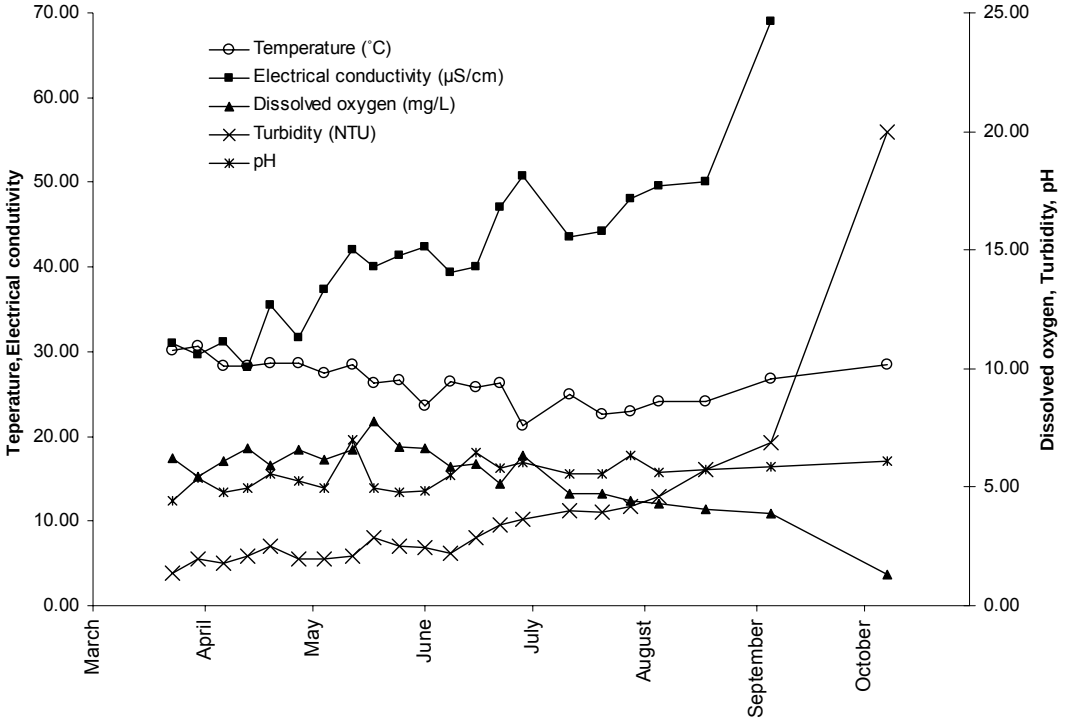


Figure A1. Field measurements of the water quality in Rapid Creek from March to October 2005.

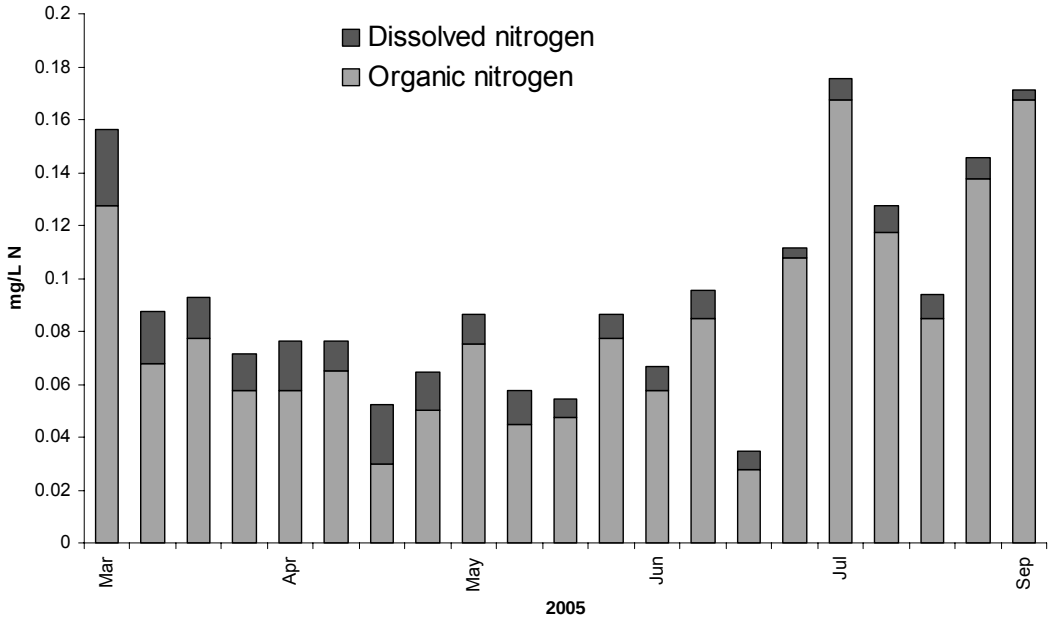


Figure A2: Comparison of relative contributions of organic nitrogen and dissolved nitrogen to the total nitrogen concentration in Rapid Creek from March to September 2005.

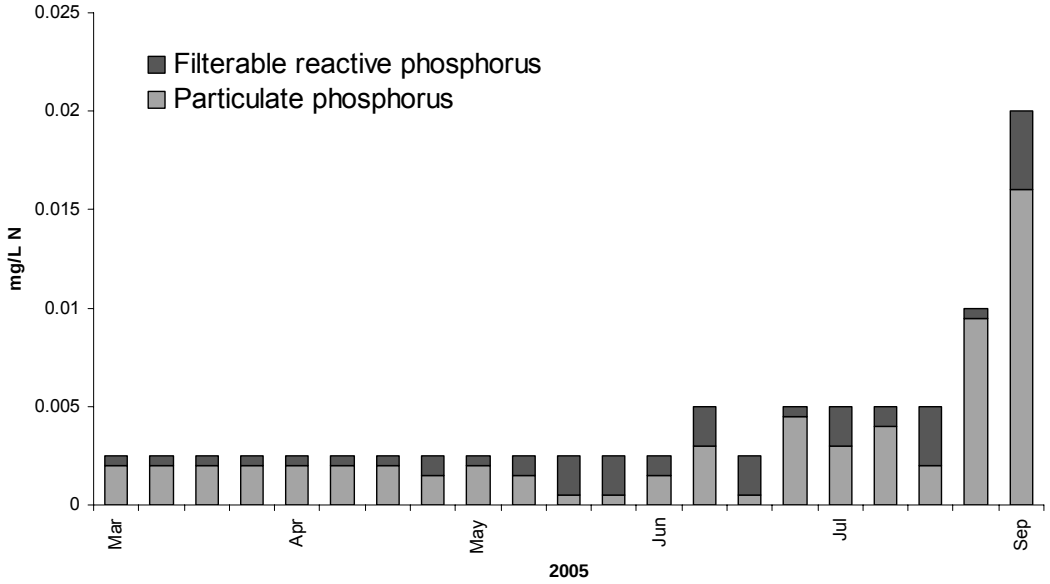


Figure A3: Comparison of relative contributions of filterable reactive phosphorus to particulate phosphorus to the total phosphorus concentration in Rapid Creek from March to September 2005.

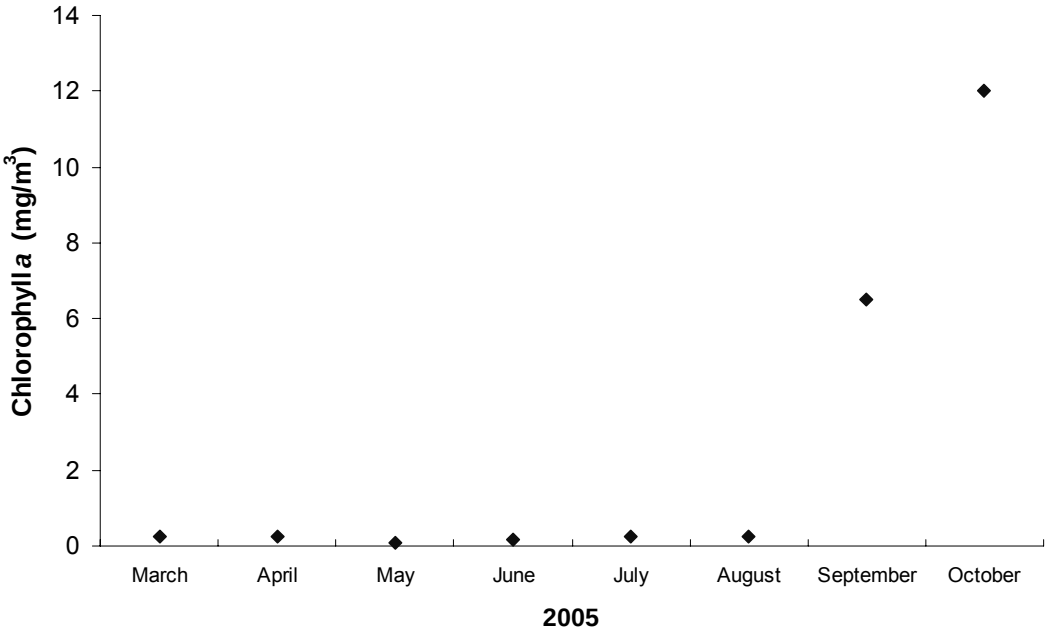


Figure A4. Concentrations of Chlorophyll *a* in Rapid Creek from March to October 2005.

Appendix B.

Comparisons of DIA and NRETA data with ANZECC Guidelines

Table B1. Comparison of 1967 – 1993 NRETA HYDSTRA data[1] with ANZECC guidelines for ecosystem protection

Analyte	Cd			Cu			Pb			Zn			P		
Season	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec
No. Samples	40	6	26	40	6	26	39	6	25	40	6	26	35	0	27
Guideline Value (ug/L, 80% Protection level)	0.8	0.8	0.8	2.5	2.5	2.5	9.4	9.4	9.4	31	31	31	10*	10*	10*
% Samples exceed guideline	53	0	42	70	0	100	38	0	100	33	0	100	0	-	0
Mean value (ug/L)	3.6	0.2	4.8	8.5	1.1	8.5	17.9	1.6	16.8	30.7	7.0	28.7	60.0	-	74.6
Maximum value (ug/L)	41.0	0.4	41.0	56.0	1.6	41.0	150.0	3.6	70.0	150	10.0	120	230	-	230
Minimum value (ug/L)	0.10	0.04	0.12	0.70	0.40	1.20	1.10	0.80	1.60	4.00	3.10	4.00	1.00	-	1.00
Median value (ug/L)	0.86	0.19	0.76	3.7	1.1	5.15	6.8	1.3	6.8	19	7.8	23	25	-	73
80th percentile value (ug/L)	3.86	0.31	6.1	11	1.5	11	24.4	1.4	34	39.6	10	38	112	-	120

Analyte	NO3			Al			As			Fe		
Season	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec
No. Samples	69	24	34	0	1	0	0	1	0	33	21	8
Guideline Value (ug/L, 80% Protection level)	17000	17000	17000	n/a	n/a	n/a	360	360	360	n/a	n/a	n/a
% Samples exceed guideline	0	0	56	n/a	n/a	n/a	-	0	-	n/a	n/a	n/a
Mean value (ug/L)	920	1000	951	-	22.0	-	-	1.0	-	342	1705	288
Maximum value (ug/L)	2300	1000	2300	-	22.0	-	-	1.0	-	1700	26000	600
Minimum value (ug/L)	4.0	1000	4.0	-	22.0	-	-	1.0	-	100	100	100
Median value (ug/L)	1000	1000	1000	-	22.0	-	-	1.0	-	200	300	250
80th percentile value (ug/L)	1000	1000	1700	-	22.0	-	-	1.0	-	500	700	460

1 Extracted from NRETA's water quality database known as HYDSTRA
* 95% ecosystem protection level, as no 80% values are provided by the guidelines.
n/a = ecosystem protection guideline not available
Wet season = November – April
Dry season = May - October

Table B2. Comparison of 2000 - 2005 Darwin International Airport data[1] with ANZECC guidelines for ecosystem protection

Analyte	Cd			Cu			Pb			Zn			P		
Season	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec
No. Samples	61	62	24	61	62	24	61	62	24	61	62	24	50	41	24
Guideline Value (ug/L, 80% Protection level)	0.8	0.8	0.8	2.5	2.5	2.5	9.4	9.4	9.4	31	31	31	10*	10*	10*
% Samples exceed guideline	74	61	58	59	56	79	8	3	17	54	15	38	80	76	100
Mean value (ug/L)	1.1	0.9	1.6	3.6	18.4	4.9	3.7	3.4	6.0	20.2	19.4	27.2	64.7	81.5	85.8
Max value (ug/L)	2.0	2.0	2.0	10.0	100.0	10.0	20.0	34.0	19.0	112	180	112	210	310	210
Min value (ug/L)	0.20	0.20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	10.0	10.0	50.0
Median value (ug/L)	1.0	1.0	2.0	4.0	3.0	5	1.0	2.0	5.0	13.0	8.0	21.0	50.0	100	55.0
80th percentile value (ug/L)	2.0	1.0	2.0	5.0	10	6	5.0	5.0	6.0	36.0	26.0	38.0	90.0	130	90.0

Analyte	NO_3			Al			As			Fe		
Season	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec	Wet	Dry	Nov-Dec
No. Samples	61	57	24	56	52	24	11	25	0	56	52	24
Guideline Value (ug/L, 80% Protection level)	17000	17000	17000	n/a	n/a	n/a	360	360	360	n/a	n/a	n/a
% Samples exceed guideline	0	0	0	n/a	n/a	n/a	0	0	-	n/a	n/a	n/a
Mean value (ug/L)	286	143	153	227	139	334	1.0	1.0	-	255	648	288
Max value (ug/L)	970	820	480	1040	810	732	1.0	1.0	-	750	3600	620
Min value (ug/L)	20.0	10.0	30.0	8.0	20.0	66.0	1.0	1.0	-	20.0	30.0	72.0
Median value (ug/L)	150	50.0	130	130	50.0	250	1.0	1.0	-	185	350	245
80th percentile value (ug/L)	570	284	220	263	174	610	1.0	1.0	-	370	878	370

1 Data from monthly (May 2000 – Apr 2001) and quarterly (Sep 2001 – May 2005) sampling at 5 sites in Rapid Creek catchment
* 95% ecosystem protection level used
n/a = ecosystem protection guideline not available
Wet season = November – April
Dry season = May - October

Appendix C.

Water quality data extracted from NRETA HYDSTRA database #

Not all HYDSTRA water chemistry data is presented.

Site	Date	Cd	Cu	Pb	Zn	Cr	Mn	Ni	Al	As	Total Phosphorous	Nitrate (as NO_3)
G8150127	24-Nov-92	0.00075	0.0016	0.0064	0.0092	0.0006		0.0019				
G8150127	26-Nov-92										0.026	
G8150127	26-Nov-92	0.011	0.013	0.068	0.12	0.016		0.057			0.15	0.58
G8150127	26-Nov-92	0.0046	0.011	0.054	0.09	0.023		0.039			0.23	0.76
G8150127	26-Nov-92	0.0032	0.0048	0.013	0.048	0.008		0.013			0.14	0.44
G8150127	26-Nov-92	0.00033	0.0025	0.009	0.017	0.0041		0.007			0.2	0.44
G8150127	26-Nov-92	0.00015	0.0016	0.0036	0.0045	0.0025		0.0046			0.091	0.42
G8150127	26-Nov-92	0.00078	0.0031	0.0059	0.015	0.0025		0.0076			0.082	0.14
G8150127	26-Nov-92	0.00023	0.0019	0.0028	0.0058	0.0015		0.0059			0.024	0.11
G8150127	27-Nov-92											0.004
G8150127	27-Nov-92										0.001	0.078
G8150127	27-Nov-92	0.00029	0.0012	0.0016	0.0046	0.0007		0.0022			0.001	0.093
G8150127	04-Dec-92	0.0061		0.018	0.029	0.0027		0.002			0.12	
G8150127	23-Dec-92	0.012	0.0087	0.015	0.025	0.014		0.012			0.18	1.2
G8150127	23-Dec-92	0.00066	0.0037	0.0068	0.046	0.0049		0.0037			0.097	0.87
G8150127	23-Dec-92	0.0061	0.0032	0.0057	0.033	0.0026		0.005			0.056	0.6
G8150127	23-Dec-92	0.027	0.0026	0.0035	0.021	0.0019		0.0039			0.047	0.47
G8150127	07-Jan-93	0.001	0.0007	0.0014	0.0054	0.0004		0.0013				
G8150127	27-Jan-93	0.0018	0.0031	0.0037	0.012	0.003		0.0034				
G8150127	06-Mar-93	0.0016	0.0092	0.018	0.08	0.0088		0.0092			0.006	0.064
G8150127	06-Mar-93	0.0012	0.0037	0.0068	0.031	0.002		0.0062			0.004	0.13
G8150127	06-Mar-93	0.00086	0.0033	0.012	0.033	0.0023		0.009			0.004	0.12
G8150127	07-Apr-93	0.00026	0.0009	0.002	0.0096	0.0003		0.0006				
G8150127	11-May-93	0.00006	0.0004	0.0013	0.006	0.0003		0.0005				
G8150127	16-Jun-93	0.00041	0.001	0.0013	0.01	0.0004		0.0007				
G8150127	30-Aug-93	0.00004	0.0012	0.0008	0.0035	0.0005		0.0005				
G8150127	06-Oct-93	0.0003	0.0015	0.0036	0.0031	0.0008		0.0006				
G8150127	21-Jun-01	0.00005	0.0005	0.0005	0.0028	0.0005	0.0064	0.0005	0.067	0.0005		
G8150127	21-May-02	0.00005	0.00025	0.0001	0.003	0.0002	0.011	0.0004	0.016	0.00025		
G8150127	05-Jun-03	0.00005	0.00025	0.0003	0.002	0.0006	0.0059	0.0008	0.12	0.00025		
G8155180	26-Nov-92										0.025	
G8155180	26-Nov-92	0.0004	0.0013	0.0042	0.004	0.0013		0.0029				0.28
G8155180	26-Nov-92	0.00012	0.0019	0.0025	0.0053	0.0013		0.0027				0.011
G8155180	27-Nov-92										0.001	
G8155180	27-Nov-92										0.001	
G8155180	27-Nov-92	0.00015	0.0014	0.0017	0.0047	0.0004		0.0019				0.031
G8155180	07-Jan-93	0.00085	0.0012	0.0011	0.0053	0.0007		0.0019				
G8155180	27-Jan-93	0.0034	0.0036	0.0022	0.014	0.0007		0.0087				
G8155180	07-Apr-93	0.0001	0.0008	0.0019	0.0053	0.0003		0.0007				
G8155180	11-May-93	0.00007	0.0009	0.0011	0.0096	0.0003		0.0005				
G8155180	16-Jun-93	0.00031	0.0016	0.0014	0.01	0.0004		0.0008				
G8155182	12-Sep-95								0.022			
G8155183	06-Dec-92	0.041	0.041	0.0068	0.061	0.0047		0.013			0.073	1.7
G8155183	23-Dec-92	0.0041	0.018	0.035	0.038	0.054		0.049			0.02	2.3
G8155183	23-Dec-92	0.00047	0.029	0.034	0.035	0.078		0.072			0.019	2.3
G8155183	23-Dec-92	0.0006	0.02	0.034	0.025	0.063		0.075			0.019	2.1
G8155183	23-Dec-92	0.00016	0.011	0.07	0.012	0.027		0.025			0.011	2.2
G8155183	23-Dec-92	0.00076	0.0095	0.0067	0.033	0.014		0.01			0.12	2
G8155183	23-Dec-92	0.0025	0.0067	0.0098	0.027	0.009		0.0086			0.11	1.7
G8155183	23-Dec-92	0.00035	0.0075	0.0028	0.015	0.0068		0.0051			0.097	1.7
G8155183	23-Dec-92	0.0011	0.0055		0.017	0.0044	0.0035	0.0035			0.074	1.8
G8155183	06-Mar-93	0.0038	0.056	0.15	0.15	0.13		0.1			0.022	1.4
G8155183	06-Mar-93	0.0013	0.017	0.052	0.084	0.072		0.089			0.015	0.96
G8155183	06-Mar-93	0.001	0.0086	0.0083	0.028	0.018		0.02			0.015	0.88
G8155183	06-Mar-93	0.00076	0.0071	0.0096	0.015	0.011		0.013			0.011	0.85
G8155183	06-Mar-93	0.00043	0.0029	0.0075	0.0091	0.0022		0.0043			0.009	0.73

*** All units mg/L**

Site	Date	Silica (mg/L SiO_2)	EC lab (µS/cm)	pH lab	Total alkalinity (mg/L $CaCO_3$)	Bicarbonate (mg/L HCO_3)	Hardness total (mg/L $CaCO_3$)	Total Dissolved Solids (mg/L)
G8150127	03-May-68		57		10	6	10	
G8150127	16-Jul-75		35	6	5	6	4	
G8150127	31-Jul-75		290	6	5	6	2	
G8150127	24-Feb-76		29	5.9	3	4	2	
G8150127	09-Mar-76		28	5.8	5	6	2	
G8150127	23-Mar-76		32	6	7	8	4	
G8150127	30-Mar-76		21	5.96	2	1	10	
G8150127	13-Apr-76		35	6.3	5	6	4	
G8150127	07-Mar-77		33	5.9	12	12	10	
G8150127	16-Mar-77		12	6.4				7.6
G8150127	17-Mar-77		17	6.4				11
G8150127	02-Dec-77		48	6.4	12	15	10	
G8150127	28-Jul-81	9	33	6.1	6	8	5	27
G8150127	28-Sep-81	3	27	5.9	10	12	12	23
G8150127	10-Nov-81	10	24	5.8	5	6	1	25
G8150127	09-Dec-81	10	35	6.2	6	7	2	35
G8150127	20-Jan-82	8	25	5.9	5	6	4	25
G8150127	22-Feb-82	8	25	6	2	3	1	20
G8150127	19-May-82	8	30	5.9	5	6	2	30
G8150127	20-Jul-82	7	23	6.1	10	12	3	21
G8150127	18-Aug-82	9	44	4.7	2	3	3	26
G8150127	05-Oct-82	9	58	6.4	6	7	3	25
G8150127	30-Nov-82	8	15	6.1	6	7	3	35
G8150127	12-Jan-83	7	26	6	3	4	9	24
G8150127	14-Feb-83	8	22	5.9	5	6	3	24
G8150127	29-Mar-83	6	50	6.5	20	25	3	40
G8150127	31-May-83	8	21	6.3	5	6	3	18
G8150127	16-Nov-83		23					15
G8150127	16-Nov-83							30
G8150127	31-Jan-84	6	20	5.8	2	2	1	15
G8150127	15-Mar-84							35
G8150127	28-Oct-92	10	56	6.5	16	20	20	45
G8150127	24-Nov-92	10	45	6.1	11	14	13	30
G8150127	07-Jan-93	10	28	5.1	2	3	7	27
G8150127	27-Jan-93	6	28	6	5	6	7	24
G8150127	01-Mar-93	4	22	6.1	5	6	7	22
G8150127	07-Apr-93	10	28	6.1	4	5	7	27
G8150127	11-May-93	10	29	6.2	5	6	7	28
G8150127	16-Jun-93	10	29	6.1	4	5	7	29
G8150127	30-Aug-93	26	80	7.5	35	43	34	58
G8150127	06-Oct-93	7	40	6.3	10	12	9	33
G8155142	28-Jul-81		25	5.7	2	2	1	23
G8155142	28-Sep-81	2	17	5.7	5	6	7	22
G8155142	10-Nov-81	9	23	5.5	5	6	1	24
G8155142	09-Dec-81	9	25	5.8	4	5	3	34
G8155142	20-Jan-82	8	30	6.4	7	9	6	35
G8155142	22-Apr-82	8	25	6	4	5	2	25
G8155142	19-May-82	8	30	6	8	10	6	15
G8155142	20-Jul-82	7	22	5.4	5	6	3	20
G8155142	18-Aug-82	8	21	6.3	2	3	1	21
G8155142	05-Oct-82	8	39	6.2	11	13	8	31
G8155142	30-Nov-82	8	12	6	4	6	2	20
G8155142	12-Jan-83	7	24	5.8	3	4	6	18
G8155142	14-Feb-83	8	31	6.2	11	14	12	26
G8155142	29-Mar-83	7	14	6	5	6	3	23
G8155142	31-May-83	8	18	5.6	3	4	3	12
G8155142	16-Nov-83		24					15
G8155142	16-Nov-83							20
G8155142	31-Jan-84	6	22	6.1	3	4	3	17
G8155142	15-Mar-84							40
G8155143	28-Sep-81	1	11	5.7	5	6	1	12
G8155143	09-Dec-81	8	20	6.3	4	5	1	25
G8155143	20-Jan-82	8	20	6.1	5	6	2	30
G8155143	12-Jan-83	7	42	6.4	17	21	10	33
G8155143	22-Feb-82	7	20	5.8	4	5	1	20

Site	Date	Silica (mg/L SiO_2)	EC lab (µS/cm)	pH lab	Total alkalinity (mg/L $CaCO_3$)	Bicarbonate (mg/L HCO_3)	Hardness total (mg/L $CaCO_3$)	Total Dissolved Solids (mg/L)
G8155143	14-Feb-83	8	21	6	6	7	3	21
G8155143	21-Mar-83	7	18	5.9	3	4	3	13
G8155143	31-May-83	7	22	5.9	1	1	1	13
G8155143	31-Jan-84	6	20	6.1	3	4	1	16
G8155143	15-Mar-84		25					
G8155180	07-Jan-93	10	28	5.2	2	3	4	26
G8155180	27-Jan-93	8	19	5.9	3	4	2	19
G8155180	01-Mar-93	8	22	6.2	3	4	7	26
G8155180	07-Apr-93	9	28	6	4	5	2	27
G8155180	11-May-93	9	31	5.8	4	5	2	34
G8155180	16-Jun-93	8	32	5.2	2	3	4	26
G8155182	12-Sep-95		34		3.1	3.8		

Appendix D.

Waterwatch Monitoring Data 1995-1999

TABLE 1 RAPID CREEK SITE CODES & DESCRIPTION

Site Code	Site Name	Latitude	Longitude	Site Description
RAP010	Marrara Swamp	12 24 79 S	130 54 64 E	Headwaters - Marrara Swamp
RAP020	RAAF 1	12 25 08 S	130 54 17 E	Southern Arm - Marrara Swamp
RAP030	RAAF 2	12 25 51 S	130 53 17 E	Northern Arm - B/hind Caravan Pks
RAP040	RAAF 3	12 24 55 S	130 53 60 E	Southern Arm - Road Crossing
RAP050	RAAF 4	12 25 48 S	130 53 52 E	Northern Arm - Northlakes G.C.
RAP060	Mitigation Wall	12 23 36 S	130 52 00 E	B/h Marrara Sports Complex
RAP070	Airport 1	12 24 36 S	130 52 70 E	U/stream Yankee Pools
RAP080	Airport 2	12 23 93 S	130 50 38 E	D/stream FAC Charles Eaton Dr. Drain
RAP090	Kimmorley Bridge	12 23 83 S	130 52 27 E	U/stream Kimmorley Bridge
RAP100	PAWA 1	12 23 65 S	130 52 11 E	WRD Gauging Station
RAP110	Foot bridge	12 24 37 S	130 52 82 E	Red Foot Bridge
RAP120	PAWA 2	12 22 94 S	130 52 82 E	PAWA Sub Station
RAP130	NT University	12 22 85 S	130 51 75 E	D/stream Casuarina Drain
RAP140	RC Mouth	12 22 68 S	130 51 58 E	In Front of large Banyan Tree

APPENDIX A

TABLE A1		WATER	QUALITY,	RAPID	CREEK	NT		
			SITE	RAP010				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
07-Feb-95	6.3	*	29.0	5.0	65	0.78	0.000	<10
14-Feb-95	6.0	42.0	28.0	4.0	49	0.08	0.000	<10
22-Feb-95	6.0	27.5	30.0	6.0	80	0.10	0.000	<10
13-Mar-96	5.5	*	30.0	8.0	100	0.00	0.000	<10
20-Mar-96	5.0	*	31.0	8.0	110	0.20	0.000	<10
27-Mar-96	5.5	*	35.0	8.0	120	0.00	0.000	<10
03-Apr-96	6.0	25.0	30.0	6.0	80	0.03	0.000	<10
01-Jan-97	5.0	28.0	30.0	4.0	55	0.02	0.003	<10
11-Feb-97	5.5	40.0	28.0	4.0	50	0.16	0.089	<10
03-Mar-97	5.5	40.0	27.0	3.0	40	0.12	0.012	<25
07-Apr-97	6.5	29.2	30.0	3.0	37	0.00	0.000	<10
n	11	7	11	11	11	11	11	11
Max.	6.5	42.0	35.0	8.0	120	0.78	0.089	<25
Min.	5.0	25.0	27.0	3.0	37	0.00	0.000	<10
Wet Median	**5.5**	**29.2**	**30.0**	**5.0**	**65**	**0.08**	**0.000**	**<10**
Mean	5.7	33.1	29.8	5.4	71	0.14	0.009	<12
Std. Dev.	0.5	7.2	2.1	2.0	28.7	0.22	0.027	

TABLE A2		WATER	QUALITY,	RAPID	CREEK	NT		
			SITE	RAP030	(mg/L)			
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
23-May-95	6.2	20.0	29.0	6.0	79	0.10	0.021	<10
22-Dec-95	6.2	20.0	25.2	5.0	60	0.00	0.500	<35
07-Nov-96	7.2	*	25.3	8.5	100	0.08	0.300	<35
10-Dec-96	*	*	25.6	7.2	85	0.09	*	<5
04-Feb-97	*	*	32.7	9.6	120	0.00	0.300	<10
03-Apr-97	*	*	31.7	9.5	120	0.03	0.030	<10
n	3	2	6	6	6	6	5	6
Max.	7.2	20.0	32.7	9.6	120	0.10	0.500	<35
Min.	6.2	20.0	25.2	5.0	60	0.00	0.021	<5
Wet Median	**6.2**	**20.0**	**27.3**	**7.9**	**93**	**0.06**	**0.300**	**<10**
Mean	6.5	20.0	28.3	7.6	94	0.05	0.230	<18
Std. dev.	0.6	0.0	3.4	1.9	24	0.05	0.204	

TABLE A3		WATER	QUALITY, RAPID	CREEK	NT			
			SITE	RAP040				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
23-Nov-95	6.3	50	34.5	8.0	110	0.50	0.000	<10
08-Dec-95	6.4	60	34.5	11.0	150	1.00	0.300	<10
22-Dec-95	6.7	40	27.5	7.5	90	0.00	0.500	<18
22-Jan-96	6.4	100	30.4	8.4	110	2.00	0.000	<13
07-Nov-96	6.8	*	29.0	8.0	100	0.02	0.000	<30
21-Nov-96	*	*	26.3	5.5	60	0.01	*	<20
10-Dec-96	*	*	25.4	5.9	70	0.02	*	<10
06-Feb-97	*	*	29.9	7.0	90	0.00	0.500	<10
03-Apr-97	*	*	30.8	7.7	95	0.04	0.130	<10
n	5	4	9	9	9	9	7	9
Max.	6.8	100.0	34.5	11	150	2.00	0.500	<30
Min.	6.4	40.0	25.4	5.5	70	0.00	0.000	<10
Wet Median	**6.4**	**55.0**	**29.9**	**7.7**	**95**	**0.02**	**0.130**	**<10**
Mean	6.5	62.5	29.8	7.7	97	0.40	0.204	<15
Std. dev.	0.2	26.3	3.2	1.6	26	0.69	0.229	

TABLE A4		WATER	QUALITY, RAPID	CREEK	NT			
			SITE	RAP050				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
21-Dec-95	6.2	30.0	27.4	8.6	110	0.20	0.200	<10
07-Nov-96	7.0	*	24.4	8.0	100	0.10	0.000	<30
21-Nov-96	*	*	26.9	6.5	80	0.05	*	<10
10-Dec-96	*	*	26.3	5.9	75	0.04	*	<5
04-Feb-97	*	*	32.0	8.0	110	0.00	0.300	<10
03-Apr-97	*	*	32.1	7.1	98	0.01	0.030	<10
n	2	1	6	6	6	6	4	6
Max.	7.0	30.0	32.1	8.6	110	0.20	0.300	<30
Min	6.2	30.0	24.4	5.9	75	0.00	0.000	<5
Wet Median	**6.6**	**30.0**	**27.2**	**7.6**	**99**	**0.05**	**0.115**	**<10**
Mean	6.6	30.0	28.2	7.4	96	0.07	0.133	<13
Std. Dev	0.6	*	3.2	1.0	15	0.07	0.142	

TABLE A5 WATER QUALITY, RAPID CREEK NT

SITE RAP060

DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
01-Jun-95	5.0	30.0	26.0	5.0	62	0.08	0.022	<10
15-Jun-95	6.0	34.0	26.0	6.0	75	0.20	0.000	<10
20-Jun-95	5.5	30.0	21.0	6.0	70	0.00	0.130	<10
22-Aug-95	6.2	49.0	27.0	5.0	68	0.00	0.000	<10
04-Oct-95	5.7	50.0	27.0	1.6	21	0.08	0.000	<11
05-Dec-95	4.9	54.3	30.0	6.0	80	0.03	0.000	<10
12-Dec-95	4.9	42.0	29.0	8.0	101	0.12	0.000	<10
16-Jan-96	5.5	34.0	32.0	5.0	68	0.16	0.000	<9
22-Jan-96	9.0	30.0	32.0	8.0	110	0.03	0.240	*
07-Feb-96	5.8	30.0	30.0	6.0	89	0.04	0.000	<10
01-Apr-96	6.3	28.9	29.0	9.0	100	0.00	0.000	<10
19-Apr-96	6.0	80.0	27.0	14.0	100	0.06	0.021	<10
30-Apr-96	7.0	41.0	26.0	8.0	100	*	0.000	<10
12-May-96	4.0	*	27.0	6.0	80	1.06	*	*
11-Jun-96	5.0	*	23.0	5.0	57	0.00	0.003	<10
25-Jun-96	5.5	46.0	25.0	5.0	60	0.00	0.006	<10
20-Jul-96	5.0	43.0	25.0	5.0	60	0.10	0.000	<10
18-Aug-96	4.5	84.0	26.0	7.0	85	0.00	0.000	<10
30-Sep-96	5.5	44.4	28.0	7.0	93	0.00	0.047	<10
15-Oct-96	5.0	47.0	29.0	7.0	90	0.00	0.000	<55
07-Nov-96	7.1	*	30.0	9.0	120	0.30	0.000	<30
20-Nov-96	5.0	54.1	30.0	6.0	80	0.03	0.000	<10
17-Dec-96	5.0	90.0	29.0	5.0	60	0.12	0.021	<10
20-Jan-97	5.0	40.0	29.0	5.0	70	0.16	0.012	<10
17-Mar-97	6.0	40.0	28.0	5.0	62	0.03	0.004	<10
09-Apr-97	6.5	40.0	31.0	6.0	80	0.12	0.043	<10
12-May-97	6.0	40.0	26.0	4.0	45	0.14	0.000	<10
15-Jun-97	6.5	112.0	22.0	5.0	60	0.04	0.003	<10
21-Jul-97	5.5	46.0	23.0	4.0	55	0.06	0.009	<10
02-Oct-97	6.0	63.1	*	*	*	0.20	0.000	<10
05-Nov-97	6.0	98.7	28.5	5.0	60	0.06	0.000	<5
n	31	28	30	30	30	30	30	29
Max	9.0	112.0	32.0	14.0	120	1.06	0.240	<55
Min	4.0	28.9	21.0	4.0	21	0.00	0.000	<5
Wet Median	**5.6**	**47**	**29.0**	**6.0**	**80**	**0.07**	**0.000**	**<10**
Dry Median	**5.5**	**43**	**26.0**	**6.0**	**70**	**0.05**	**0.000**	**<10**
Mean	5.7	50.8	27.4	6.1	75	0.11	0.019	<13
Std. Dev.	0.9	22.2	2.8	2.2	21	0.19	0.049	

TABLE A6		WATER	QUALITY,	RAPID	CREEK	NT		
			SITE	RAP070				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
02-Feb-95	5.2	180.0	30.0	7.0	91	*	*	<10
07-Feb-95	6.0	44.0	28.0	7.0	90	1.20	0.420	<10
14-Feb-95	5.9	268.0	29.0	6.0	80	0.10	0.090	<10
22-Feb-95	6.3	27.1	29.0	6.0	80	0.07	0.000	<10
06-Jun-95	4.5	280.0	26.0	7.0	90	0.00	0.090	<10
20-Sep-95	5.5	43.0	29.0	5.0	70	0.18	0.000	<10
07-Feb-96	5.6	30.0	30.0	5.0	70	0.10	0.000	<10
10-Apr-96	6.0	31.7	27.0	6.0	78	0.22	0.000	<10
27-May-96	5.0	*	25.0	5.0	60	0.28	0.006	<10
24-Jun-96	5.0	42.0	25.0	6.0	70	0.20	0.000	<10
22-Jul-96	5.5	47.0	25.0	5.0	60	0.00	0.003	<10
13-Aug-96	5.5	50.0	26.0	6.0	80	0.06	0.043	<10
19-Sep-96	5.0	50.0	25.0	7.0	85	0.14	0.021	<25
06-Dec-96	6.0	30.0	30.0	5.0	60	0.25	0.003	<10
17-Dec-96	6.5	111.0	28.0	6.0	77	0.18	0.012	<10
17-Mar-97	7.0	40.0	28.0	5.0	65	0.06	0.021	<10
12-May-97	6.0	40.0	26.0	5.0	60	0.20	0.000	<10
07-Jun-97	6.5	73.0	22.0	5.0	60	0.18	0.000	<10
21-Jul-97	6.0	30.0	24.0	4.0	45	0.03	0.009	<10
05-Nov-97	6.0	77.8	28.5	2.0	22	0.00	0.000	<15
n	20	19	20	20	20	19	19	20
Max.	7.0	280.0	30.0	7.0	91	1.20	0.420	<25
Min.	4.5	27.1	22.0	2.0	22	0.00	0.000	<10
Wet Median	**6**	**44**	**29.0**	**6.0**	**77**	**0.10**	**0.008**	**<10**
Dry Median	**5.5**	**45**	**25.0**	**5.0**	**70**	**0.18**	**0.003**	**<10**
Mean	5.8	78.7	27.0	5.5	70	0.18	0.038	<12
Std.Dev.	0.6	77.9	2.3	1.2	17	0.26	0.097	

TABLE A7 WATER QUALITY, RAPID CREEK NT

SITE RAP080

DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
01-Apr-95	5.8	*	29.0	6.0	79	0	0	<10
02-May-95	6.0	*	27.0	*	*	0	0	<10
23-May-95	5.5	*	23.0	6.0	70	*	*	>10
18-Jun-95	6.4	35.0	24.0	7.0	82	0.24	0	<10
22-Aug-95	5.0	30.0	26.0	6.0	70	0.28	0	<10
05-Sep-95	6.1	29.0	30.0	7.0	90	0.14	0.003	<10
04-Oct-95	5.5	39.0	27.0	3.1	35	0.06	0	<10
16-Jan-96	6.6	*	31.0	5.0	67	0.02	0.006	<10
10-Apr	7.1	34.7	26.0	9.0	110	0	0.003	<10
27-May-96	6.0	37.0	25.0	7.0	80	0.1	0	<10
18-Jun-96	6.0	37.0	24.0	7.0	90	0.18	0.003	<10
25-Jul-96	5.5	43.0	35.0	7.0	85	0.12	0	<10
12-Aug-96	5.0	60.0	24.0	7.0	98	0.14	0.04	<20
24-Sep-96	5.0	*	26.0	6.0	85	0.16	0	<10
28-Sep-96	*	*	26.5	6.0	70	0.16	0	<10
26-Oct-96	5.5	40.0	28.0	7.0	95	0.00	0	<10
16-Nov-96	6.0	30.0	28.0	8.0	101	0.03	0.006	<10
12-Dec-96	6.5	43.2	29.0	6.0	80	0.00	0.012	<10
21-Jan-97	6.5	37.1	31.0	5.0	60	0.18	0.012	<10
22-Feb-97	5.5	20.0	26.0	7.0	88	0.00	0.051	<15
16-Jun-97	6.0	40.0	23.0	6.0	75	0.07	0.032	<10
21-Jul-97	5.5	30.0	23.0	6.0	70	0.00	0.003	<10
02-Oct-97	6.0	54.7	*	*	*	0.06	0.000	<10
n	22	17	22	21	21	22	22	23
Max.	7.1	60.0	35.0	9.0	110	0.28	0.051	<20
Min.	5.0	20.0	23.0	3.1	35	0.00	0.000	<10
Wet Median	**6.0**	**39.0**	**28.0**	**6.0**	**80**	**0.03**	**0.006**	**<10**
DryMedian	**5.9**	**36.0**	**26.0**	**6.5**	**81**	**0.13**	**0.000**	**<10**
Mean	5.9	37.6	26.9	6.4	80	0.09	0.008	<11
Std. Dev.	0.6	9.5	3.1	1.2	16	0.09	0.014	

TABLE A8		WATER	QUALITY, RAPID		CREEK	NT		
			SITE	RAP090				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
05-Sep-95	6.1	30.0	28.0	6.0	80	0.26	0.220	<10
19-Sep-95	4.8	30.0	27.0	5.0	64	0.00	0.047	<10
26-Sep-95	6.2	64.0	29.0	5.0	68	0.00	0.750	<75
04-Oct-95	5.4	50.0	27.0	1.8	24	0.18	0.003	<20
10-Oct-95	5.0	17.0	28.0	5.0	65	0.06	0.000	<10
17-Oct-95	6.7	35.0	28.0	5.0	65	0.06	0.000	<13
31-Oct-95	5.5	*	28.0	3.0	40	0.10	0.003	<31
28-Nov-95	7.7	115.0	29.0	5.0	65	0.34	0.006	<10
05-Dec-95	6.9	49.7	30.0	9.0	120	0.32	0.000	<10
18-Dec-95	5.6	38.8	29.0	7.0	90	0.06	0.000	<10
16-Jan-96	6.6	*	31.0	6.0	80	0.12	0.000	<10
09-Apr-96	5.5	40.0	28.0	6.0	70	0.00	0.000	<10
26-Apr-96	5.0	*	26.0	7.0	90	0.00	0.000	<10
14-May-96	5.0	*	27.0	8.0	100	0.06	*	<10
21-May-96	6.0	39.0	23.0	5.0	60	0.26	0.000	<10
04-Jun-96	6.0	20.0	25.0	8.0	100	0.02	0.006	<10
30-Jul-96	5.0	40.0	24.0	8.0	88	0.00	0.000	<15
27-Aug-96	6.0	25.0	24.5	8.0	100	0.00	0.000	<10
12-Sep-96	5.0	23.0	26.0	5.0	60	0.00	0.000	<10
08-Oct-96	6.5	40.0	29.0	4.0	65	0.00	0.000	<10
02-Nov-96	6.0	36.5	29.0	7.0	98	0.03	0.003	<10
17-Dec-96	6.0	34.0	29.0	7.0	90	0.08	0.000	<10
31-Jan-97	6.0	33.1	28.8	7.0	85	0.02	0.051	<10
19-Feb-97	6.0	29.0	28.0	6.0	76	0.10	0.021	<10
17-Mar-97	6.0	30.0	28.0	5.0	60	0.06	0.012	<10
09-Apr-97	5.5	60.0	28.0	7.0	85	0.06	0.003	<10
07-May-97	*	40.0	26.0	6.0	75	0.30	0.000	<300
12-May-97	6.0	30.0	26.0	7.0	85	2.92	0.000	<10
16-Jun-97	6.0	40.0	24.0	6.0	70	0.08	0.059	<10
21-Jul-97	4.5	96.0	23.0	6.0	70	0.00	0.000	<10
05-Nov-97	7.0	56.6	27.5	3.0	35	0.08	0.000	<16
n	30	27	31	31	31	31	30	31
Max.	7.7	115.0	31.0	9.0	120	2.92	0.750	<300
Min.	4.5	17.0	23.0	1.8	24	0.00	0.000	<10
Wet median	**6.0**	**36.5**	**28.8**	**5.0**	**65**	**0.08**	**0.000**	**<10**
Dry Median	**5.5**	**39.5**	**26.0**	**6.0**	**78**	**0.01**	**0.000**	**<10**
Mean	5.9	42.3	27.2	5.9	75	0.18	0.039	<12
Std. Dev.	2.0	12.9	8.7	2.2	33	1.53	1.018	

TABLE A9 WATER QUALITY, RAPID CREEK NT

SITE RAP100

DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
23-Apr-95	6.1	97.1	28.0	7.0	90	0.04	0.000	<10
28-May-95	6.5	20.0	24.0	7.0	82	0.00	0.012	<10
23-Jul-95	7.9	30.0	25.0	6.0	78	0.00	0.000	<10
10-Sep-95	7.4	30.0	27.0	5.0	61	0.02	0.000	<10
26-Sep-95	5.8	46.6	27.0	6.0	50	0.04	0.055	<16
04-Oct-95	5.9	48.0	28.0	1.6	18	0.08	0.000	<17
04-Nov-95	7.6	36.9	29.0	2.0	27	0.08	0.000	<25
03-Dec-95	6.4	59.8	29.0	5.0	60	0.06	0.000	<10
18-Dec-95	5.6	40.5	30.0	7.0	95	0.00	0.003	<10
14-Jan-96	7.6	*	29.0	9.0	115	1.77	0.012	<10
07-Apr-96	7.6	24.0	29.0	5.0	65	0.00	0.000	<10
10-May-96	6.0	45.0	26.0	9.0	115	0.03	0.003	<10
12-May-96	5.5	113.0	27.2	5.0	65	0.00	0.063	<10
24-Jun-96	5.5	37.0	26.0	7.0	85	0.04	0.000	<10
02-Jul-96	7.0	164.0	25.0	7.0	80	0.14	0.000	<10
21-Aug-96	5.5	43.0	24.0	5.0	60	0.03	0.000	<10
15-Sep-96	5.0	32.8	26.0	2.0	40	0.00	0.000	<25
20-Oct-96	6.0	38.9	28.0	6.0	80	0.00	0.000	<10
18-Dec-96	6.0	34.0	29.0	6.0	80	0.00	0.015	<10
15-Jan-97	6.5	31.7	30.0	6.0	80	0.06	0.051	<10
19-Feb-97	6.0	29.6	28.0	6.0	78	0.06	0.024	<10
07-Apr-97	6.5	31.8	30.0	6.0	80	0.14	0.000	<10
20-Apr-97	6.0	30.0	28.0	5.0	60	*	0.000	<20
18-May-97	6.0	28.5	26.5	8.0	100	0.07	1.000	<10
16-Jun-97	6.0	40.0	23.0	6.0	75	0.04	0.180	<10
21-Jul-97	5.5	97.0	23.0	5.0	55	0.12	0.012	<10
13-Aug-97	6.5	40.0	23.5	5.0	60	0.40	0.000	<10
10-Sep-97	5.5	43.3	26.0	3.5	40	0.36	0.000	<14
02-Oct-97	5.5	302.0	*	*	*	0.00	0.000	<20
20-Nov-97	6.0	49.1	29.5	4.0	55	0.00	0.003	<20
n	30	29	29	29	29	29	30	30
Max.	5.0	20.0	30.0	9.0	115	1.77	0.180	<25
Min.	7.9	302.0	23.0	1.6	18	0.00	0.000	<10
Wet Median	**6**	**40.0**	**27.5**	**6**	**76**	**0.06**	**0.030**	**<10**
Dry Median	**6**	**40.0**	**26.0**	**6**	**65**	**0.04**	**0.000**	**<10**
Mean	6.2	57.4	27.0	5.6	70	0.12	0.048	<13
Std. Dev	0.8	56.4	2.2	1.8	22.9	0.3	0.2	

TABLE A10		WATER	QUALITY,	RAPID	CREEK	NT		
			SITE	RAP110				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
27-Apr-95	6.5	30.0	24.0	8.0	98	0.040	0.000	<10
11-May-95	6.0	30.0	26.5	7.0	90	0.000	0.006	<10
25-May-95	6.0	30.0	26.5	6.0	78	0.080	0.003	<10
08-Jun-95	6.0	40.0	26.0	10.5	125	0.000	0.000	<10
15-Jun-95	6.5	3540.0	26.0	6.0	78	0.100	0.006	<10
06-Jul-95	5.5	45.0	23.0	9.0	105	0.000	0.000	<10
09-Aug-95	7.8	53.0	24.0	8.0	99	0.000	0.000	<10
12-Aug-95	8.0	*	26.0	8.0	100	0.000	0.000	<10
28-Sep-95	9.3	38.0	34.0	9.0	130	0.120	0.003	<25
18-Dec-95	5.8	137.2	30.0	7.0	90	0.160	0.000	<10
19-Feb	5.0	50.0	30.0	5.0	62	0.200	0.000	<10
09-Apr-96	7.4	21.0	28.0	7.0	90	0.000	0.000	<10
18-May-96	6.0	1187.0	25.0	6.5	80	0.000	0.040	<10
24-Jun-96	6.0	80.0	26.0	8.0	100	0.000	0.000	<10
02-Jul-96	6.0	2091.0	25.0	7.0	85	0.000	0.060	<10
20-Jul-96	6.0	53.0	28.0	10.0	125	0.000	0.009	<10
30-Jul-96	*	947.0	25.0	8.0	100	0.000	0.000	<10
18-Aug-96	6.0	110.0	28.8	9.0	110	0.000	0.000	<10
16-Sep-96	6.0	*	31.5	9.0	120	0.000	0.000	<10
10-Oct-96	7.0	21800.0	25.0	5.0	60	0.060	0.018	<10
21-Oct-96	5.0	235.0	27.5	8.0	100	0.000	0.012	<10
16-Nov-96	6.5	819.0	32.0	8.0	105	0.070	0.006	<10
18-Dec-96	6.0	98.0	29.0	6.0	80	0.000	0.036	<10
19-Dec-96	5.5	872.0	29.0	6.0	80	0.180	0.028	<10
14-Jan-97	6.5	43.6	32.0	4.0	55	0.068	0.000	<10
19-Feb-97	6.0	59.0	28.0	6.0	78	0.000	0.021	<10
18-Mar-97	6.5	41.1	31.5	7.0	100	0.070	0.000	<30
20-Apr-97	6.5	43.9	28.0	7.0	90	0.000	0.000	<10
18-May-97	5.5	44.0	28.0	6.0	75	0.000	0.000	<10
16-Jun-97	6.0	30.0	24.0	6.0	70	0.000	0.000	<10
21-Jul-97	6.5	2140.0	22.0	7.0	80	0.000	0.055	<10
02-Oct-97	7.5	20740.0	*	2.0	*	0.040	0.000	<20
n	31	30	31	32	31	32	32	32
Max.	9.3	21800.0	34.0	10.5	130	0.200	0.060	<30
Min.	5.0	21.0	22.0	2.0	55	0.000	0.000	<10
Wet Median	**6.0**	**137.2**	**29.5**	**6.0**	**80**	**0.700**	**0.006**	**<10**
Dry Median	**6.0**	**45.0**	**26.0**	**8.0**	**98**	**0.000**	**0.000**	**<10**
Mean	6.3	1848.3	27.4	7.1	92	0.037	0.009	<12
Std. Dev.	0.9	5344.2	2.9	1.7	19	0.058	0.017	

TABLE A11		WATER	QUALITY,	RAPID	CREEK	NT		
			SITE	RAP120				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
15-Apr-96	5.5	18000.0	29.0	7.0	90	0.26	0.000	<10
28-May-96	6.0	18000.0	27.0	5.0	70	0.16	0.000	<10
18-Jun-96	7.0	*	25.0	4.0	45	0.00	0.000	<15
09-Jul-96	7.0	15600.0	*	5.0	*	0.00	0.000	<32
09-Aug-96	5.0	14129.0	26.0	5.0	60	0.00	0.000	<10
08-Sep-96	6.0	*	23.0	7.0	82	0.00	0.000	<10
05-Oct-96	7.0	1870.0	32.0	8.0	110	0.00	0.006	<20
27-Oct-96	7.5	17000.0	33.0	7.0	95	0.00	0.060	<10
24-Nov-96	7.0	1208.0	30.0	7.0	90	0.00	0.000	<10
27-Jan-97	6.5	*	30.0	5.0	70	0.00	0.051	<25
19-Feb-97	6.5	2740.0	29.0	5.0	65	0.00	0.018	<10
17-Mar-97	6.5	13000.0	29.0	6.0	80	0.06	0.043	<10
28-Apr-97	7.0	11280.0	27.0	7.0	90	0.00	0.018	<10
30-Jun-97	7.5	7930.0	22.0	6.0	75	1.54	0.012	<12
21-Jul-97	8.5	33300.0	24.0	6.0	70	0.00	0.320	<10
02-Oct-97	7.5	33500.0	*	*	*	0.18	0.032	<10
n	16	13	14	15	14	16	16	16
Max.	8.5	33500.0	33.0	8.0	110	1.54	0.320	<32
Min.	5.0	1208.0	22.0	4.0	45	0.00	0.000	<10
Wet Median	**7.0**	**7870.0**	**30.0**	**6.5**	**85**	**0.00**	**0.032**	**<10**
Dry Median	**7.0**	**15600.0**	**25.5**	**6.0**	**73**	**0.00**	**0.000**	**<10**
Mean	6.8	14427.5	27.6	6.0	78	0.14	0.035	<14
Std. Dev.	0.9	10314.8	3.3	1.1	17	0.383	0.079	

TABLE A13		WATER	QUALITY,	RAPID	CREEK	NT		
			SITE	RAP140				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn.	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
31-Oct-95	7.1	40000.0	33.0	3.0	40	0.00	0.000	<10
26-Mar-96	8.0	*	30.0	6.0	80	0.00	0.000	<10
28-Apr-96	7.0	*	31.0	7.0	97	*	0.000	<10
09-May-96	9.0	58000.0	28.0	6.0	80	0.00	0.000	<10
04-Jun-96	7.0	59000.0	26.0	7.0	90	0.00	0.000	<10
01-Jul-96	7.0	55000.0	25.0	7.0	87	0.00	0.000	<10
02-Aug-96	7.0	25000.0	27.0	8.0	100	0.00	0.000	<10
28-Oct-96	*	49800.0	30.0	6.0	80	0.00	0.000	<10
15-Jan-97	7.5	16910.0	31.0	5.0	70	0.00	0.360	<20
11-Feb-97	8.0	40000.0	29.0	5.0	75	0.00	0.018	<30
19-Mar-97	6.5	*	30.0	5.0	65	0.07	0.009	*
07-Apr-97	7.0	29100.0	31.0	6.0	80	0.06	0.006	<10
12-May-97	8.0	*	26.0	5.0	60	0.00	0.000	<15
27-Jun-97	8.5	45000.0	22.0	8.0	90	0.00	0.000	<10
21-Jul-97	8.5	42400.0	23.5	7.0	80	0.00	0.028	<10
02-Oct-97	6.5	34700.0	*	*	*	0.12	0.000	<10
n	15	12	15	15	15	15	16	15
Max.	9.0	59000.0	33.0	8.0	100	0.12	0.360	<30
Min.	6.5	16910.0	22.0	3.0	40	0.00	0.000	<10
Wet Median	**7.3**	**40000.0**	**30.0**	**5.0**	**73**	**0.00**	**0.000**	**<10**
Dry median	**7.0**	**45000.0**	**26.0**	**7.0**	**87**	**0.00**	**0.000**	**<10**
Mean	7.5	41242.5	28.2	6.1	78	0.02	0.026	<13
Std. Dev.	0.8	13223.0	3.1	1.3	15	0.04	0.089	

TABLE A14		WATER	QUALITY,	RAPID	CREEK	NT		
			SITE	RAP130				
DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	NITRATE mg/L	TURB NTU
15-Apr-96	7.0	19850.0	32.0	6.0	90	0.07	0.000	<15
24-Jun-96	7.0	52300.0	27.0	6.0	75	0.03	0.009	<20
09-Jul-96	7.0	54100.0	29.0	5.0	70	0.03	0.018	<12
12-Aug-96	7.0	37500.0	25.0	4.0	50	0.00	0.000	<20
10-Sep-96	8.5	50200.0	29.0	*	*	0.10	0.000	<12
16-Oct-96	8.6	54400.0	29.9	5.5	65	0.10	0.000	<10
31-Oct-96	7.9	40000.0	29.2	5.9	70	3.50	1.500	<13
12-Nov-96	9.3	57000.0	36.4	9.0	120	1.00	0.500	<5
28-Nov-96	8.3	57900.0	34.6	7.8	95	0.50	0.500	<6
n	9	9	9	8	8	9	9	9
Max.	9.3	57900.0	36.5	9.0	120	3.50	1.500	<20
Min.	7.0	19850.0	25.0	4.0	50	0.00	0.000	<5
Wet Median	**8.5**	**55700.0**	**32.3**	**6.9**	**83**	**0.75**	**0.500**	**<10**
Dry Median	**7.0**	**50200.0**	**29.0**	**5.5**	**73**	**0.03**	**0.000**	**<15**
Mean	7.8	47027.8	30.2	6.2	79	0.59	0.281	<13
Std. Dev.	0.9	12443.2	3.6	1.6	22	1.14	0.505	

APPENDIX A

Water Quality Rapid Creek 1998 DRY

SITE RAP060

DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
16-May-98	6.0	43.7	27	5.0	65	0.12	0.000	0
14-Jun-98	6.0	49.0	24	5.0	60	0.12	0.000	0
11-Jul-98	6.0	21.0	23	6.5	75	0.18	0.032	0
15-Aug-98	5.5	26.0	23	5.0	60	0.08	0.000	0
12-Sep-98	6.0	42.0	22	6.0	70	0.24	0.000	0
Max	6	49	27	6.5	75	0.24	0.032	0
Min	5.5	21	22	5	60	0.08	0	0
Dry Median	**6**	**42**	**23**	**5**	**65**	**0.12**	**0**	**0**

SITE RAP090

DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
1-May-98	6.0	30.0	28.0	na	na	0.003	0.006	5
29-May-98	6.0	45.0	27.0	6	80	0.080	0.000	0
3-Jun-98	5.5	43.6	26.0	6	70	0.000	0.024	0
31-Jul-98	4.5	55.0	19.0	8	90	0.200	0.000	0
14-Aug-98	6.0	43.0	27.0	5	60	0.120	0.000	0
28-Aug-98	6.0	45.0	28.0	6	80	0.120	0.000	0
11-Sep-98		52.8	27.5			0.400	0.000	0
Max	6	52.8	28	8	90	0.4	0.024	5
Min	4.5	30	19	5	60	0	0	0
Median	**6**	**45**	**27**	**6**	**80**	**0.12**	**0**	**0**

SITE RAP100

DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
27-May-98	6.5	45	26.0	6	70	0.00	0.000	0
15-Jun-98	6.0	41	27.5	6	75	0.00	0.021	0
8-Jul-98	6.0	34	24.0	5	60	0.00	0.000	0
12-Aug-98	5.5	20	25.0	4	50	0.06	0.000	0
Max	6.5	45	27.5	6	75	0.06	0.021	0
Min	5.5	20	24	4	50	0	0	0
Median	**6**	**37.5**	**25.5**	**5.5**	**65**	**0**	**0**	**0**

SITE RAP110

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
13-May-98	6.0	37	26.0	5	65	0.00	0.000	0
12-Jun-98	5.5	29	24.5	5	60	0.00	0.000	0
13-Jun-98	5.5	28	23.0	5	60	0.10	0.018	0
27-Jul	6.8	22	24.0	5	60	0.00	0.036	0
29-Jul-98	6.7	22	24.5	5	60	0.00	0.000	0
10-Aug-98	7.0	43	24.0	5	65	0.00	0.000	0
12-Aug-98	7.0	22	24.0	5	65	0.00	0.009	0
24-Aug-98	6.0	23	25.0	5	65	0.10	0.060	0
26-Aug-98	6.5	30	24.0	5	65	0.08	0.000	0
3-Sep-98	6.5	119	26.0	5	65	0.06	0.000	0
Max	7	119	26	5	65	0.1	0.06	0
Min	5.5	22	23	5	60	0	0	0
Median	**6.5**	**28.5**	**24.25**	**5**	**65**	**0**	**0**	**0**

SITE RAP120

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
16-May-98	7.5	12200	29	6	80	0.10	0.0180	0
20-Jun-98	7.5	13200	24	7	80	0.08	0.0000	10
18-Jul-98	8.0	18410	24	6	70	0.00	0.0000	0
22-Aug-98	7.5	14690	25	6	70	0.16	0.0360	0
22-Sep-98	8.0	17500	23	6	70	0.08	0.0000	10
Max	8	18410	29	7	80	0.16	0.036	10
Min	7.5	12200	23	6	70	0	0	0
Median	**7.5**	**14690**	**24**	**6**	**70**	**0.08**	**0**	**0**

SITE RAP140

DATE	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
24-May-98	8.0	46210	28	6	80	0.00	0.000	0
15-Jun-98	8.5	42600	25	7	85	0.10	0.000	10
8-Jul-98	8.0	43200	26	7	90	0.00	0.000	10
17-Aug-98	8.0	42100	26	6	80	0.18	0.032	10
7-Sep-98	8.5	46100	24	6	70	0.00	0.000	10
Max	8.5	46210	28	7	90	0.18	0.032	10
Min	8	42100	24	6	70	0	0	0
Median	**8**	**43200**	**26**	**6**	**80**	**0**	**0**	**10**

Water Quality Rapid Creek 1998 WET

Site RAP010

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
15-Jan-98	6.3	20	29.0	7	90	0.06	0	0
13-Feb-98	5.5	35	30.0	6	80	0.20	0	0
12-Mar-98	6	40	29.0	8	100	0.00	0	0
27-Apr	5.5	29	28.5	5	60	0.08	0	0
Max	6.3	40	30.0	8.0	100	0.20	0	0
Min	5.5	20	28.5	5.0	60	0.00	0	0
Median	**5.75**	**32**	**29.0**	**6.5**	**85**	**0.07**	**0**	**0**

SITE RAP030

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
28-Apr-98	6.6	20	32.0			0.17	0.02	0
28-May-98	6.6	20	31.0			0.15	0.04	0
Max	6.6	20	32.0			0.17	0.04	0
Min	6.6	20	31.0			0.15	0.02	0
Median	**6.6**	**20**	**31.5**			**0.16**	**0.03**	**0**

SITE RAP040

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
28-Apr-98	6.8	20	31.5			0.1500	0.020	0
28-May-98	6.8	40	32.0			0.1800	0.030	0
Max	6.8	40	32.0			0.1800	0.030	0
Min	6.8	20	31.5			0.1500	0.020	0
Median	**6.8**	**30**	**31.75**			**0.1650**	**0.025**	**0**

SITE RAP050

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
28-Apr-98	6.6	40	32.5			0.10	0.04	0
28-May-98	6.8	40	32.0			0.14	0.02	0
Max	6.8	40	32.5			0.14	0.04	0
Min	6.6	40	32.0			0.10	0.02	0
Median	**6.7**	**40**	**32.25**			**0.12**	**0.03**	**0**

SITE RAP060

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
6-Jan-98	6	51.0	30.0	6	80	0.00	0.00	0
25-Feb-98	6	49.0	28.0	8	100	0.08	0.00	0
18-Mar-98	6	41.0	28.0	6	80	0.14	0.06	0
13-Apr-98	6	35.6	29.5			0.00	0.006	0
21-Oct-98	6	33.0	28.0	5	65	0.08	0.01	0
14-Nov-98	6	42.0	29.5	6	80	0.05	0.032	0
20-Dec-98	6	51.0	30.0	7	95	0.00	0.000	0
Max	6	51	30	8	100	0.14	0.06	0
Min	6	33	28	5	65	0	0	0
Median	**6**	**42**	**29.5**	**6**	**80**	**0.05**	**0.006**	**0**

SITE RAP070

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
25-Feb-98	6	42	29	7	90	0.12	0	12
13-Apr	6	36	28			0.00	0	0
Max	6	42	29	7	90	0.12	0	12
Min	6	36	28	7	90	0.00	0	0
median	**6**	**39**	**28.5**	**7**	**90**	**0.06**	**0**	**6**

SITE RAP080

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
17-Jan-98	6.0	112.0	29.6	7	80	0.50	0.042	30
14-Feb-98	5.5	153.0	30.0	8	100	0.06	0.051	20
15-Mar-98	6.0	51.0	31.0	7	100	0.12	0.000	0
13-Apr-98	6.0	37.5	26.0			0.00	0.009	0
21-Oct-98	5.5	44.0	27.0	5	65	0.20	0.230	10
14-Nov-98	6.0	51.0	29.0	5	65	0.00	0.000	0
20-Dec-98	6.0	40.0	29.5	6	80	0.20	0.050	0
Max	6	153	31	8	100	0.5	0.23	30
Min	5.5	37.5	26	5	65	0	0	0
Median	**6**	**81.5**	**29.8**	**7**	**100**	**0.09**	**0.0255**	**10**

SITE RAP090

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU

6-Feb-98	6.0	48.0	28	6	70	0.00	0	0
13-Feb-98	5.6	27.0	32	8	110	0.00	0	0
26-Feb-98	6.0	46.0	26	8	70	0.12	0	0
20-Mar-98	5.5	42.3	28	6	68	0.0	0	0
24-Apr-98	7.0	63.0	29	7	80	0.06	0	0
Max	7	63	32	8	110	0.12	0	0
Min	5.5	27	26	6	68	0	0	0
Median	**6**	**46**	**28**	**7**	**70**	**0**	**0**	**0**

SITE RAP100

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
15-Jan-98	6.0	54	30	8	100	0.32	0.050	12
13-Feb-98	6.0	30	29	6	80	0.10	0.180	0
25-Mar-98	6.5	36	29	6	80	0.18	0.000	15
13-Apr-98	6.0	47	28			0.11	0.000	0
29-Apr-98	6.0	36	26	5	60	0.18	0.027	0
Max	6.5	54	30	8	100	0.32	0.18	15
Min	6	30	26	5	60	0.1	0	0
Median	**6**	**36**	**29**	**6**	**80**	**0.18**	**0.027**	**0**

SITE RAP110

Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
10-Jan-98	6.0	129	30	8	105	0.08	0.000	0
7-Feb-98	6.5	44	29	7	95	0.20	0.032	12
23-Mar-98	6.5	33	26	6	75	0.18	0.000	0
24-Apr	5.5	42	25	5	60	0.10	0.000	0
Max	6.5	129	30	8	105	0.2	0.032	12
Min	5.5	33	25	5	60	0.08	0	0
Median	**6.25**	**43**	**27.5**	**6.5**	**85**	**0.14**	**0**	**0**

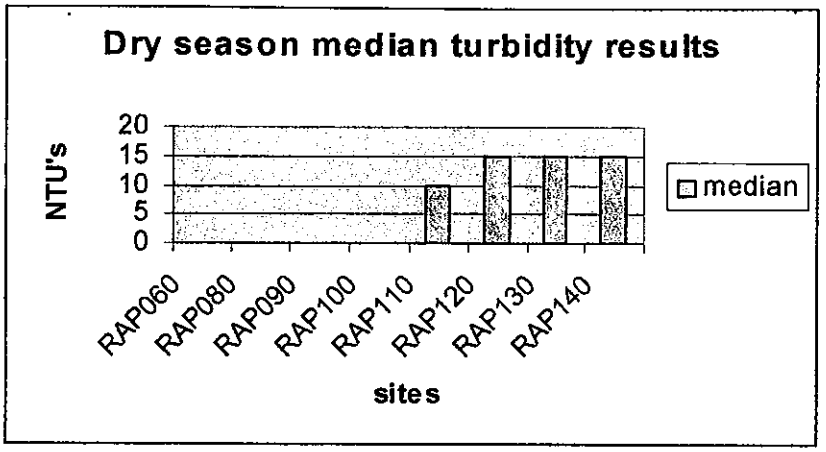
SITE RAP120

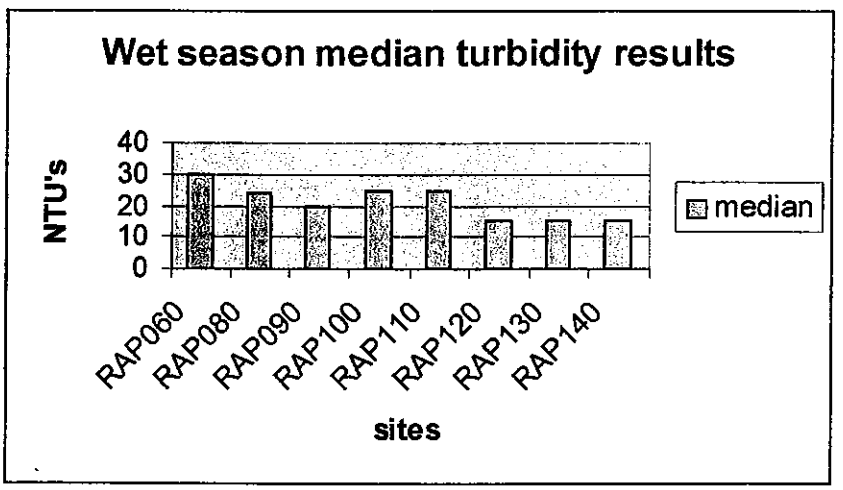
Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % satn	Reactive P (mg/l)	Nitrate mg/L	Turb NTU
18-Jan-98	7.5	13,561	29.0	6	80	0.06	0.000	10
21-Feb-98	8.0	12,500	31.0	6	80	0.00	0.000	0
22-Mar-98	8.0	4,236	29.0	7	95	0.08	0.032	0
24-Apr-98	8.0	12,121	29.5	6	80	0.00	0.000	0
Max	8	13,561	31	7	95	0.08	0.032	10
Min	7.5	4,236	29	6	80	0	0	0
Median	**8**	**12310.5**	**29.25**	**6**	**80**	**0.03**	**0**	**0**

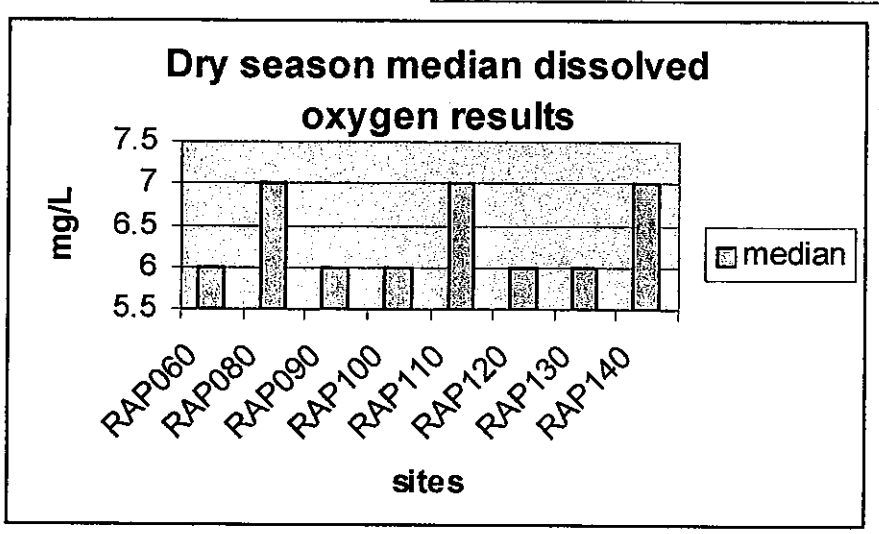
	SITE	RAP130						
Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
No Wet	Season	Data						

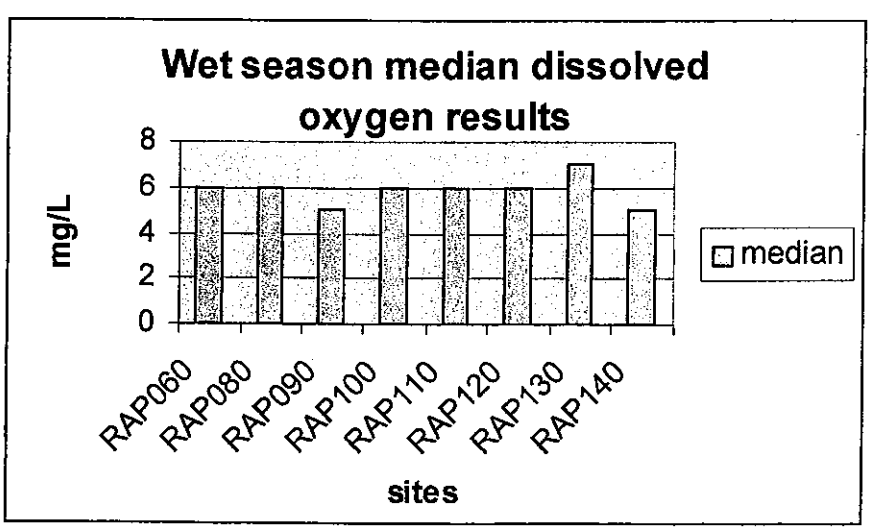
	SITE	RAP140						
Date	pH	EC uS/cm	T oC	Dissolved mg/L	Oxygen % Satn	Reactive P (mg/L)	Nitrate mg/L	Turb NTU
15-Jan-98	8	45,221	31	6	80	0	0.000	10
13-Feb-98	8.5	43,700	31	6	80	0	0.000	0
23-Mar-98	8	45,932	29	7	95	0	0.000	0
13-Apr-98	7.5		32			0	0.032	9
Min	7.5	43,700	29	6	80	0	0	0
Max	8.5	46	32	7	95	0	0.032	10
Median	**8**	**45221**	**31**	**6**	**80**	**0**	**0**	**4.5**

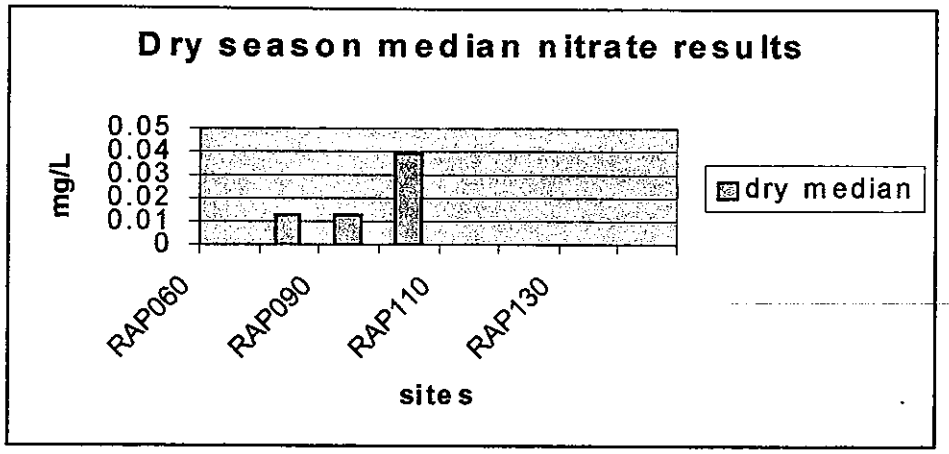
1999 Data

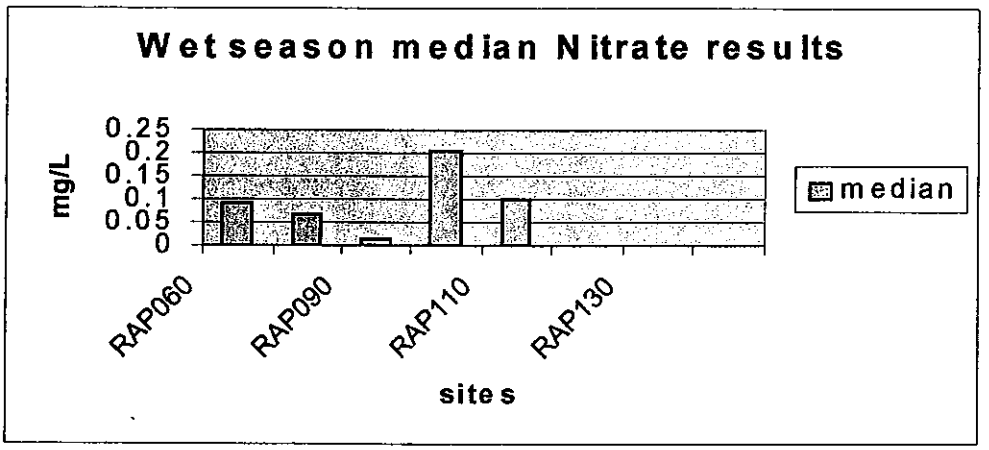

Dry season median turbidity results
NTU's
20
15
10
5
0
median
RAP060
RAP080
RAP090
RAP100
RAP110
RAP120
RAP130
RAP140
sites

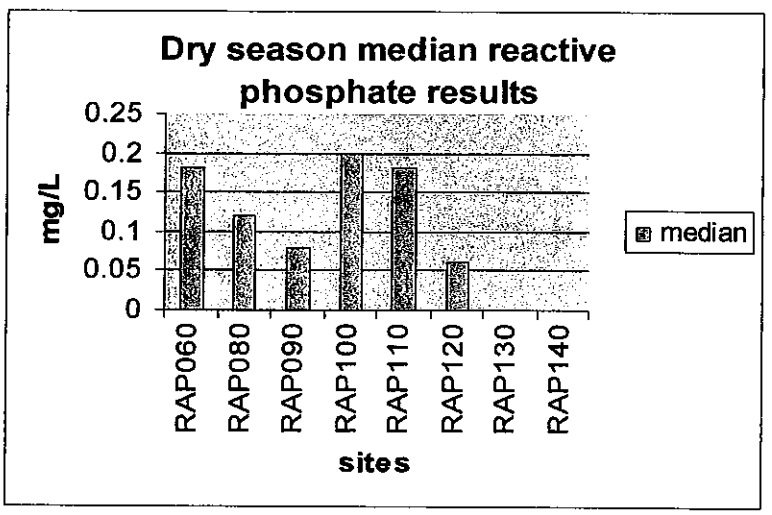

Wet season median turbidity results
NTU's
40
30
20
10
0
median
RAP060
RAP080
RAP090
RAP100
RAP110
RAP120
RAP130
RAP140
sites

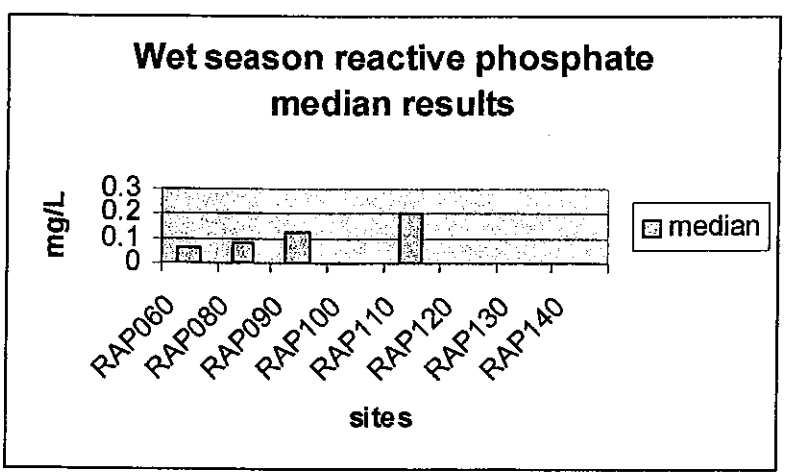

Dry season median dissolved oxygen results
mg/L
7.5
7
6.5
6
5.5
median
RAP060
RAP080
RAP090
RAP100
RAP110
RAP120
RAP130
RAP140
sites


Wet season median dissolved oxygen results
mg/L
8
6
4
2
0
median
RAP060
RAP080
RAP090
RAP100
RAP110
RAP120
RAP130
RAP140
sites


Dry season median nitrate results
mg/L
0.05
0.04
0.03
0.02
0.01
0
RAP060
RAP090
RAP110
RAP130
sites
dry median


Wet season median Nitrate results
mg/L
0.25
0.2
0.15
0.1
0.05
0
RAP060
RAP090
RAP110
RAP130
sites
median


Dry season median reactive phosphate results
mg/L
0.25
0.2
0.15
0.1
0.05
0
RAP060
RAP080
RAP090
RAP100
RAP110
RAP120
RAP130
RAP140
sites
median


Wet season reactive phosphate median results
mg/L
0.3
0.2
0.1
0
RAP060
RAP080
RAP090
RAP100
RAP110
RAP120
RAP130
RAP140
sites
median