



# Mackay Whitsunday Healthy Waterways

## Ambient Monitoring Program Regional Report 2008



# Mackay Whitsunday Healthy Waterways

Ambient Monitoring Program Regional Report 2008

## The ambient monitoring component of the Integrated Monitoring Program

A report written by

**L. Galea<sup>1</sup>**

With contributions from

**D. Peplinkhouse<sup>2</sup>, F. Loft<sup>3</sup> and A. Folkers<sup>4</sup>**

Funding provided by the Mackay Whitsunday Natural Resource Management Group,  
through the Natural Heritage Trust and Coastal Catchments Initiative

<sup>1</sup> Department of Natural Resources and Water

22 – 30 Wood St, Mackay

Queensland, 4740

Phone: (07) 4967 0873

Email: [Luke.Galea@nrw.qld.gov.au](mailto:Luke.Galea@nrw.qld.gov.au)

<sup>2</sup> Whitsunday Catchment Landcare Inc., Proserpine, QLD, 4800

<sup>3</sup> Pioneer Catchment and Landcare Group Inc., Mackay, QLD, 4740

<sup>4</sup> Sarina Landcare Catchment Management Association Inc., Sarina, QLD, 4737



Prepared by:  
Natural Resource Sciences, Mackay  
Department of Natural Resources and Water  
© State of Queensland (Department of Natural Resources and Water) 2008

This document has been prepared with all due diligence and care, based on the best available information at the time of publication. The department holds no responsibility for any errors or omissions within this document. Any decisions made by other parties based on this document are solely the responsibility of those parties. Information contained in this document is from a number of sources and, as such, does not necessarily represent government or departmental policy.

May 2008

ISBN 978-1-7417-2924-5



This publication should be cited as:

Galea, L., Peplinkhouse, D., Loft, F., and Folkers, A. (2008). Mackay Whitsunday Healthy Waterways Ambient Monitoring Program Regional Report. Queensland Department of Natural Resources and Water for the Mackay Whitsunday Natural Resource Management Group, Australia.

---

# **ACKNOWLEDGEMENTS**

The following volunteers and project officers have made a significant contribution to the Mackay Whitsunday Healthy Waterways Ambient Monitoring Program. Without the countless hours of time and dedication spent monitoring water quality in sometimes very difficult environmental circumstances, this report would not have been possible.

We would like to sincerely thank the following:

## **Whitsunday region**

Christine Peterson, David Peplinkhouse, Cate Morris, Norm Large, Nathan Sainsbury, Robin Mares, Cassandra Shaw, Scott Hall, Eric and Helen Loft, Peter Alden, Danielle Seymour, Deborah Hixon, Ed Oldmeadow, Kerry Beasley, Nino Timkiv, Leigh Scott, Kia Whitely, Karen Evans and Jodie Bonney

## **Mackay and surrounding regions**

Jane Eales, Chris Palmer, Fiona Loft, Eddie Adams, Ed Oldmeadow, Patricia Julian, Tom Hay, Veronique Bossom Leemreyze, Herman Leemreyze, Jan McDonald, John Ross, Neiola Vella, Eric McKellar, Paul Vassalo, Mick Davinia, Sue and Charlie Deguara, John and Judy Prout, Tora and Michael Walker, Harold Smith Petryce Badger, Kathryn Elliott, Kerry Morgan, Dell Sarich, Dianne Williams, Dave and Janet Hunter, Bernice Wright, Steve Giesman, Deborah Hixon, Valma and Ald Harridine, Joan Fitzsimmons, Jill McDonald, Andrew Powell, Allan Trembath, Victor Jordan, Helen Paulsen, Bill Dorham, Maya Harrison, Shane McMullen, Julie Aird, Brooke McReynolds, Margaret Meng, Sharon Taylor, Alyth Tweedie, David Fenech, Tom Marshall, Helen Malone, Lynda Jordan, John Armour, Ben Hooper, Margaret Lane, Kate Brunner, Nola Bradly, Maureen Cooper, Robyn Birkett, Joshua Bedwell, Luke Galea, Natalie Fries, Ken Rohde, Bronwyn Masters, Matthew Brown, Will Higham, Carl Mitchell, John Drewry and Diversity QLD.

## **Sarina and surrounding regions**

Saskia Von Fahland, Adam Folkers, Joel Rawlins, Jon Graftdyk, Arthur Gardner, Neil and Gail Bradley, Jodie Bonney, Alma Hindle, Richard Mills, Ruth Clifton, Kerry Bennison, Nate Troxell, Lisa Fowell and Harry Bienke



## TABLE OF CONTENTS

EXECUTIVE SUMMARY .....	iii
1 INTRODUCTION .....	1
2 REGIONAL DESCRIPTION .....	5
2.1 Whitsunday Catchment (Proserpine and O'Connell Basins).....	7
2.2 Pioneer Catchment.....	8
2.3 Plane Catchment.....	9
3 METHODOLOGY .....	11
3.1 Water Quality Guidelines .....	15
3.2 Quality Assurance and Quality Control.....	15
3.3 Meter Calibration .....	15
3.4 Training .....	15
4 WATER QUALITY INDICATORS.....	17
4.1 Dissolved Oxygen (DO).....	17
4.2 pH.....	17
4.3 Electrical Conductivity (EC).....	17
4.4 Water Temperature.....	17
4.5 Clarity.....	18
4.6 Filterable Reactive Phosphorus (FRP).....	18
5 RESULTS and DISCUSSION.....	19
5.1 Whitsunday Catchment Sites.....	19
5.1.1 Water Temperature .....	19
5.1.2 Dissolved Oxygen ( % Saturation) .....	20
5.1.3 Electrical Conductivity .....	22
5.1.4 pH .....	24
5.1.5 Filterable Reactive Phosphorus (FRP).....	25
5.1.6 Clarity .....	27
5.2 Pioneer Catchment Sites.....	29
5.2.1 Water Temperature .....	29
5.2.2 Dissolved Oxygen ( % Saturation) .....	30
5.2.3 Electrical Conductivity .....	32
5.2.4 pH .....	34
5.2.5 Filterable Reactive Phosphorus (FRP).....	35
5.2.6 Clarity .....	37
5.3 Plane Catchment Sites .....	39
5.3.1 Water Temperature .....	39
5.3.2 Dissolved Oxygen.....	40
5.3.3 Electrical Conductivity (EC) .....	43
5.3.4 pH .....	44
5.3.5 Filterable Reactive Phosphorus (FRP).....	46
5.3.6 Clarity .....	47
6 CONCLUSIONS.....	51
7 REFERENCES .....	53

## List of Figures

Figure 1 Mackay Whitsunday Healthy Waterways Integrated Monitoring Program Organisational Flow Chart.....	3
Figure 2 Mackay Whitsunday region showing the major catchments (left) and land uses (right).....	6
Figure 3 Healthy Waterways Ambient Monitoring Sites – Whitsunday Catchment .....	7
Figure 4 Healthy Waterways Ambient Monitoring Sites – Pioneer Catchment .....	8
Figure 5 Healthy Waterways Ambient Monitoring Sites – Plane Creek Catchment .....	9
Figure 6 Healthy Waterways Sampling Kit.....	13
Figure 7 An example of a box and whisker plot (Dissolved oxygen – Whitsunday catchment sites) ...	14
Figure 8 Water temperature – Whitsunday catchment sites .....	19
Figure 9 Water temperature Vs Land use – Whitsunday catchment sites.....	20
Figure 10 Dissolved oxygen – Whitsunday catchment sites.....	21
Figure 11 Dissolved oxygen Vs Land use – Whitsunday catchment sites.....	22
Figure 12 Electrical conductivity – Whitsunday catchment sites .....	23
Figure 13 Electrical conductivity Vs Land use – Whitsunday catchment sites .....	23
Figure 14 pH – Whitsunday catchment sites .....	24
Figure 15 pH Vs Land use – Whitsunday catchment sites .....	25
Figure 16 Filterable reactive phosphorus – Whitsunday catchment sites .....	26
Figure 17 Filterable reactive phosphorus Vs Land use – Whitsunday catchment sites .....	26
Figure 18 Proserpine River hydrograph showing the point at which the sample was collected.....	27
Figure 19 Clarity – Whitsunday catchment sites .....	28
Figure 20 Clarity Vs Land use – Whitsunday catchment sites .....	28
Figure 21 Water temperature – Pioneer catchment sites .....	29
Figure 22 Water temperature Vs Land use – Pioneer catchment sites.....	30
Figure 23 Dissolved oxygen – Pioneer catchment sites.....	31
Figure 24 Dissolved Oxygen Vs Land use – Pioneer catchment sites.....	32
Figure 25 Electrical conductivity – Pioneer catchment sites .....	33
Figure 26 Electrical conductivity Vs Land use – Pioneer catchment sites .....	33
Figure 27 pH - Pioneer catchment sites .....	34
Figure 28 pH Vs Land use – Pioneer catchment sites .....	35
Figure 29 Filterable reactive phosphorus – Pioneer catchment sites .....	36
Figure 30 Filterable reactive phosphorus Vs Land use – Pioneer catchment sites .....	36
Figure 31 Clarity – Pioneer catchment sites .....	37
Figure 32 Clarity Vs Land-use – Pioneer catchment sites.....	38
Figure 33 Water temperature – Plane catchment sites.....	39
Figure 34 Water temperature Vs Land use – Plane catchment sites.....	40
Figure 35 Water Lettuce bloom – Plane Creek at Sarina.....	41
Figure 36 Dissolved oxygen – Plane catchment sites.....	42
Figure 37 Dissolved oxygen Vs Land use – Plane catchment sites .....	42
Figure 38 Electrical conductivity – Plane catchment sites .....	43
Figure 39 Electrical conductivity Vs Land use – Plane catchment sites.....	44
Figure 40 pH – Plane catchment sites.....	45
Figure 41 pH Vs Land use – Plane catchment sites.....	45
Figure 42 Filterable reactive phosphorus – Plane catchment sites .....	46
Figure 43 Filterable reactive phosphorus Vs Land use – Plane catchment sites.....	47
Figure 44 Carmila Creek hydrograph and rainfall plot showing the point at which the sample was collected.....	48
Figure 45 Clarity – Plane Catchment Sites.....	48
Figure 46 Clarity Vs Land Use – Plane Catchment Sites .....	49

## List of Tables

Table 1 Healthy Waterways catchments, sub-catchments, sampling sites and dominant land uses .....	12
---	----

## EXECUTIVE SUMMARY

The Mackay Whitsunday Ambient Monitoring Program is funded by the Natural Heritage Trust and is a component of the Mackay Whitsunday Natural Resource Management Groups (MWNRM) *Healthy Waterways Program*. The initiative seeks to monitor water quality from a multitude of freshwater rivers, streams and creeks that are affected by the characterising land use classifications within the region. This Ambient Monitoring Program acts as an informant to the Water Quality Improvement Plan (WQIP) by aiding in the establishment of goals, objectives and targets for ambient physico-chemical parameters in order to establish a current condition status of aquatic ecosystem health within the region.

The Ambient Monitoring Program is a cooperative program between federal, state and local governments, as well as volunteers within the local community. Volunteers are the driving force behind the success of this program and have been effectively monitoring water quality in the Mackay Whitsunday Region since 2003. They provide countless hours of time and dedication in order to undertake this sampling. Variables monitored include, electrical conductivity, pH, dissolved oxygen, water temperature, air temperature, clarity and filterable reactive phosphorus. This is undertaken on a monthly basis. Volunteers are well trained in all elements of Workplace Health and Safety as well as quality assurance (QA) and quality control (QC) by their individual catchment coordinators (Whitsunday, Pioneer and Sarina).

This report provides an overview of the ambient physico-chemical parameters which were sampled from various freshwater rivers, streams and creeks in the Mackay Whitsunday region.

The main objectives of the Healthy Waterways Ambient Monitoring Program are to:

- Maintain a safe, high quality, volunteer-driven water quality sampling program.
- Develop a monthly, ambient water quality data set from a suite of parameters based on different land use types reflective of the surrounding environment.
- Inform the WQIP by aiding in the establishment of goals, objectives and targets for ambient physico-chemical parameters to provide a current condition status of aquatic ecosystem health.
- Aid in the establishment of a localised set of water quality guidelines pertaining to the Mackay Whitsunday region, therefore being more precise than existing national or state guidelines.

Site selection was based on a variety of factors including stream order or “ecological value”, land use type and proximity to stream-flow gauging stations. The dominant land use types in the region include intensive cropping (primarily sugar cane farming), bushland (national park reference sites), cattle grazing, industrial uses, urban use and various mixtures of these. Direct correlations have been established between land use, water quality and the overall health of the in-stream aquatic environment.

All water quality parameters were analysed for minimum, maximum as well as 20<sup>th</sup>, 50<sup>th</sup> and 80<sup>th</sup> percentile values. This was done to allow comparison of the region's waterways with the Central Queensland values in the Queensland Water Quality Guidelines (QWQG).

The findings in 2008 mimic similar trends to those obtained from 2003 to 2007. These include:

- Relatively uniform water temperatures across the majority of sites and land uses. This indicates that water temperature is primarily governed by the physical structure of the waterway (water depth, stream width and riparian shading etc.) rather than surrounding land use practice.
- Low dissolved oxygen (DO) concentrations were prevalent for the vast majority of sites, with DO concentrations outside Central Queensland Water Quality Guidelines on 50% of occasions. Through these results, it is evident that the Mackay Whitsunday region exhibits behaviour of a hypoxic nature.
- Electrical conductivity (EC) varied among sites with high readings from various sites caused by groundwater influence or catchment geology.
- pH values were within the Central Queensland water quality guideline range on 50% of occasions at each site.
- Filterable reactive phosphorus (FRP) levels were higher in urban catchments, cane / urban catchments or areas where point source pollution was an influence.
- Water clarity was consistently good across all land use types where substantial groundcover was prevalent. This is attributed to the widespread adoption of "Best Management Practices" such as green cane trash blanketing on a paddock scale. Sites exhibiting higher clarity at various times were attributed to localised rainfall events.

# 1 INTRODUCTION

This regional water quality report was commissioned by the Mackay Whitsunday Natural Resource Management Group (MWNRM) as part of the Healthy Waterways program. The MWNRM Group is one of fifteen Natural Resource Management groups in Queensland who are delivering on components of the Reef Plan. They are funded by the Natural Heritage Trust.

The MWNRM Group have produced a Natural Resource Management Plan which aims to protect and restore natural and cultural assets. Through a bi-lateral agreement with the Natural Heritage Trust, the following objectives have been established: (MWNRM 2005)

- Biodiversity conservation – *“The conservation of Australia’s biodiversity by the protection and restoration of terrestrial, freshwater, estuarine and marine ecosystems and habitat for native plants and animals”*
- Sustainable use of natural resources – *“The sustainable use and management of Australia’s land, water and marine resources to maintain and improve the productivity and profitability of resource based industries”*

These plan objectives emphasized the critical need for the Mackay Whitsunday Healthy Waterways program as a long term integrated monitoring regime aimed at determining the effectiveness of on-ground actions and the success of achieving water quality goals, objectives and targets for each major catchment.

A feature of this program is the emphasis on community involvement. A growing contingent of over 70 dedicated volunteers (past and present) have been gathering quality-assured water quality data from 45 sites in the Mackay Whitsunday region since 2003. These sites are distributed throughout the Whitsunday, Pioneer and Plane (Sarina) catchment areas and encompass the primary land use types in these areas.

Previous studies have illustrated that water quality and the ecology of water bodies are greatly influenced by surrounding land use practices (Brodie 2004). The primary land uses dominating the Mackay Whitsunday region consist of bushland, sugarcane, grazing, urban and industrial. By June 2006, the data collected was deemed sufficient for the first statistical analysis to be undertaken. The 2008 data complements previous data and reports.

The continuation of this regional water quality monitoring is essential for a number of reasons:

- It is a way of assessing the ambient health of the waterways
- It bridges information gaps between land use practices and the health of the aquatic environment
- It is an essential tool for making important environmental decisions
- It promotes community partnerships with people - working together to achieve a common goal

This report outlines the results and main findings of the ambient community volunteer component of the *Mackay Whitsunday Healthy Waterways Integrated Monitoring Program*. Other components, reported separately, include the baseline water quality monitoring program (Galea *et al.* 2008b), event-based water quality monitoring program (Rohde *et al.* 2008) and plot-scale monitoring of cane management practices (Masters *et al.* 2008). These reports are supporting documents for the Mackay Whitsunday region's water quality improvement plan (Drewry *et al.* 2008).

Funding for the Mackay Whitsunday Healthy Waterways Ambient Monitoring Program is provided by the Mackay Whitsunday Natural Resource Management Group. They are funded by the Natural Heritage Trust. Catchment project officers implement the program within the volunteer network and provide support to the NRW project officer (Figure 1).



Figure 1 Mackay Whitsunday Healthy Waterways Integrated Monitoring Program Organisational Flow Chart



## 2 REGIONAL DESCRIPTION

The Mackay Whitsunday Natural Resource Management region occupies approximately 9000 km<sup>2</sup> of Central Queensland coastline. The region stretches for 300 kilometres along the coast and is 80 kilometres wide at its widest point (Pioneer catchment) (Rohde *et al.* 2006). It encompasses the popular tourist areas of Finch Hatton Gorge and Eungella National Park

The Pioneer, O'Connell / Andromache and Proserpine are the major rivers in the region. These rivers, along with a number of smaller streams, discharge directly into the Great Barrier Reef lagoon. The region displays an abundance of natural assets which includes extensive wetlands, riparian areas, national parks, waterfalls and dynamic mangrove and seagrass ecosystems (Rohde *et al.* 2006).

The Proserpine, O'Connell, Pioneer and Plane basins (Figure 2 left) which make up the region and are identified as 4 of the top 10 high-risk basins illustrated in the Reef Water Quality Protection Plan (The State of Queensland and Commonwealth of Australia 2003). The Reef Plan aims to address the decline in water quality entering the Great Barrier Reef World Heritage Area by addressing diffuse pollution from broad scale land use, particularly nutrients and sediments (The State of Queensland and Commonwealth of Australia 2003).

The Mackay Whitsunday region is one of the most intensively developed agricultural areas in Queensland. The region is the centre of extensive agricultural development (primarily sugar cane farming), with numerous small townships and communities associated with sugar production based out of Mackay and Proserpine. Widespread cattle grazing contributes to the region, occupying the fringes of the sugar cane farming areas. Cooler temperatures and higher than average rainfall have ensured that rainforest and Notophyll vine forests have colonised the Clarke, Conway and Connors ranges (Figure 2 right).

Temperatures within the region bare resemblance of a subtropical coastal zone with extensive durations or warm temperatures before, during and after the wet season and short periods of cool weather during the middle of June, July and August. Temperatures range from a mean overnight low of 23°C to a mean maximum of 30°C in January to a mean overnight low of 13°C to a mean maximum of 21°C in July.

Streamflow within the region is variable, depending on climatic conditions. As a general trend, flows peak during the wet season (December – April) and then reside to low or no flow during the dry season (May – November). Within the region, the Pioneer and O'Connell Rivers display the highest mean annual discharges (900,000ML and 200,000ML respectively) (Arthington *et al.* 2001).

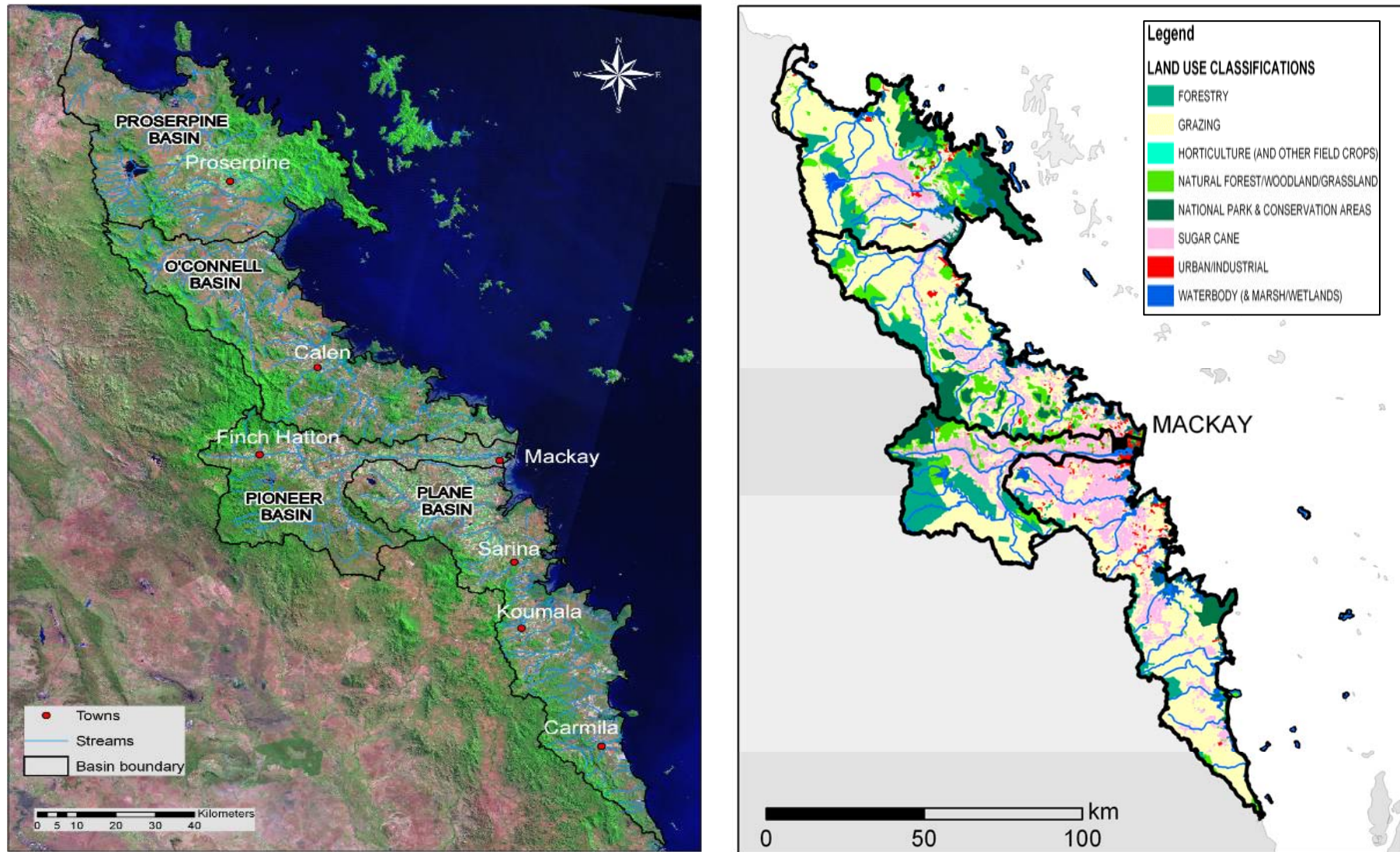


Figure 2 Mackay Whitsunday region showing the major catchments (left) and land uses (right)

## 2.1 Whitsunday Catchment (Proserpine and O’Connell Basins)

The Australian Water Resource Council (AWRC) issued the Proserpine basin “number 122” and O’Connell basin “number 124” in the hydrological basin network. These 2 basins are situated within the Whitsunday catchment (Figure 3). Sugarcane farming and cattle grazing are the major land use types in these basins. This catchment includes the townships of Proserpine, Cannonvale and Airlie Beach (Brodie *et al.* 2004).

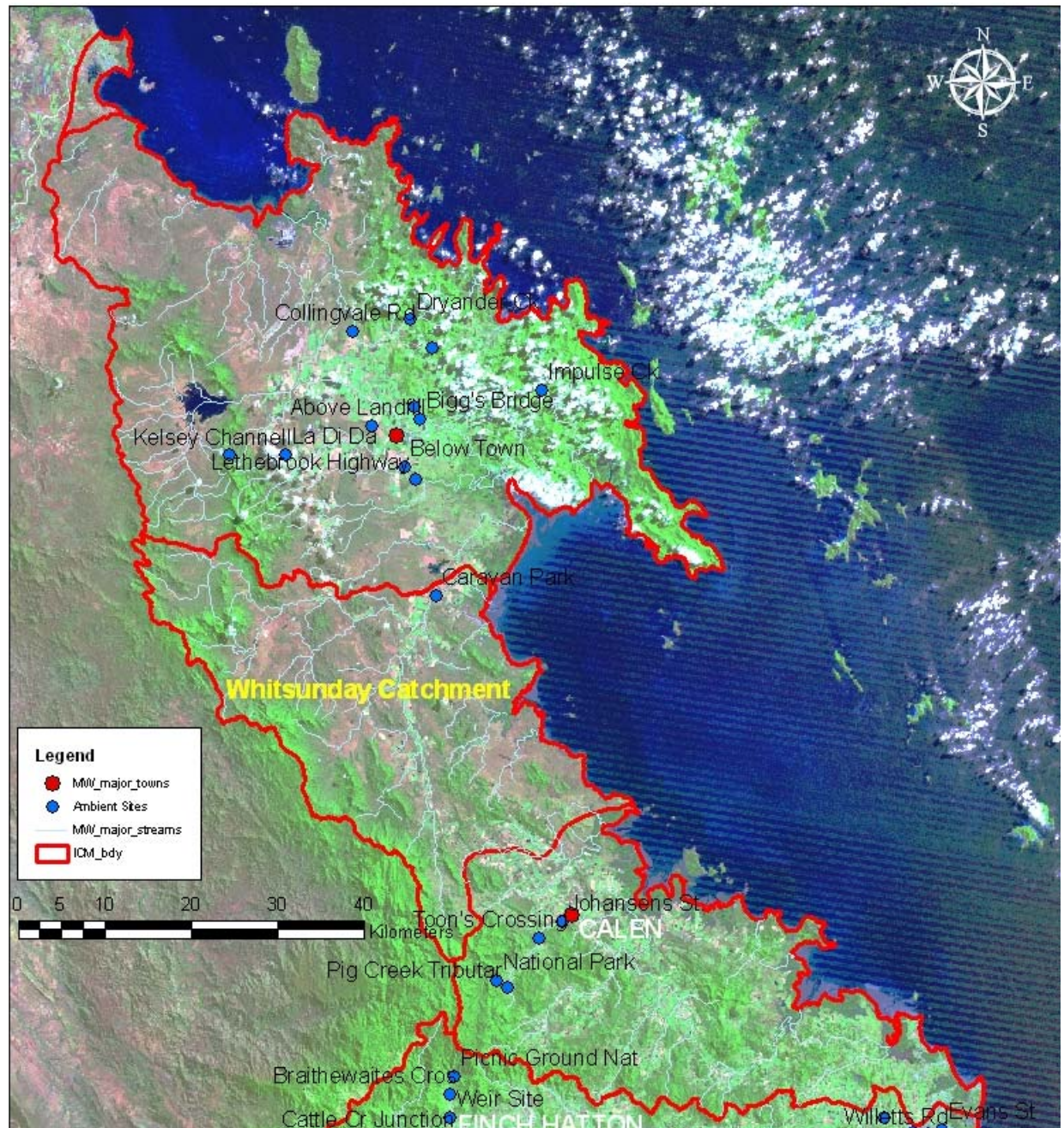


Figure 3 Healthy Waterways Ambient Monitoring Sites – Whitsunday Catchment

## 2.2 Pioneer Catchment

The Pioneer catchment (AWRC Basin 125) is 120 km in length and has a catchment area of 1550 km<sup>2</sup> (Figure 4). The Pioneer River is highly regulated, supplying water for extensive sugarcane farming throughout the Pioneer valley. Cattle grazing is also prevalent in the middle and lower reaches.

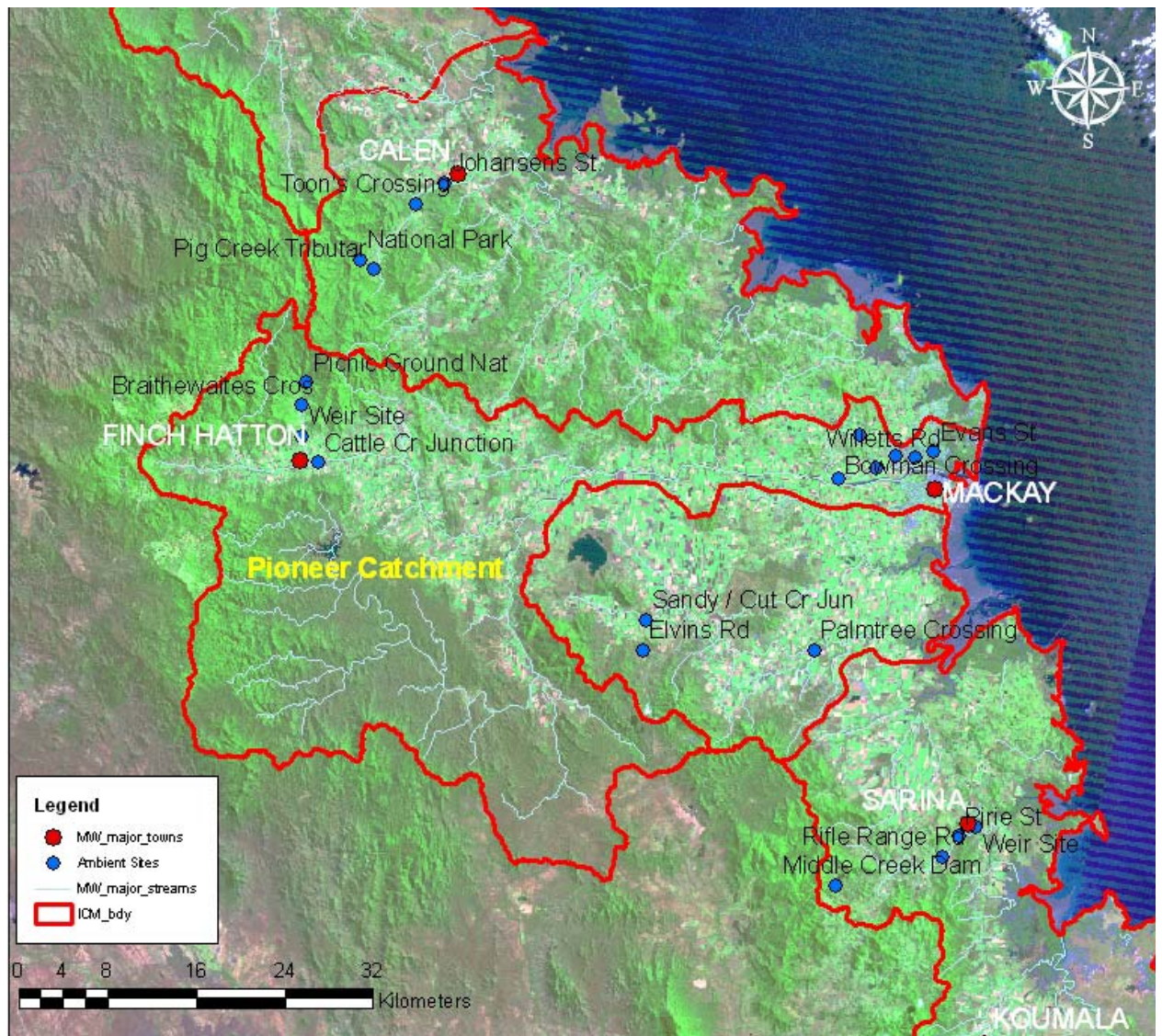


Figure 4 Healthy Waterways Ambient Monitoring Sites – Pioneer Catchment

### 2.3 Plane Catchment

The Plane Catchment (Figure 5) (AWRC Basin 126) is bordered by Sandy Creek in the north, Clairview in the south and by the Connors Range in the west. Sugarcane dominates the northern part of the basin whereas cattle grazing dominates the southern part.



Figure 5 Healthy Waterways Ambient Monitoring Sites – Plane Creek Catchment



### **3 METHODOLOGY**

The monitoring strategy for the Mackay Whitsunday Ambient Monitoring Program has been developed in accordance with the National Water Quality Monitoring Strategy 2000 (NWQMS) and the Environmental Protection Policy 1997 (EPP). It fulfils the requirements of the Mackay Whitsunday Natural Resource Management Plan 2005 and the Reef Plan 2003 (Fries 2007b).

Whitsunday Catchment and Landcare (WCL), Pioneer Catchment and Landcare (PCL) and Sarina Landcare Catchment Management Association (SLCMA) are the 3 individual catchment groups which make up the region. Part-time project officers employed by these catchment groups are responsible for the on-ground implementation of the ambient monitoring program. They co-ordinate this monitoring with the volunteer network and provide data and support to the full time co-ordinating project officer housed within the Department of Natural Resources and Water (NRW). This project officer ensures all aspects of quality assurance, workplace health and safety and training is provided to these project officers in order to consistently and safely implement the monitoring program across the region (Fries 2007a) A multitude of rivers and creeks from different land use types within the region have been sampled in order to gain current condition status of the regions waterways and act an informant to the WQIP (Table 1).

**Table 1 Healthy Waterways catchments, sub-catchments, sampling sites and dominant land uses**

<b>CATCHMENT</b>	<b>SUB-CATCHMENT</b>	<b>SAMPLING SITE</b>	<b>LAND-USE</b>
<b>Whitsunday</b>	<b>Repulse Creek</b>	Impulse Creek @ National Park	Bushland
	<b>Gregory River</b>	Dryandra Creek Site	Bushland
		Collingvale Road	Cane
	<b>Myrtle Creek</b>	Myrtle Creek	Cane
	<b>Proserpine River</b>	Proserpine River	Urban
		Waite Creek	Urban
	<b>Lethe Brook</b>	La Di Da Creek (Above Landfill)	Cane
		Lagoon Creek (Below Town)	Cane
		Lethe Brook Creek - Highway	Cane / Urban
	<b>O'Connell River</b>	O'Connell River	Grazing / State Forest
<b>Pioneer</b>	<b>Pioneer River</b>	Lagoons Site 1	Cane
		Lagoons Site 2	Cane
	<b>St Helens Creek</b>	National Park	Bushland
		Toons Crossing	Cane
		Johansens Road Site	Cane
	<b>Reliance Creek</b>	Site 1	Cane
		Site 2	Cane
	<b>Janes Ck/Gooseponds</b>	Glendaragh Road	Cane
		Magpies	Cane / Urban
		Willetts Road	Urban
		Evans Avenue	Urban
	<b>Fursden Creek</b>	Bowman Crossing	Cane
		Erakala Crossing	Cane
	<b>Finch Hatton Creek</b>	National Park	Bushland
		Braithwaite's Crossing	Bushland
Weir Site		Grazing	
Cattle Creek Junction		Cane	
<b>Plane</b>	<b>Sandy Creek</b>	Sandy /Cut Creek Junction	Cane
	<b>Plane Creek</b>	Middle Creek Dam	Forestry / Horticulture
		Rifle Range Road	Cane
		Bridge Site	Urban / Industry
	<b>Rocky Dam Creek</b>	Cotters Creek	Grazing
		Campbells Road	Cane
		The Crossing	Grazing / Cane
	<b>Carmila Creek</b>	Top Causeway	Grazing / Cane
		Jacksons Road	Grazing / Cane
Streeters Road		Cane	

Dissolved oxygen, pH, electrical conductivity, filterable reactive phosphorus, clarity and water temperature are the ambient water quality parameters sampled monthly at each of the selected sites. A range of antecedent conditions including rainfall, water level, flow rate, water colour and presence of exotic floral specimens are also noted on the sampling trips. These trips commence at the same time of the day each month to ensure minimal variability which may be caused by sampling at different times throughout the day (Fries 2007b; Oldmeadow 2004). The volunteers are provided with a sampling kit by their catchment project officers (Figure 6). These kits contain reliable WTW water quality meters and probes as well as calibration solutions, turbidity tubes, data sheets, phosphate kit and all relevant instructions.



**Figure 6 Healthy Waterways Sampling Kit**

The volunteers use a bucket with a lanyard attached to collect the sample water. The bucket is triple rinsed with water from the site and the rinse water is discarded away from the sampling area to avoid contamination. The sample is taken from within the top 50 centimetres of the water column. After the sample has been collected, the volunteer relocates to a shaded area where the *in-situ* parameters are measured and recorded.

Water quality data for each parameter has been analysed for the minimum and maximum readings as well as the 20<sup>th</sup>, 50<sup>th</sup> and 80<sup>th</sup> percentiles. Percentiles are values in a given set of observations which divides the data into 100 equal parts. A percentile value means that for a given percentage of sampling occasions, the data points are below the resulting value. For example, a 50<sup>th</sup> percentile is found by arranging the values in ascending order and then selecting the one in the middle. The median is a useful number in cases where the distribution has very large extreme values which would otherwise skew the data. The 50<sup>th</sup> percentile is also known as the median. The extremities are the minimum and maximum values which occur in the data set. The

variability within the data is illustrated as the range between the minimum and maximum value.

Box and whisker plots are graphical displays which were used to illustrate the results (Figure 7). They are constructed entirely out of the percentile values. The top edge of the box represents the point at which 80% of the data lies below, the bottom of the box represents the point at which 20% of the data lies and the line in the middle indicates the 50<sup>th</sup> percentile (median value) of the data. The ends of the vertical lines or “whiskers” indicate the minimum and maximum data values. The smaller the boxes and the closer the whisker lines are, the less variable data. The values of “n” represent the number of times the parameter was sampled at the site.

Throughout this report, the box and whisker plots for all water quality parameters have been compared to the Central Queensland Water Quality Guidelines (EPA 2006).

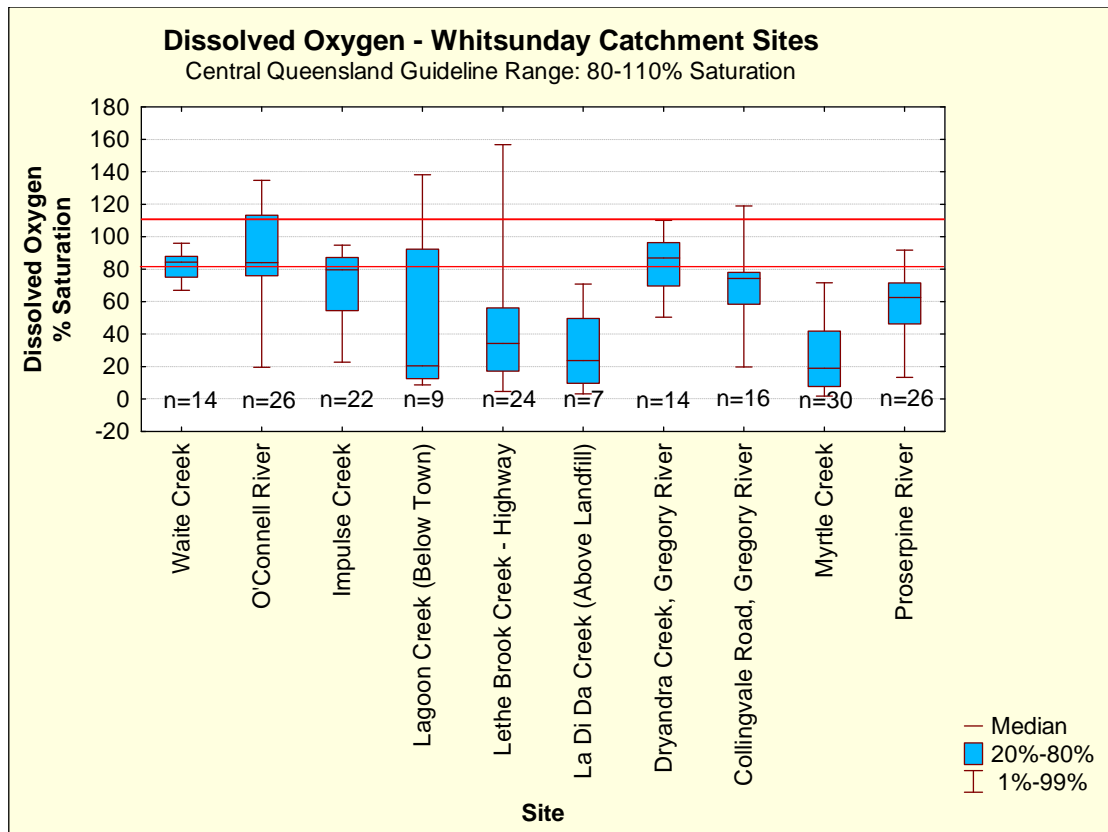


Figure 7 An example of a box and whisker plot (Dissolved oxygen – Whitsunday catchment sites)

Figure 7 is an example of a box and whisker plot which illustrates DO in the Whitsunday catchment. The “Myrtle Creek” site exhibits a minimum saturation value of 1.8 %, a maximum of 72 %, an 80<sup>th</sup> percentile value of 40 %, a median value of 19 % and a 20<sup>th</sup> percentile value of 7.2 % saturation. The site was sampled (n=) 30 times. The red lines indicate the central Queensland water quality guideline range for the parameter of dissolved oxygen. It should be noted that central Queensland water quality guideline values for water temperature and electrical conductivity do not exist at this stage.

### **3.1 Water Quality Guidelines**

The process used in establishing water quality objectives is based on recommendations by the National Water Quality Management Strategy (NWQMS). The Environmental Protection Agency (EPA) has been collecting water quality data since 1992. The collation of this data allowed for the development of the ANZECC 2000 guidelines, which provides guideline values for a range of water quality indicators. This took place to ensure the protection of aquatic ecosystems and water users at a national scale (ANZECC and ARMCANZ 2000). This national framework emphasized the need for the development of more locally relevant guidelines.

Through this critical requirement, the Queensland Water Quality Guidelines (QWQG) were developed. The central Queensland water quality guidelines were obtained from the QWQG and were used as the guideline values for this report. The development of more localised guidelines needs to occur, hence the reason for this monitoring program (EPA 2006).

### **3.2 Quality Assurance and Quality Control**

The goal of quality assurance and quality control is to identify and implement sampling methods which will limit the degree of error in data collection and analysis whilst maintaining the highest statistical integrity. The Healthy Waterways Ambient Monitoring Program meets the requirements set out in (1) the Australian and New Zealand Standard AS/NZS 5667.11:1998 Water Quality – Sampling – Guidance on sampling rivers and streams; and (2) Queensland's Department of Natural Resources and Water, Water Monitoring Collection Standards, May 2003 (AS/NZS 1998; DNR 2003).

The Ambient Monitoring Program has specific QA / QC procedures in place to ensure the quality of data is of the highest integrity. The results provide a clear idea of the condition of the selected waterways in the Mackay Whitsunday region and will be used by MWNRM to create more localised guidelines which will inform the Water Quality Improvement Plan.

### **3.3 Meter Calibration**

The WTW water quality meters are calibrated to the manufacturer's specifications before each sampling trip. The EC meter is calibrated every 6 hours, the pH meter calibrated once in the morning and once in the afternoon and the calibration of the DO meter at every site. The calibration record is written on the data sheet and then stored on a secure database.

The water quality meters undergo a full maintenance every 2 months by the catchment project officers. This involves the chemical cleaning of probes, calibration of meters and the changing of calibration solutions. A maintenance and storage record is kept and archived.

### **3.4 Training**

In 2003, the MWNRM group provided water quality monitoring training to the NRW project officer. This project officer was required to conduct a similar training session with the 3 catchment project officers. Once these project officers were successfully

trained, they were responsible for training their volunteers. The catchment project officer accompanies the volunteers on their first 3 sampling trips (DNRM 2006).

**Trip 1** – The project officer undertakes the sampling, stepping the volunteer through the process.

**Trip 2** – The project officer assists the volunteer in the sampling

**Trip 3** – The volunteer undertakes the sampling and explains the process back to the project officer.

Risk assessments are completed during these first 3 sampling rounds which identifies the potential risks or hazards that may occur at each site. A risk / likelihood matrix is followed which produces a ranked score in order of its severity.

To comply with guidelines set out under the Mackay Whitsunday Healthy Waterways Ambient Monitoring Program – an annual refresher training course is provided to the catchment project officers by the regional NRW project officer. The last training session of this nature was conducted in October 2007 and incorporated the following components:

- Equipment Calibration
- Sampling Methodology
- Bi-monthly Kit Maintenance
- Occupational Health and Safety
- Volunteer Training

## **4 WATER QUALITY INDICATORS**

### **4.1 Dissolved Oxygen (DO)**

Dissolved oxygen is the level of oxygen dissolved in a water body. DO is essential to fish, micro-organisms, plants and all forms of aquatic flora and fauna for respiratory processes.

Oxygen infiltrates the water via diffusion from the surrounding air, rapid water movement or by in-stream macrophyte photosynthesis. In general, dissolved oxygen levels increase during the day when the sun is out and aquatic plants are actively photosynthesising. When night falls, oxygen is removed from the water as a result of animal, plant and bacterial respiration (Faithful 2003).

DO levels are generally indicative of water quality. Extremely low concentrations are hazardous as they promote fish kills. High concentrations may cause oxygen bubbles or narcosis in the fish's bloodstream which can harm circulation (Faithful 2003). Volunteers endeavour to sample their sites at approximately the same time of day every month to avoid the natural DO variation that occurs throughout the day. DO is measured in per cent saturation (% sat).

### **4.2 pH**

pH is a measure of the acidity or alkalinity of water and ranges from 1-14, 1 being acidic, 7 being neutral, and 14 being alkaline. The optimal pH for most organisms in Australian freshwaters is 6.5 – 8.0 (EPA 2006). A reduction in species diversity will occur if the pH is outside this range as more sensitive species are lost. Skin irritation, ulcers and impaired gill function will occur in all fish communities within waterways exhibiting low or acidic pH levels. pH affects the solubility of heavy metals (lead, copper, cadmium etc.) present in water as well as the concentrations of total dissolved solids. As carbon dioxide is taken up and used in the process of photosynthesis, pH increases. In contrast, decaying of organic matter lowers the pH (Faithful 2003).

### **4.3 Electrical Conductivity (EC)**

Electrical Conductivity is the ability for water to conduct an electric current. The greater the quantity of dissolved salts in the water, the greater the EC. These salts can include chlorides, sulphates and carbonates of sodium, magnesium, calcium and potassium.

Natural phenomena affecting EC includes, groundwater discharge, local geology, evaporation and rainfall. Groundwater presence and evaporation increases EC whereas rainfall reduces it. EC is measured in micro-siemens per centimetre ( $\mu\text{S}/\text{cm}$ ).

### **4.4 Water Temperature**

The temperature of a water body is of fundamental importance as it is a governing factor contributing to many chemical, biological and in-stream processes. Water temperature has direct and indirect effects on nearly all aspects of stream ecology. Water temperature affects dissolved oxygen (cooler water holds more oxygen), influences the rate of photosynthesis of macrophytes and the metabolic rate of aquatic fauna. It is measured in Degrees Celsius ( $^{\circ}\text{C}$ )

#### **4.5 Clarity**

Clarity is a measure of the amount of sunlight able to pass through a column of water. The greater the total suspended solids (TSS) present in the water, the cloudier it appears and the higher the clarity reading (Clarity of 0 is very clear and clarity of 100 is very cloudy).

High concentrations of particulate matter not only reduces light penetration but also destroys benthic habitat, damages the sensitive gill structures of fish (which decreases their resistance to disease) and visually impairs predator / prey relationships (Faithful 2003). Clarity also affects temperature and the rate of photosynthesis which could in turn have a disastrous effect on the entire aquatic food web. Clarity is measured in Nephelometric Turbidity Units (NTU).

#### **4.6 Filterable Reactive Phosphorus (FRP)**

FRP is essential for living organisms. It is commonly distributed in rocks and soils, but only exists as a trace element in the aquatic environment. It has a low water solubility and binds with suspended soil particles in the water column. The sinking of these soil particles is the reason why the concentration of phosphorus within the water column is very limited. Artificial sources of FRP may include fertilisers, detergents, wastewater and industrial effluents. Increased FRP in the aquatic environment is hazardous as it enhances algal growth which then lowers dissolved oxygen concentrations. FRP is measured in milligrams per litre (mg/L).

## 5 RESULTS and DISCUSSION

### 5.1 Whitsunday Catchment Sites

#### 5.1.1 Water Temperature

ANZECC 2000 nor Central Queensland water quality guidelines have been established for water temperature as it can be extremely variable depending on the time of day, cloud cover, riparian shade, water depth, stream width etc.

Relative uniformity was found between all sites in the Whitsunday catchment with median temperatures ranging from 21°C - 26°C, regardless of land use (Figure 8). The minimum temperature recorded was 13.8°C at Impulse Creek, a bushland site located in an elevated section in the headwaters of Conway National Park. It is a state reference site which discharges into Repulse Bay. Sites such as this naturally exhibit lower water temperatures due to their elevation. All sites in the Whitsunday catchment ranged from 18.4°C – 29.2°C on 80% of occasions. This range may seem large but given seasonal variation (fluctuations between summer and winter temperatures), it is relatively minor

Once sites were grouped and categorised into their respective land uses, median temperatures ranged from 23°C – 26°C (Figure 9). Urban, bushland, cane and cane / urban sites portrayed median temperatures around 23°C with 80<sup>th</sup> percentile values of 25°C – 26°C. The grazing / state forest site (O’Connell River) was slightly higher with a median temperature of 26°C and 80<sup>th</sup> percentile of 28.5°C. This may be due to the fact that the O’Connell River has a large width and therefore able to retain more of the suns warmth.

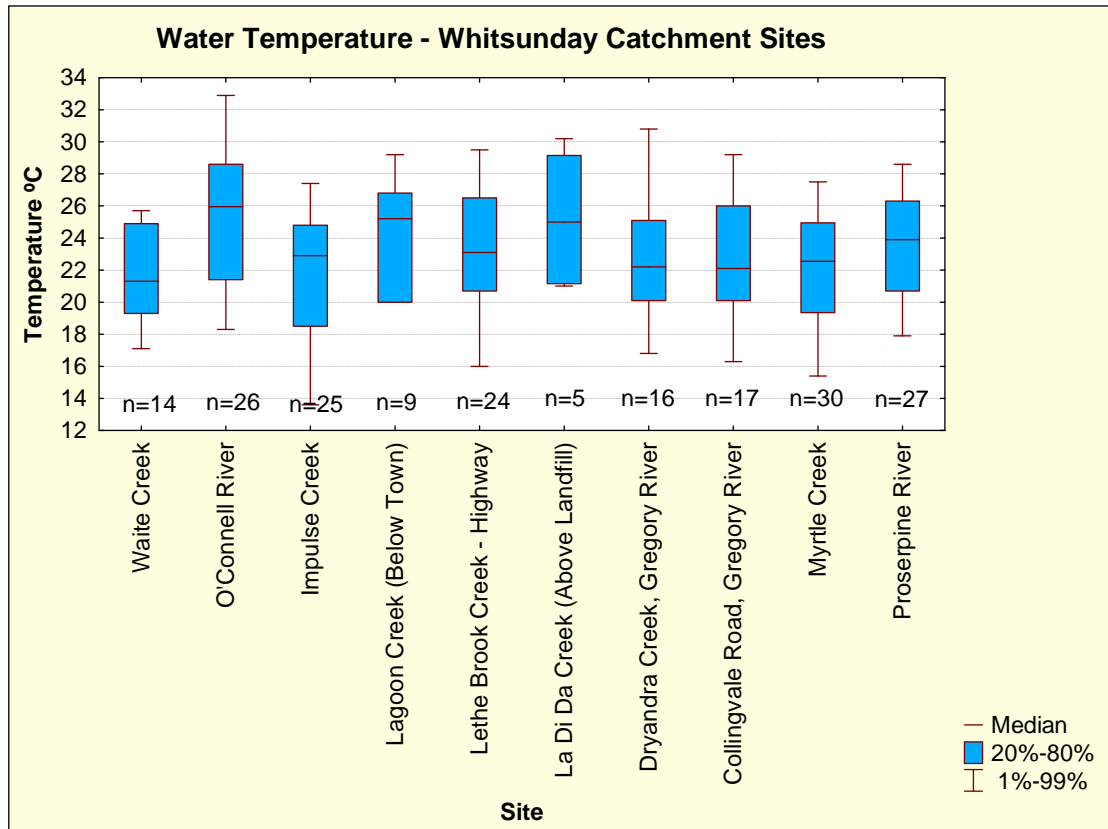


Figure 8 Water temperature – Whitsunday catchment sites

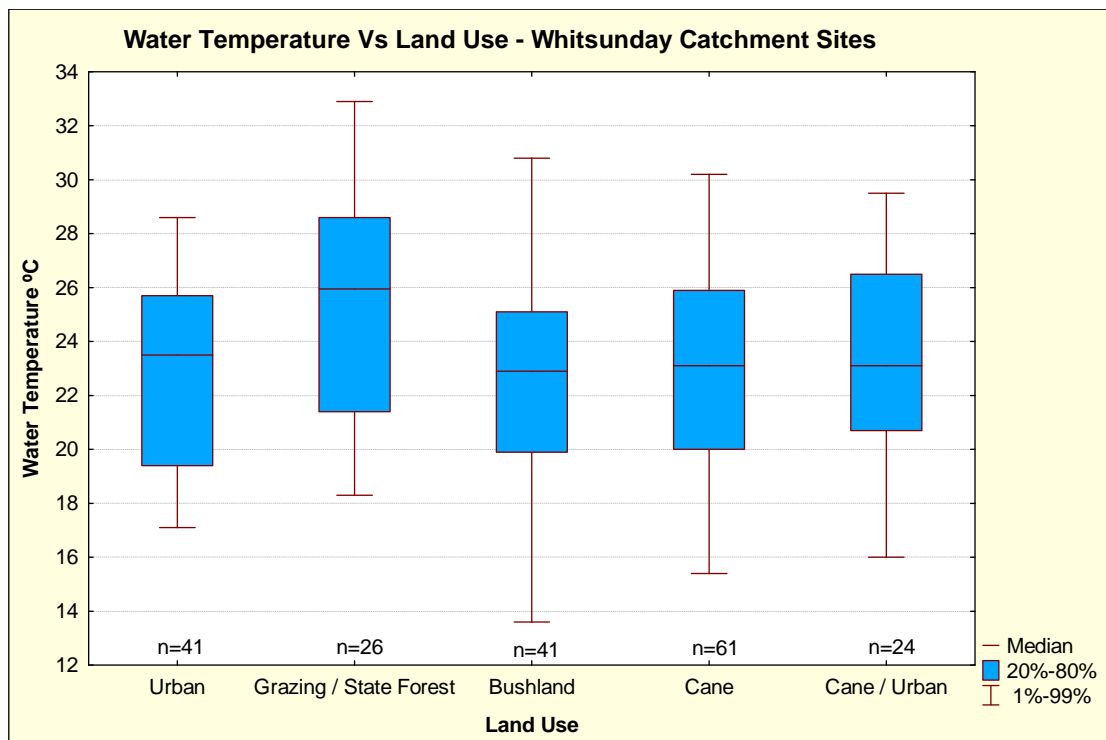


Figure 9 Water temperature Vs Land use – Whitsunday catchment sites

### 5.1.2 Dissolved Oxygen ( % Saturation)

The Central Queensland water quality guideline for dissolved oxygen is 80% - 110% saturation. Great variability in dissolved oxygen concentrations were prevalent across all sites in the Whitsunday catchment. Waite Creek, O'Connell River, Impulse Creek and Dryandra Creek fell within this guideline range on 50% of occasions (Figure 10), however Waite Creek, O'Connell River and Dryandra Creek rated considerably better than Impulse Creek, which is a national park reference site. This result indicates that Impulse Creek exhibits naturally hypoxic conditions in comparison with bushland sites from other catchments. This may be due to the fact that this site is restricted to a shallow pool environment with abundant algal growth and no flow for the majority of the year.

La Di Da Creek and Myrtle Creek are cane-dominated sites and exhibit very poor dissolved oxygen levels, with 20% and 24% saturation on 50% of occasions. These low levels occurred at the end of the sugar cane harvesting season. Reports of fish kills downstream of intensively cropped areas have been confirmed by past studies and are most likely due to depleted oxygen levels from sugar juice lost during mechanical cane harvesting (Rayment 2003). Most concerning is the movement of water containing sugar to waterways when harvesting during wet weather or soon after harvest. DO levels can be dramatically reduced for a number of days after a rainfall event. This sucrose promotes bacterial growth which severely diminishes oxygen levels within the waterway.

Adversely, the O'Connell River, Lagoon Creek and Lethe Brook Creek exhibit some very high one off readings (higher than 135% saturation). Extremely high oxygen

concentrations such as this can also be harmful to fish populations by causing narcosis or air bubbles in their blood stream.

Grazing / State forest, as well as bushland sites, fell within the central Queensland guideline range on 50% of occasions (Figure 11). The grazing / state forest site (O’Connell River) has higher oxygen concentrations than the Impulse Creek site. Once again this shows that Impulse creek may be oxygen deficient in comparison to other bushland sites.

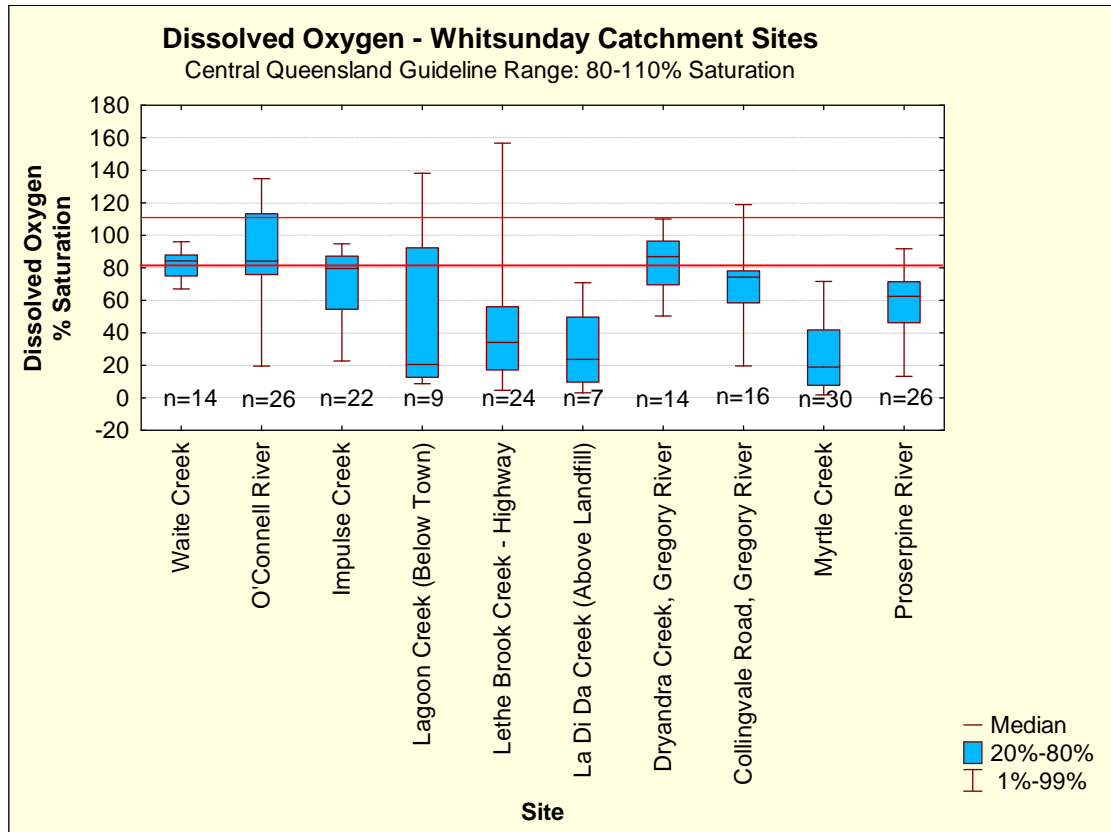


Figure 10 Dissolved oxygen – Whitsunday catchment sites

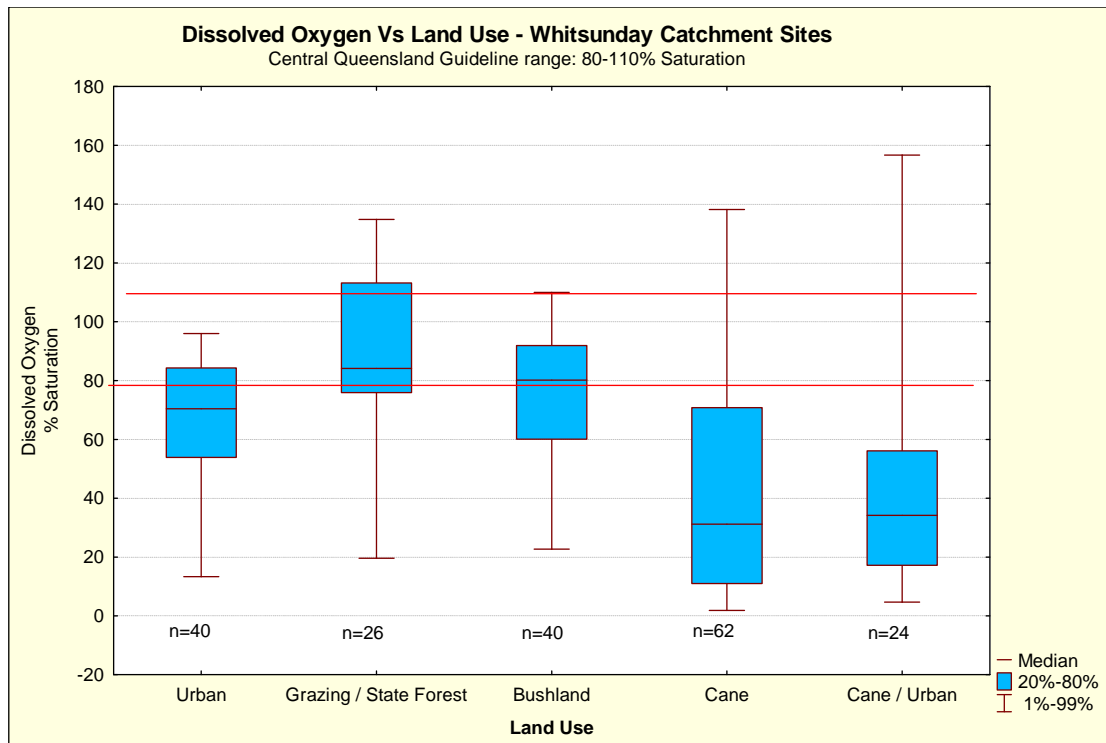


Figure 11 Dissolved oxygen Vs Land use – Whitsunday catchment sites

### 5.1.3 Electrical Conductivity

Six out of the 10 sites in the Whitsunday region displayed fairly uniform readings between 200 – 400  $\mu\text{S}/\text{cm}$  on 50% of occasions (Figure 12). This is quite acceptable and is within the water quality guideline range suitable for all uses including drinking, irrigation and stock watering (EPA 2006). An aquatic ecosystem guideline value for electrical conductivity has not yet been established.

Dryandra Creek on the Gregory River is a bushland site and exhibits low electrical conductivity and the lowest range. The Collingvale Road site is the second site on the Gregory River and has significantly higher electrical conductivity than the Dryandra Creek site. This is because the Dryandra Creek site is located on forested slopes whereas the Collingvale Road site is located on alluvial plains where cane and cattle grazing are the dominant land uses.

Bushland sites (Figure 13) (with the exception of Impulse Creek) exhibited the lowest EC readings. This is due to the high rainfall which falls in these rangeland areas. Impulse Creek is a bushland site with high readings and high variation (ranging between 120  $\mu\text{S}/\text{cm}$  and 910  $\mu\text{S}/\text{cm}$ ), however, this site is influenced by a groundwater recharge. The local geology of the Conway Ranges (predominately granite) may also contribute to these high EC values.

The O’Connell River exhibits the greatest range (180  $\mu\text{S}/\text{cm}$  – 1300  $\mu\text{S}/\text{cm}$ ). The sampling site is at the caravan park which is located in a tidally influenced area.

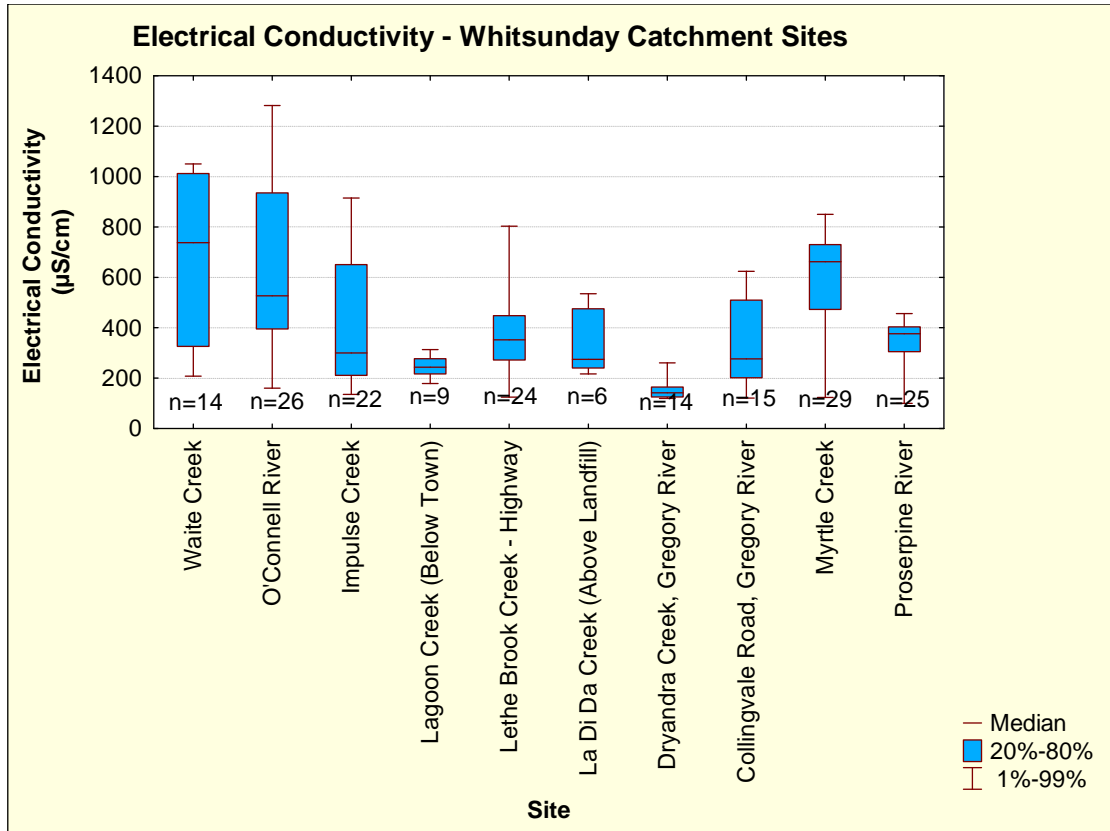


Figure 12 Electrical conductivity – Whitsunday catchment sites

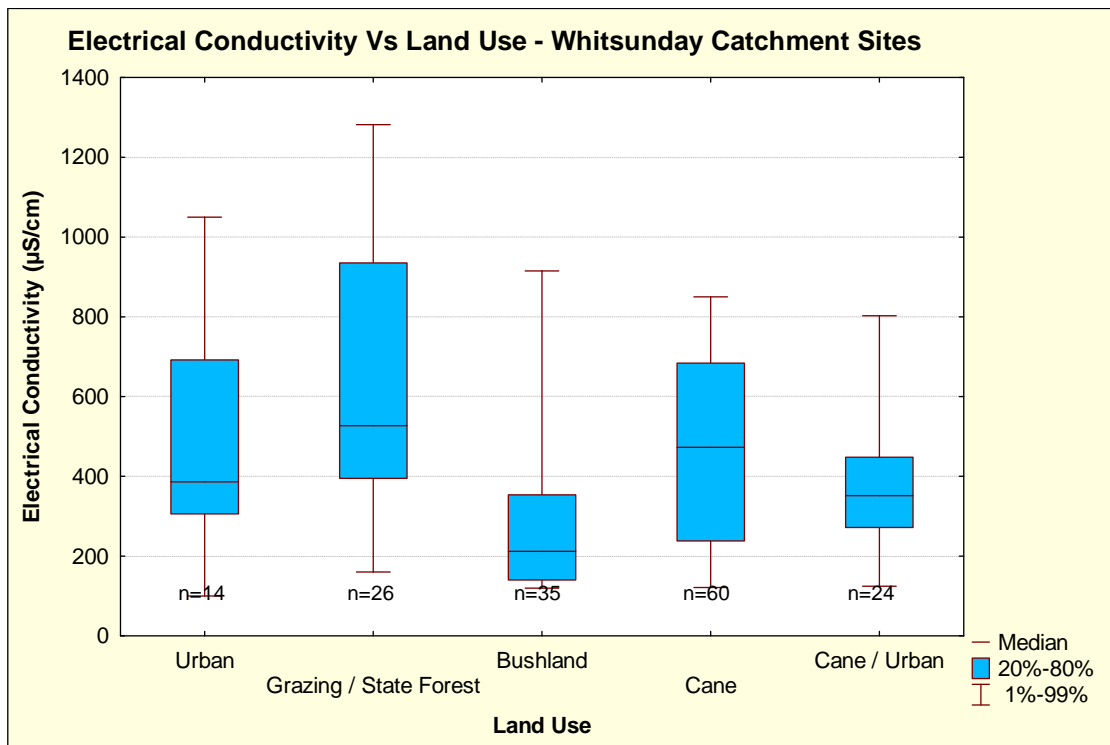


Figure 13 Electrical conductivity Vs Land use – Whitsunday catchment sites

### 5.1.4 pH

All sites in the Whitsunday catchment area fall within the Central Queensland water quality guideline range of 6.5 – 8.0 on 50% of occasions (Figure 14). Myrtle Creek exhibited extreme values well outside this range in some instances with levels reaching as low as 5.78 (acidic) and as high as 8.75 (basic). This range illustrates instability within the waterway and can be caused by dissolving organic matter, presence of nutrients and carbon as well as seasonal variation. These flow modified pools also cater for irrigational purposes. This pumping frequently changes the water level thus affecting the pH within Myrtle Creek.

Lagoon Creek and Lethe Brook Creek exhibited very basic pH readings of 9.18 and 9.69 on occasions throughout the year.

Cane and cane / urban sites have exhibited both acidic as well as basic readings on various sampling occasions (Figure 15).

Urban sites fall within the Central Queensland guideline range 99% of the time.

All the Whitsunday streams vary within the guideline range on 80% of occasions with a slight tendency towards the acidic end of the spectrum. This may be due to the volcanic origin of the geological features existing in the Conway ranges (predominately granite).

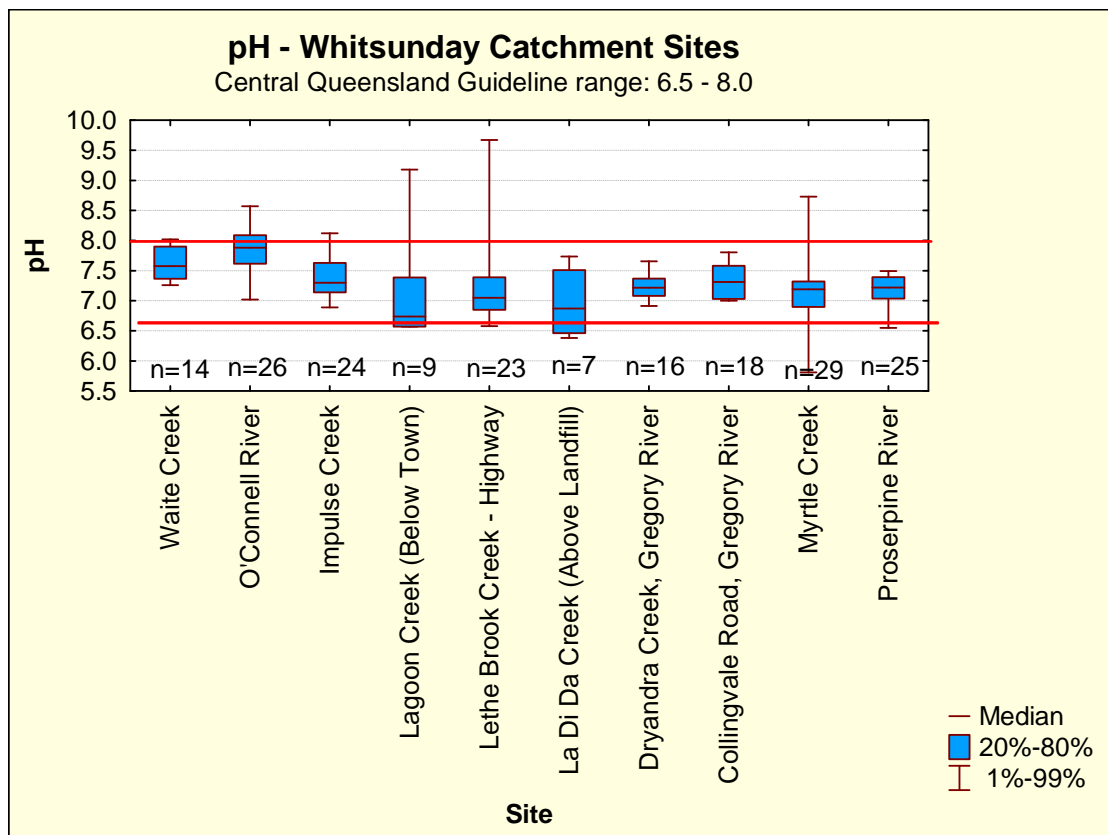


Figure 14 pH – Whitsunday catchment sites

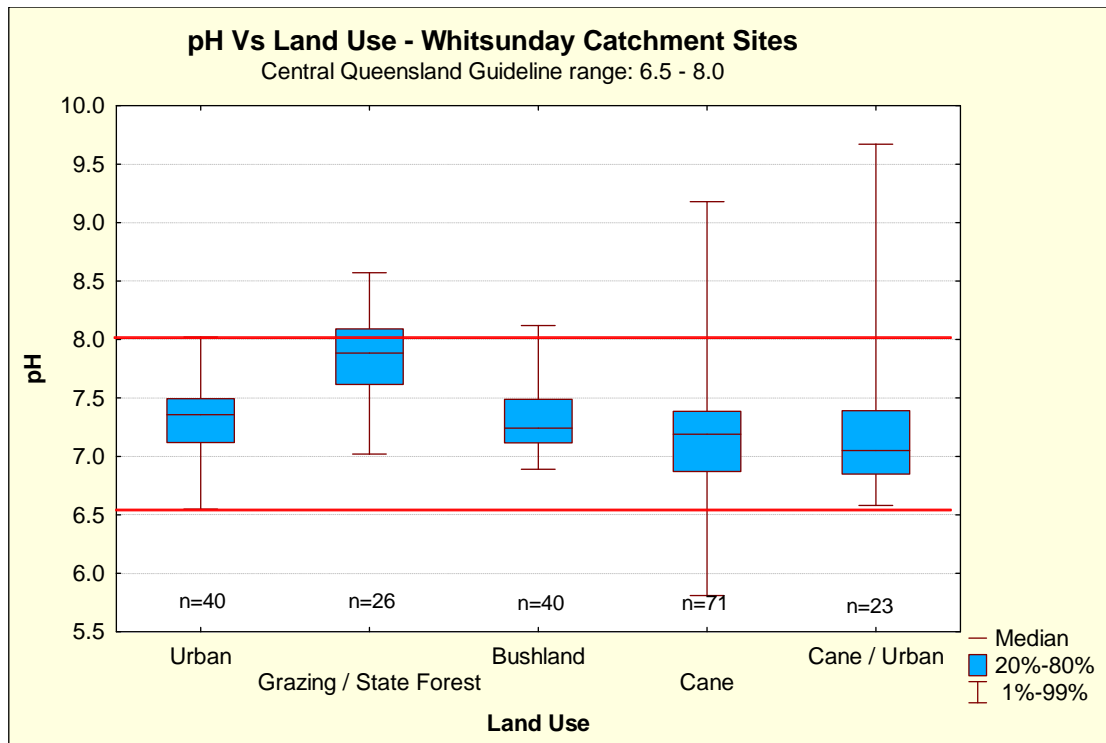


Figure 15 pH Vs Land use – Whitsunday catchment sites

### 5.1.5 Filterable Reactive Phosphorus (FRP)

FRP was below detectable limits at Waite Creek, Dryandra Creek, Collingvale Road and the O’Connell River.

Lagoon Creek, La Di Da Creek and the Proserpine River were all above the guideline value of 0.02 mg/L (Figure 16). There is a sewage treatment plant outlet located one kilometre upstream from the monitoring site on the Proserpine River and may be the reason why FRP levels were elevated on each sampling occasion. There are plans for an upgrade to this sewage treatment plant in 2008. This may reduce these high FRP levels as well as associated weed and algal growth.

Impulse Creek possessed a level of 0.2 mg/L on one sampling occasion which is above guideline value, however local geology of this granite-dominated region, naturally provides higher than usual FRP levels.

Urban, cane and cane / urban sites were definitely the land uses of concern with levels of 1 – 1.5 mg/L at certain times of the year (Figure 17). Fertiliser in runoff from cane dominated catchments, and urban stormwater runoff are the likely reasons for these high FRP concentrations.

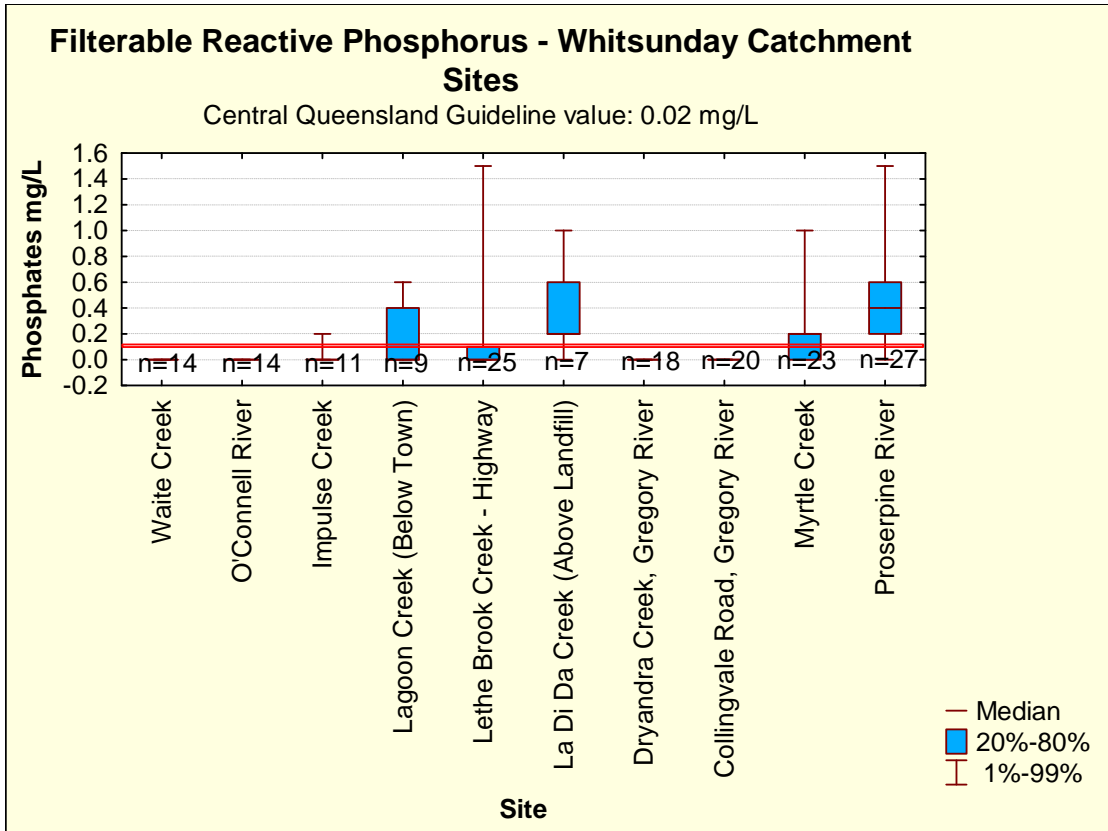


Figure 16 Filterable reactive phosphorus – Whitsunday catchment sites

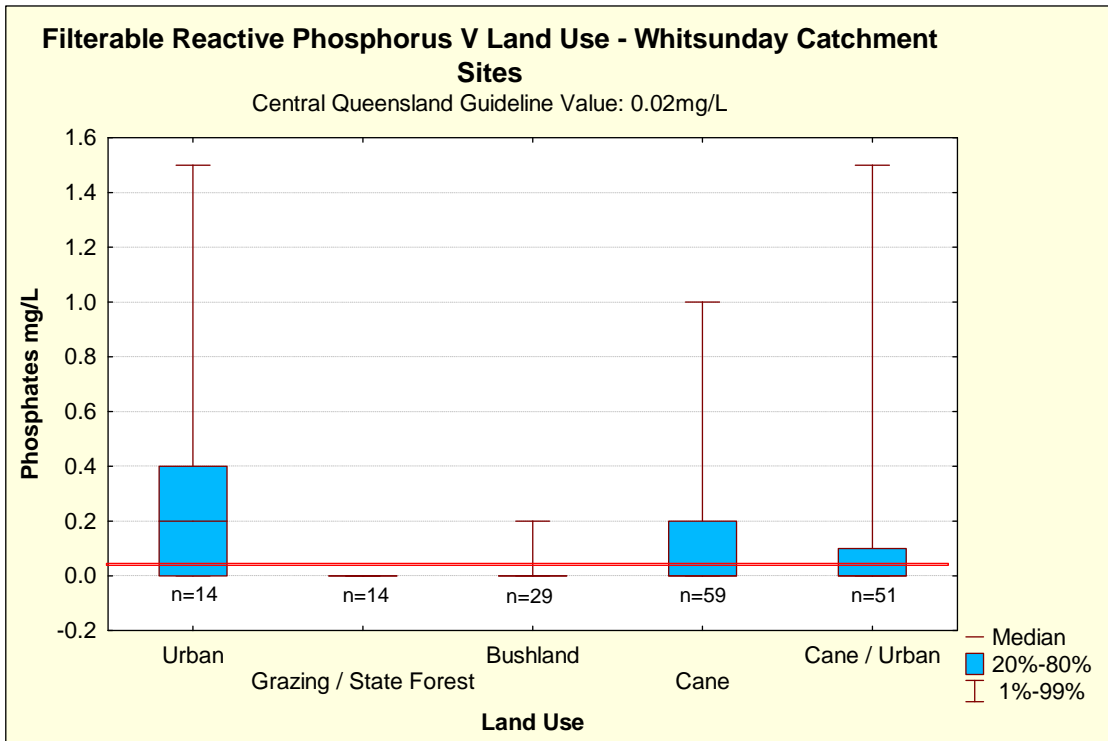


Figure 17 Filterable reactive phosphorus Vs Land use – Whitsunday catchment sites

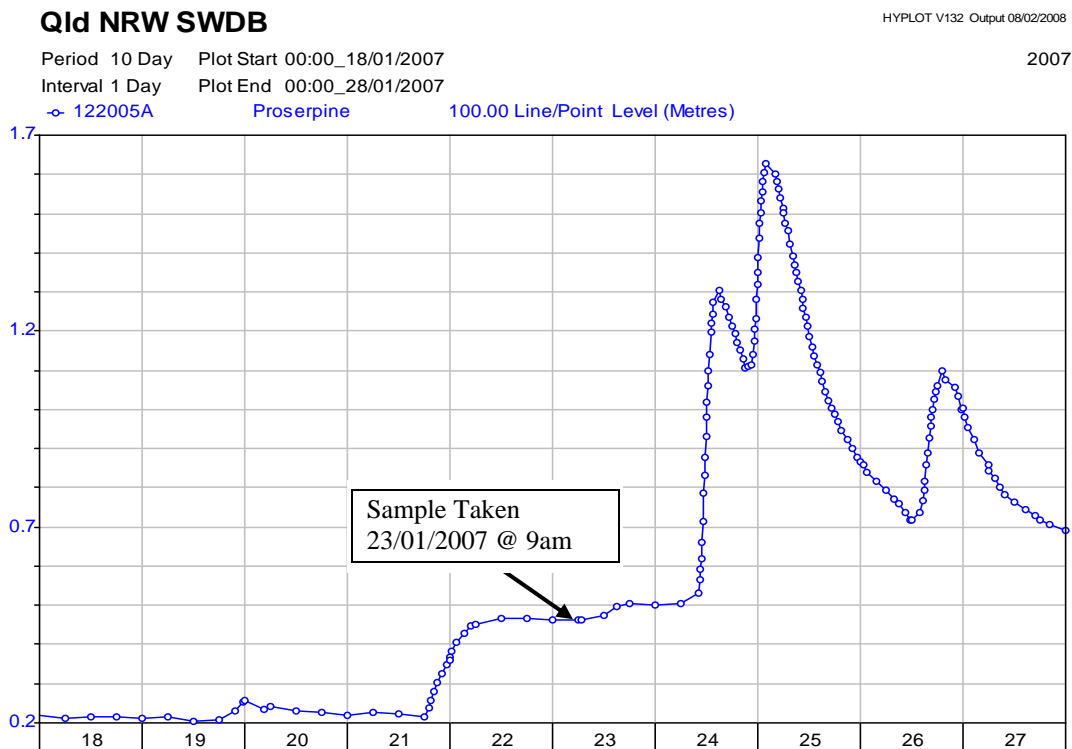
### 5.1.6 Clarity

The poor clarity reading (80 NTU) sampled in the Proserpine River on January 23<sup>rd</sup>, 2007 was sampled after a relatively minor rainfall event where the river rose 26cm (Figure 18). There is a Sewage Treatment Plant outlet located one kilometre upstream from the monitoring site on the Proserpine River. It releases effluent which may account for the poor clarity as well as the high FRP readings.

Whitsunday catchment sites exhibited clarity results lower than the Central Queensland Water Quality Guideline value for lowland streams on 80% of occasions (Figure 19).

Lagoon Creek, Myrtle Creek and the Proserpine River displayed readings above the guideline value on various sampling occasions. Lagoon Creek and Myrtle Creek are cane dominated catchments. Lagoon Creek possessed poor clarity of 100 NTU after localised rainfall events.

These results indicate that clarity within the catchment was consistently good, with poorer readings attributed to localised rainfall events or effluent from infrastructure such as the Sewage Treatment Plant. Clarity was not greatly affected by the surrounding land use practices within the Whitsunday catchment (Figure 20). This may not have always been the case as intensively cropped sites have had considerably higher clarity levels occurring in the past. Increasing awareness of issues posed by high clarity readings in waterways has led to encouraging results from intensively cropped sites. With the widespread adoption of green cane trash blanketing and minimum tillage, soil erosion has decreased dramatically (Rohde *et al.* 2006). Increasing adoption of these “best management practices” by farmers is likely to improve the overall clarity of the region in the short and long term.



**Figure 18 Proserpine River hydrograph showing the point at which the sample was collected.**

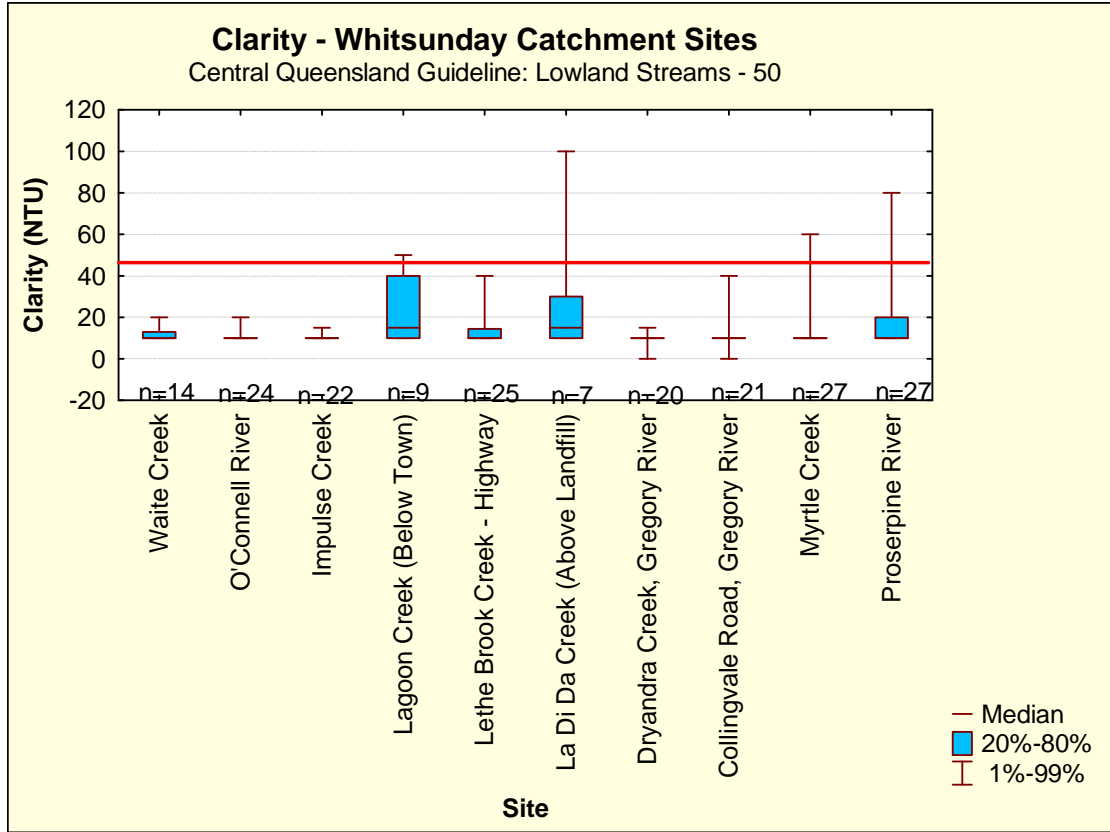


Figure 19 Clarity – Whitsunday catchment sites

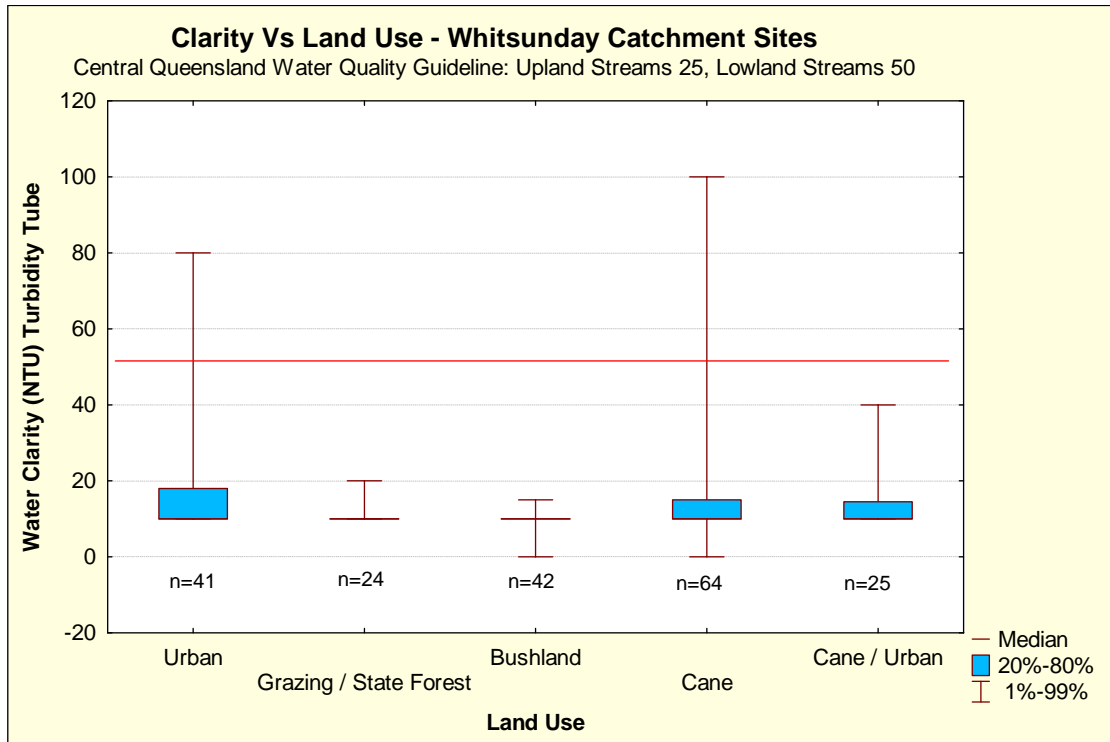


Figure 20 Clarity Vs Land use – Whitsunday catchment sites

## 5.2 Pioneer Catchment Sites

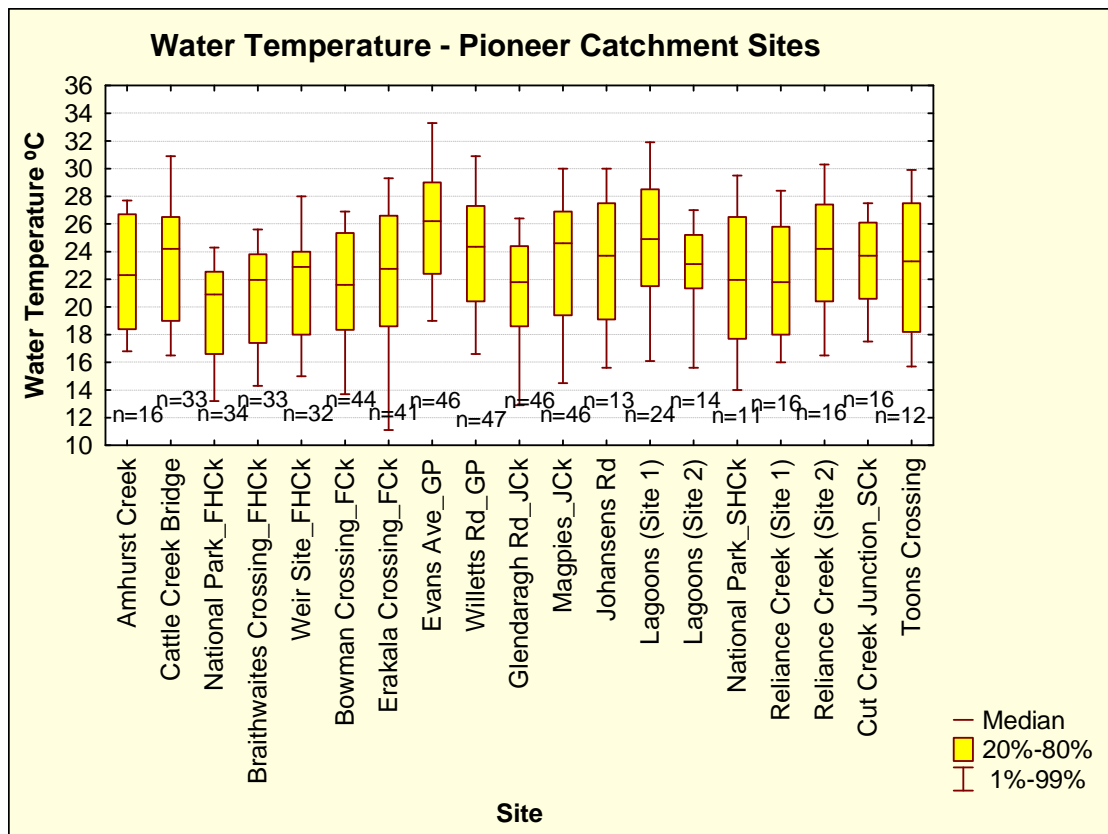
### 5.2.1 Water Temperature

Median temperatures in the Pioneer catchment ranged from 21°C – 26°C (Figure 21). This is the same median range as the sites in the Whitsunday catchment.

Erakala Crossing on Fursden Creek exhibited a one-off minimum of 11°C and Evans Avenue on the Gooseponds had a one-off maximum of 33.3°C. These extremes, along with large fluctuations in temperature range are a result of seasonal variation within the sampling rounds.

The temperature variability within land uses ranged from 21.1°C – 26.0°C on 50% of occasions (Figure 22). Bushland sites portrayed lower temperatures than sites from other land uses.

Urban sites (Willets Road and Evans Avenue) portrayed the highest temperatures which were just below 26°C on 50% of occasions. The poor state of the riparian vegetation at these sites may attribute to these elevated water temperatures.



**Figure 21 Water temperature – Pioneer catchment sites**

(Note: FHCK – Finch Hatton Creek; FCK – Fursden Creek; GP – Gooseponds; JCK – Janes Creek; SHCK – St Helens Creek; SCK – Sandy Creek)

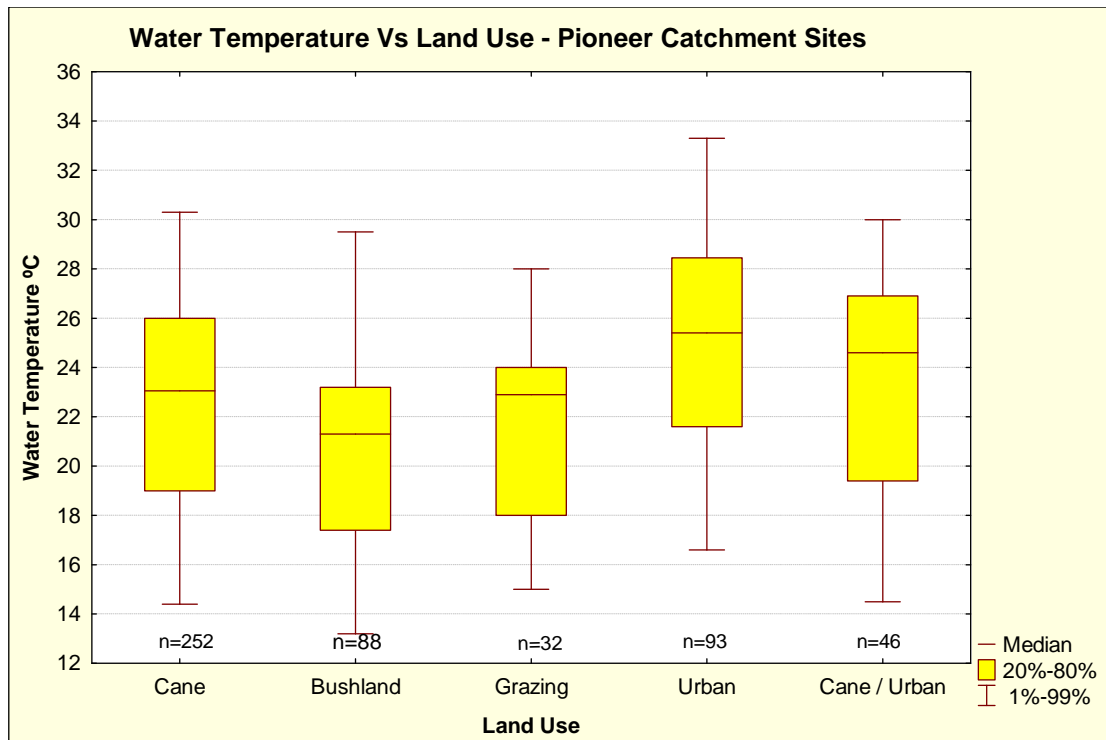


Figure 22 Water temperature Vs Land use – Pioneer catchment sites

### 5.2.2 Dissolved Oxygen ( % Saturation)

Significant variability occurred within the Pioneer catchment with regards to dissolved oxygen concentrations (Figure 23). This was largely due to the surrounding land use practice. The central Queensland water quality guideline range for dissolved oxygen is 80 - 110% saturation. Four of the 19 sites lay within this range on 50% of occasions. These sites are Cattle Creek Bridge, National Park – Finch Hatton Creek, National Park – St Helens Creek and Toons Crossing. Both National park sites (Finch Hatton Creek and St Helens Creek) are located in bushland catchments whereas Cattle Creek Bridge and Toons Crossing are in areas of sugar cane farming where a large proportion of the catchment is actually bushland. Very good riparian cover is present in the headwaters of Finch Hatton Creek.

National Park – St Helens Creek shows very little variability with consistent readings between 87 and 110% saturation for 99% of occasions.

Bowmans Crossing (Fursden Creek), Erakala Crossing (Fursden Creek) and Glendaragh Road (Janes Creek) exhibited very poor results (around 20% saturation for 50% of occasions). These sites are located in areas where sugar cane farming dominates the primary land use. Low DO concentrations such as these are deemed hypoxic and are detrimental to life within an aquatic ecosystem. Fursden Creek is considered an important nursery ground for fish species such as Barramundi and Mangrove Jack. Hypoxic conditions limits the ability of these important recreational fish species to successfully colonise these areas. Fish may suffer acute asphyxiation when dissolved oxygen levels fall below 25% saturation (Faithful 2003).

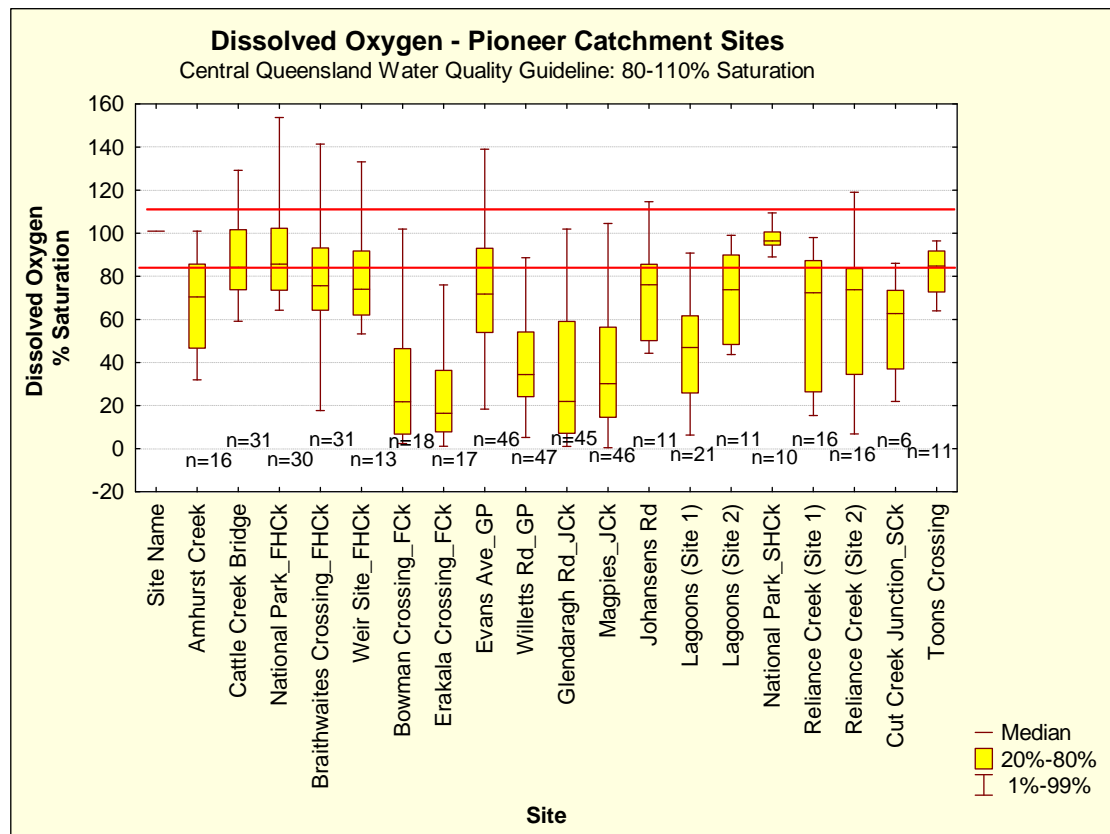
The Fursden Creek catchment is undergoing development which is leading to greater volumes of urban stormwater entering the stream. Low dissolved oxygen, low clarity and high phosphorus readings at the Fursden Creek sites support this claim.

Cattle Creek Bridge, National Park (Finch Hatton Creek), Braithwaites Crossing (Finch Hatton Creek), Weir Site (Finch Hatton Creek) and Evans Avenue (Gooseponds) reached maximum levels between 130 - 155% saturation at times.

In summary:

- Bushland sites were within the guideline range at least 50% of occasions but also displayed the highest variability (20% - 155% saturation) (Figure 24).
- Grazing sites were just below minimum guideline value on 50% of occasions
- Cane / urban sites rated most poorly with levels around 30% saturation on 50% of the occasions, as well as a minimum of almost 0 on one occasion.

Cane / urban sites in the Pioneer catchment would not be able to sustain populations of higher order fish for 50% of the time.



**Figure 23 Dissolved oxygen – Pioneer catchment sites**  
 (Note: FHCK – Finch Hatton Creek; FCK – Fursden Creek; GP – Gooseponds; JCK – Janes Creek; SHCK – St Helens Creek; SCK – Sandy Creek)

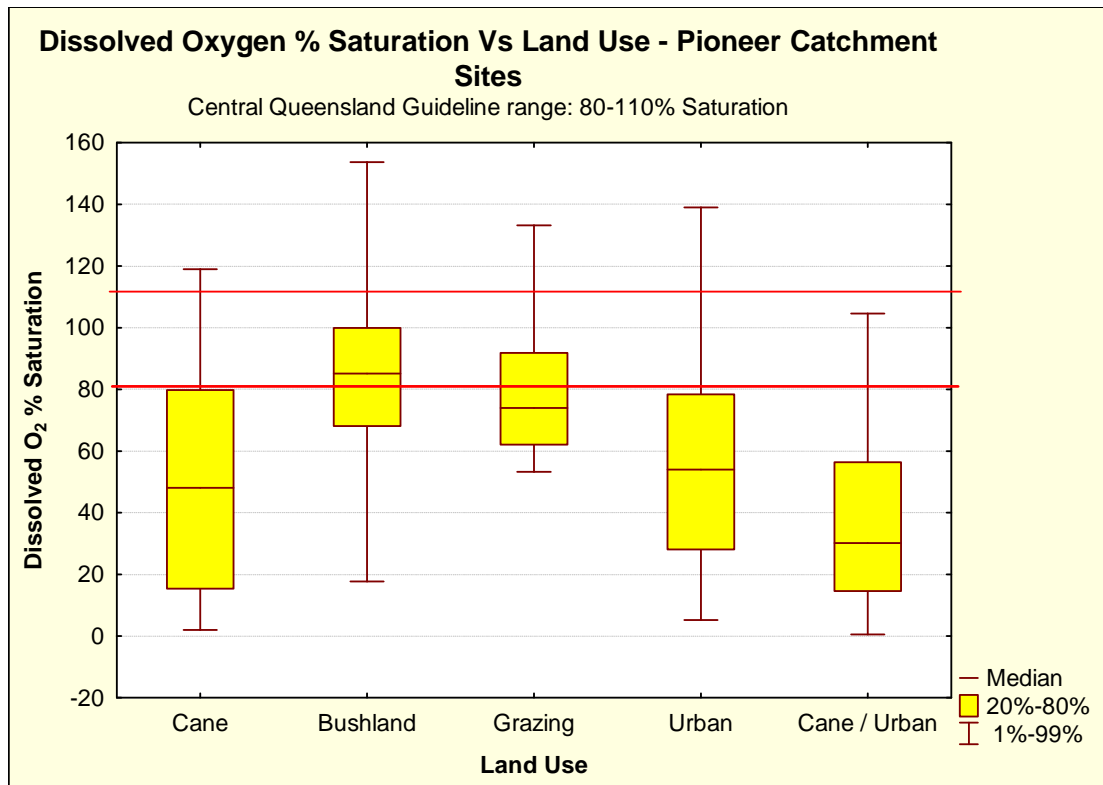


Figure 24 Dissolved Oxygen Vs Land use – Pioneer catchment sites

### 5.2.3 Electrical Conductivity

Seven sites exhibited EC readings below 200  $\mu\text{S}/\text{cm}$  on 99% of occasions (Figure 25). These sites were from creeks located high up the catchment in national park ranges or in areas of sugar cane that were part of a largely bushland dominated catchment. All sites except one had median EC values from 50 – 700  $\mu\text{S}/\text{cm}$ . The exception was Cut Creek Junction (1300  $\mu\text{S}/\text{cm}$  for 50% of occasions). These results illustrate that there is a groundwater influence on Sandy Creek at Cut Creek Junction. The readings ranged from 1000 – 1550  $\mu\text{S}/\text{cm}$ , 13 out of 14 sampling occasions.

Bushland and grazing sites exhibited low variability. Water samples taken at these sites had EC values less than 100  $\mu\text{S}/\text{cm}$ , 99% of the time (Figure 26).

Cane and urban catchments were the land uses exhibiting the greatest variability. They both had median values just less than 400  $\mu\text{S}/\text{cm}$ , minima of 50 – 90  $\mu\text{S}/\text{cm}$  (sampled after localised rainfall events) and maxima of 980 – 1415  $\mu\text{S}/\text{cm}$ .

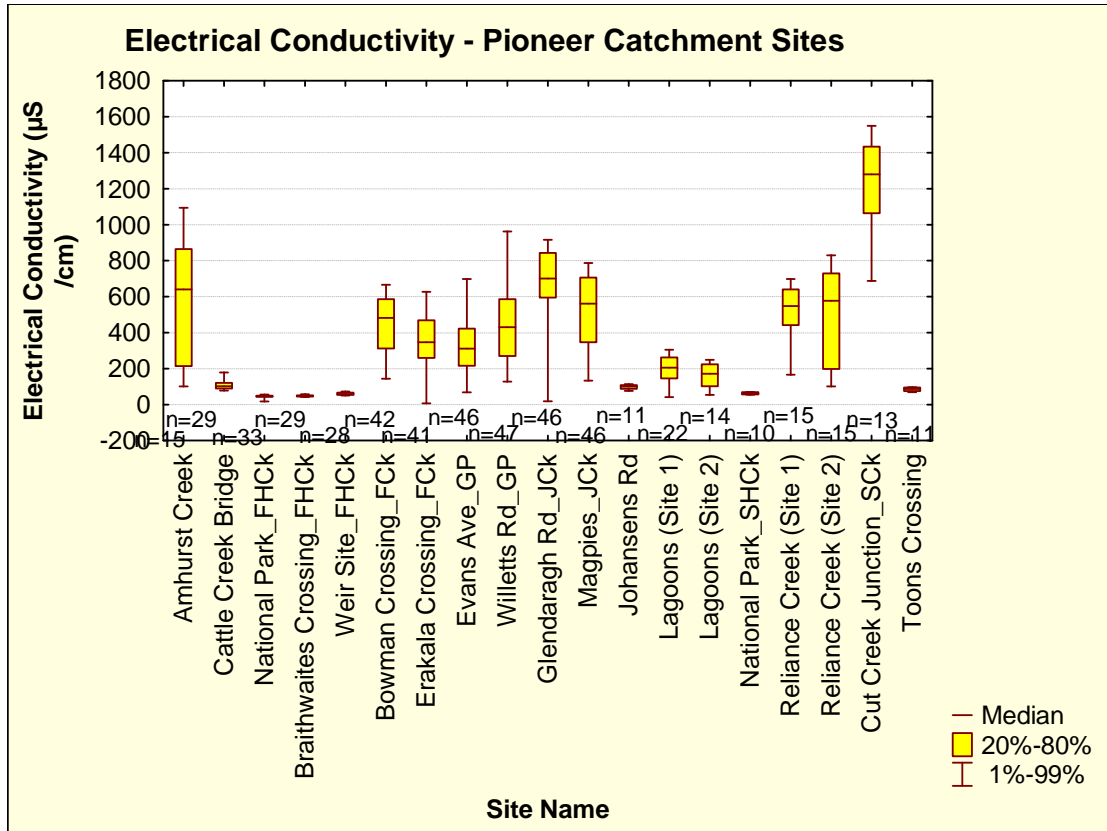


Figure 25 Electrical conductivity – Pioneer catchment sites

(Note: FHCK – Finch Hatton Creek; FCK – Fursden Creek; GP – Gooseponds; JCK – Janes Creek; SHCK – St Helens Creek; SCK – Sandy Creek)

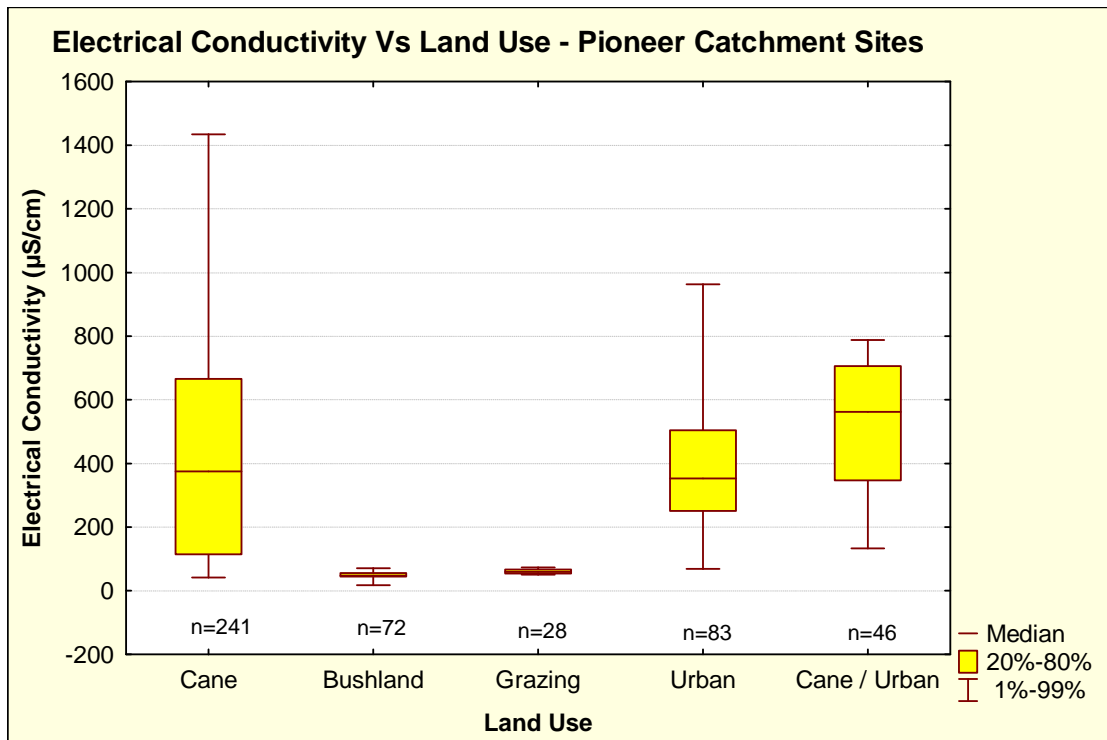


Figure 26 Electrical conductivity Vs Land use – Pioneer catchment sites

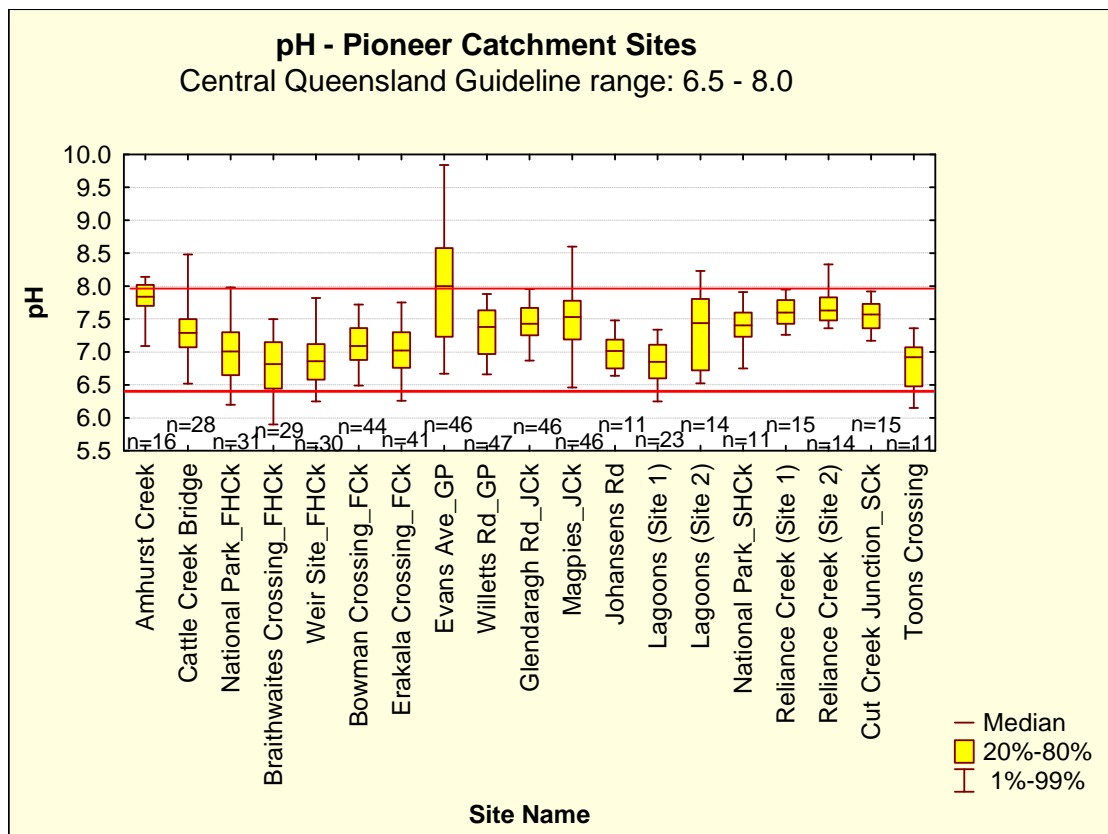
### 5.2.4 pH

pH results are consistent throughout all Pioneer catchment sites. They fall within the Central Queensland guideline range of 6.5 – 8.0 on 50% of sampling occasions (Figure 27), however, the results are highly variable within this range.

Evans Avenue at the Gooseponds is an urban site and portrayed a very high maximum of 9.87. This high reading is indicative of a rapidly fluctuating and unstable body of water. August, September and October (2005) presented high pH levels associated with algal blooms at this site.

National Park (Finch Hatton Creek), Braithwaites Crossing (Finch Hatton Creek), Weir site (Finch Hatton Creek) and Toons Crossing have all exhibited acidic readings between 5.9 and 6.30 on occasions. The resulting pH levels between these sites differ with elevation as sites in the upper part of the catchment (Braithwaites Crossing and Weir Site) have median pH readings between 6.8 and 6.9. Once the stream discharges into Cattle Creek, the median pH shifts to around 7.30.

Bushland sites had the lowest minimum pH values with readings around 5.9 on occasions (Figure 28). This may be due to the lithology of Finch Hatton Creek and St Helens Creek.



**Figure 27 pH - Pioneer catchment sites**  
(Note: FHCK – Finch Hatton Creek; FCK – Fursden Creek; GP – Gooseponds; JCK – Janes Creek; SHCK – St Helens Creek; SCK – Sandy Creek)

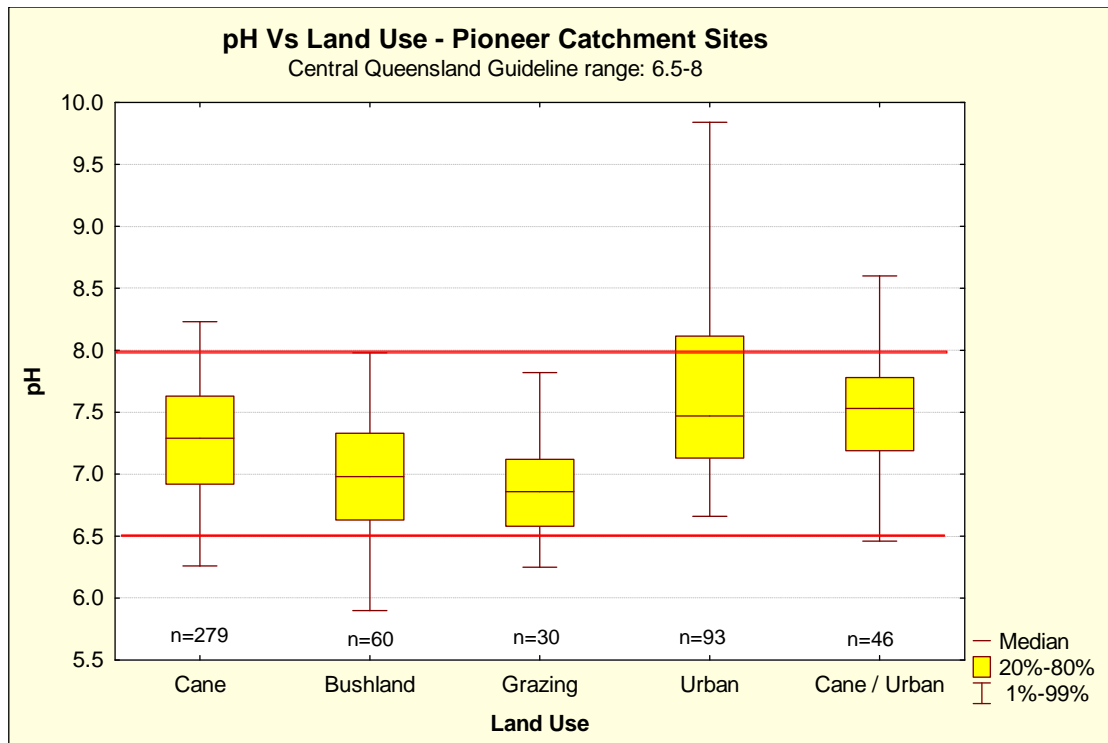


Figure 28 pH Vs Land use – Pioneer catchment sites

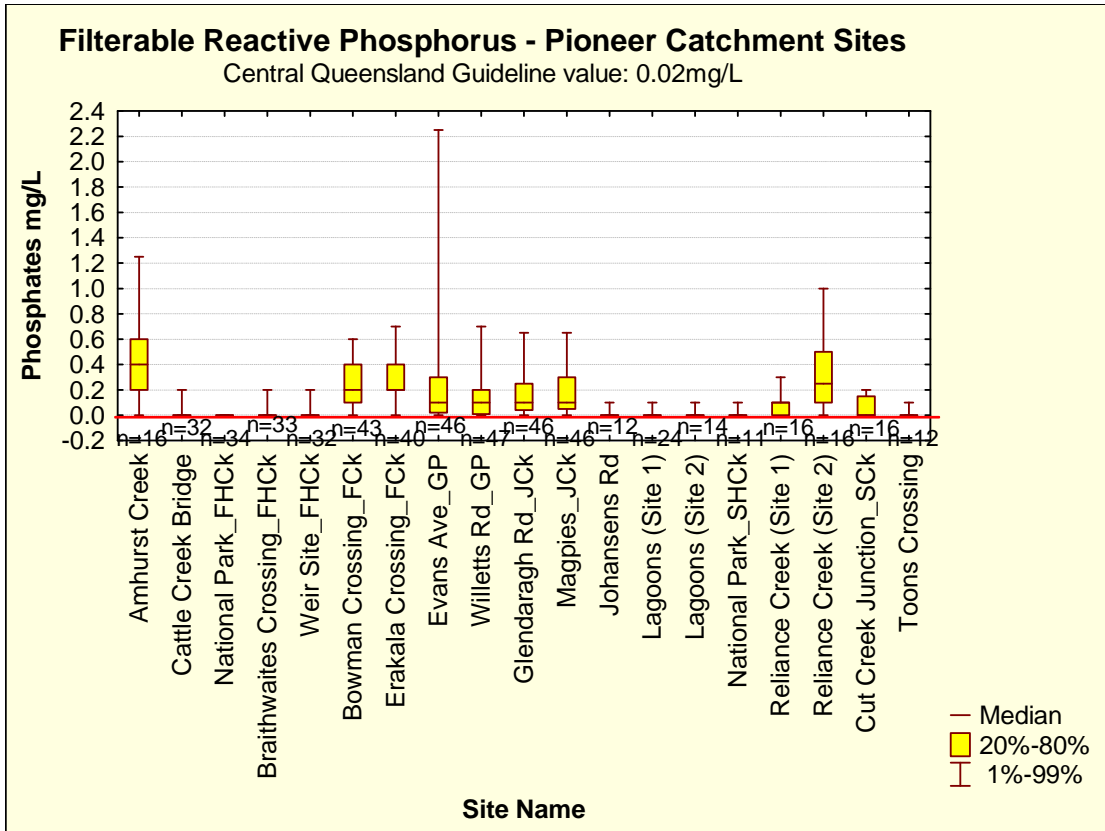
### 5.2.5 Filterable Reactive Phosphorus (FRP)

All FRP results were above the guideline value, excluding the national park (Finch Hatton Creek) site where FRP was not detected (Figure 29).

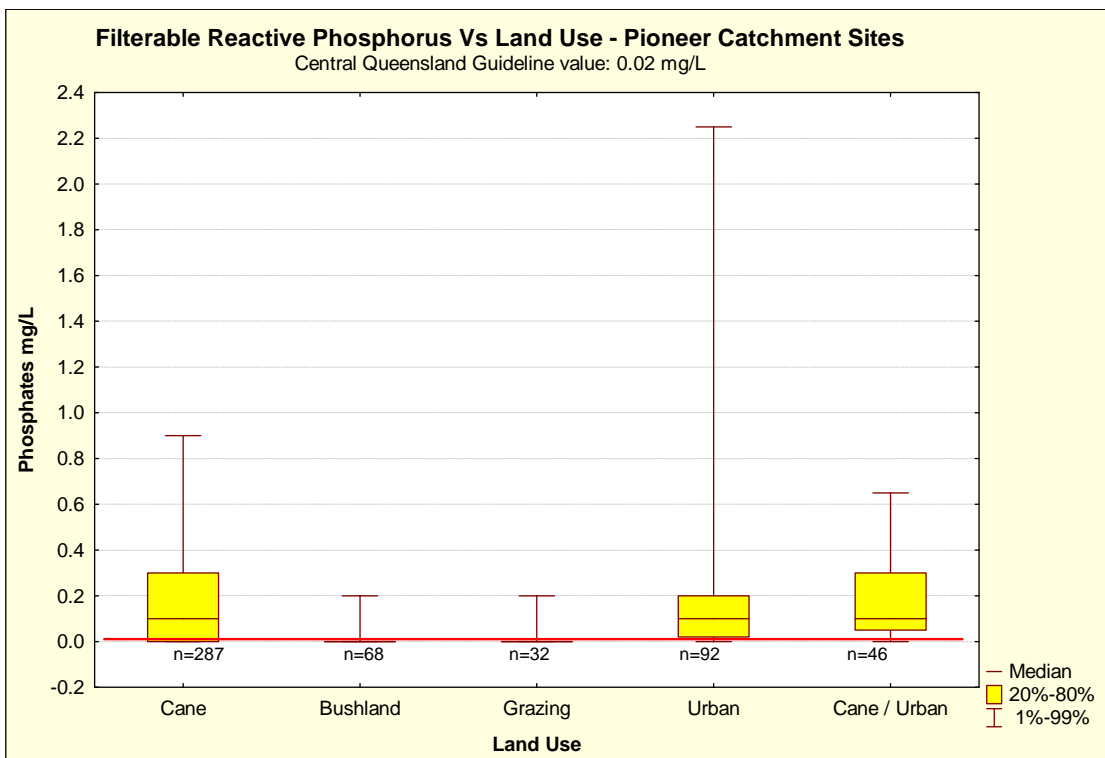
Amhurst Creek, Bowmans Crossing, Erakala Crossing, Willets Road, Glendaragh Road, Magpies and Reliance Creek (Site 2) contained maximum levels of 0.6 – 1.0 mg/L on some sampling occasions. Evans Avenue in the Gooseponds experienced an extremely high reading of 2.2 mg/L on the 2<sup>nd</sup> of March 2004. This result, coupled with lower EC readings, low clarity readings and volunteer notes on the record sheet indicates that this reading was taken after a rainfall event.

The Gooseponds are a very popular recreational area and do suffer from algal blooms at certain times of the year. March 2004 saw the Gooseponds suffering from one of these algal blooms with Anabaena and Microcystan algal colonies present. This may have been due to an un-seasonal rainfall event the month previous. This rainfall may have caused stratification within the water column which resulted in the phosphorus particles becoming unbound from the soil particles. This rainfall event, exacerbation by storm water runoff within this developing urban area, and potential presence of fertiliser in the runoff from cane catchments upstream are the likely causes for this algal bloom.

Urban dominated sites exhibited large maximum FRP levels after rainfall (Figure 30). This indicates the need for adequate storm water runoff measures to decrease organic matter, pollutants and sediment entering the aquatic ecosystem



**Figure 29 Filterable reactive phosphorus – Pioneer catchment sites**  
(Note: FHCK – Finch Hatton Creek; FCK – Fursden Creek; GP – Gooseponds; JCK – Janes Creek; SHCK – St Helens Creek; SCK – Sandy Creek)



**Figure 30 Filterable reactive phosphorus Vs Land use – Pioneer catchment sites**

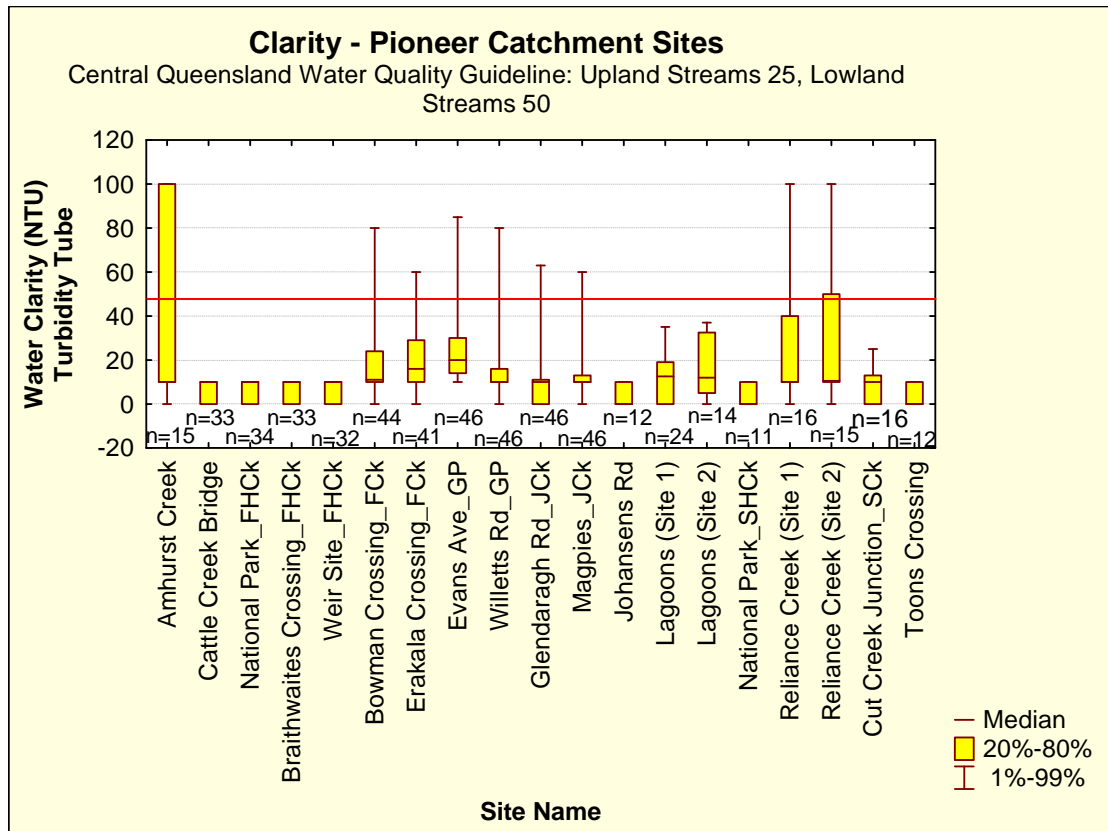
### 5.2.6 Clarity

All sites within the Pioneer catchment portrayed results lower than the central Queensland water quality guideline value for lowland streams on 50% of occasions (Figure 31). All bushland and forest sites maintained a high degree of clarity with readings less than 10 NTU. Many creeks including Fursden Creek, Gooseponds, Janes Creek and Reliance Creek exhibited poor clarity values on various occasions. Maximum readings for the Fursden Creek sites, Gooseponds sites and Janes Creek sites were 60 – 85 NTU and up to 100 NTU for both Reliance Creek sites. Sampling after rainfall events contributed to these poor readings in these catchments.

The ever-present urbanisation threat in the Janes Creek / Gooseponds catchments means stormwater measures need to be adequately designed to decrease organic matter, pollutants and sediment entering these systems.

All bushland and grazing sites gave results between 0 and 10 NTU each time they were sampled. Cane, urban and cane / urban sites were all relatively clear with readings around 10 NTU on 50% of occasions and 20 NTU on 80% of occasions (Figure 32), however as mentioned above, sites from these land use types all had results higher than the guideline value on occasions after rainfall.

Amhurst Creek exhibits very poor clarity (100 NTU on 80% of occasions). The number of samples (15) indicates that this site has been sampled all through the year, so one off event sampling for this location can be ruled out as the likely cause for this poor clarity. This site is located downstream of Farleigh Mill which releases mill water and effluent into the creek.



**Figure 31 Clarity – Pioneer catchment sites**  
 (Note: FHCK – Finch Hatton Creek; FCK – Fursden Creek; GP – Gooseponds; JCK – Janes Creek; SHCK – St Helens Creek; SCK – Sandy Creek)

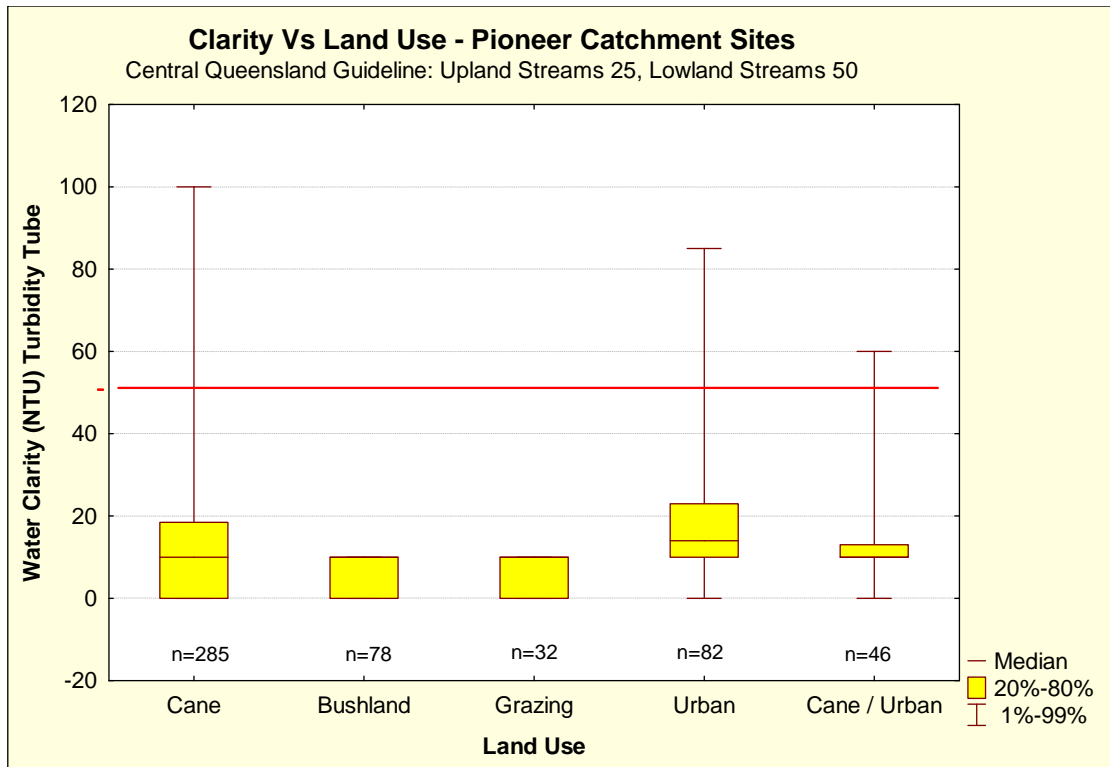


Figure 32 Clarity Vs Land-use – Pioneer catchment sites

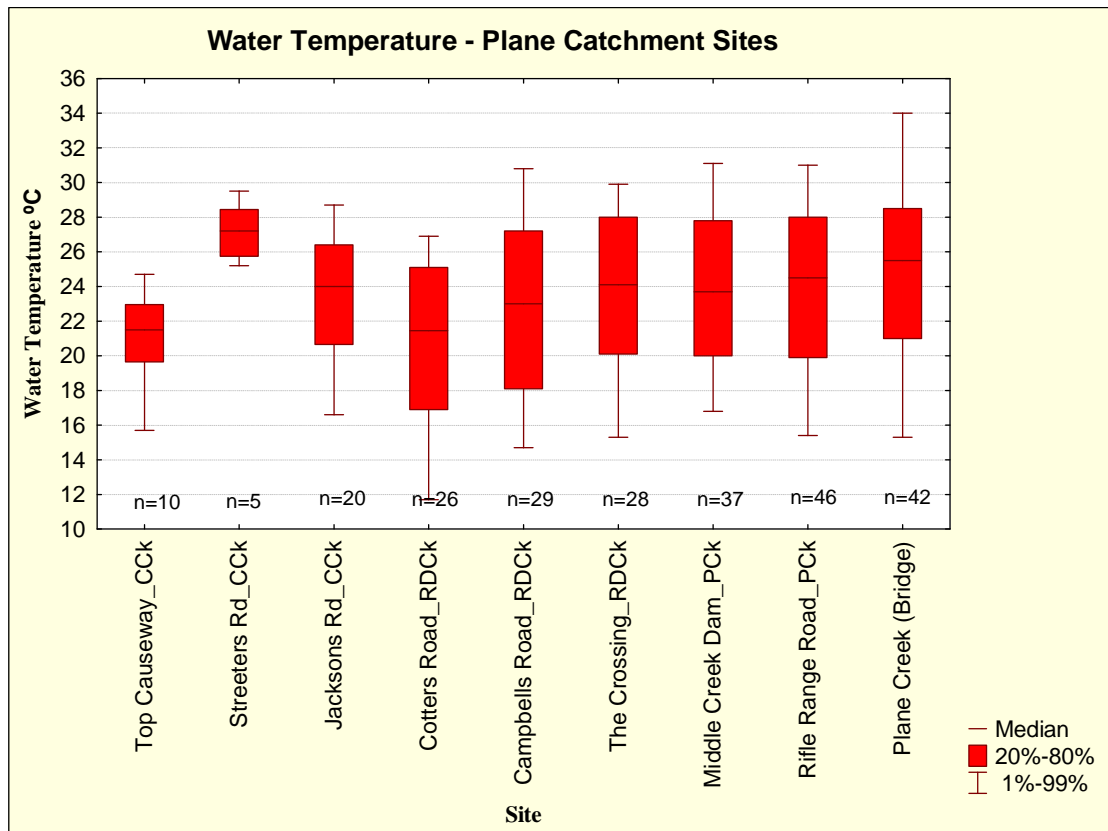
### 5.3 Plane Catchment Sites

#### 5.3.1 Water Temperature

Plane catchment sites portrayed uniformity amongst its median temperature range (Figure 33). This range was from 21.5 – 27.1°C, for 50% of the sampling occasions. These results fall within the range encompassed by all the ambient monitoring sites in the Mackay Whitsunday region.

The Cotters Road site on Rocky Dam Creek experienced the minimum recorded temperature of 11.7°C in August, 2004. Plane Creek Bridge in Sarina had the greatest temperature variation with results from 15.3°C in the winter to 34.0°C in summer. This temperature is quite warm even for summer and may be a result of sugar mill effluent and water pumping. The mill is located less than 200m upstream from the sampling site.

The Streeters Road site on Carmila Creek had the least variation with a range of 25.2 – 29.5°C. Its median temperature of 27.1°C is slightly higher than the median temperatures of other sites. This result may be potentially misleading due to the fact that this site had only been sampled 5 times (hence the low variability shown in the box plot) with samples taken from October 2005 to February 2006. These are the warmer months of the year and will account for the higher median temperature.



**Figure 33 Water temperature – Plane catchment sites**  
 (Note: Cck – Carmila Creek; RDck – Rocky Dam Creek; PCk – Plane Creek)

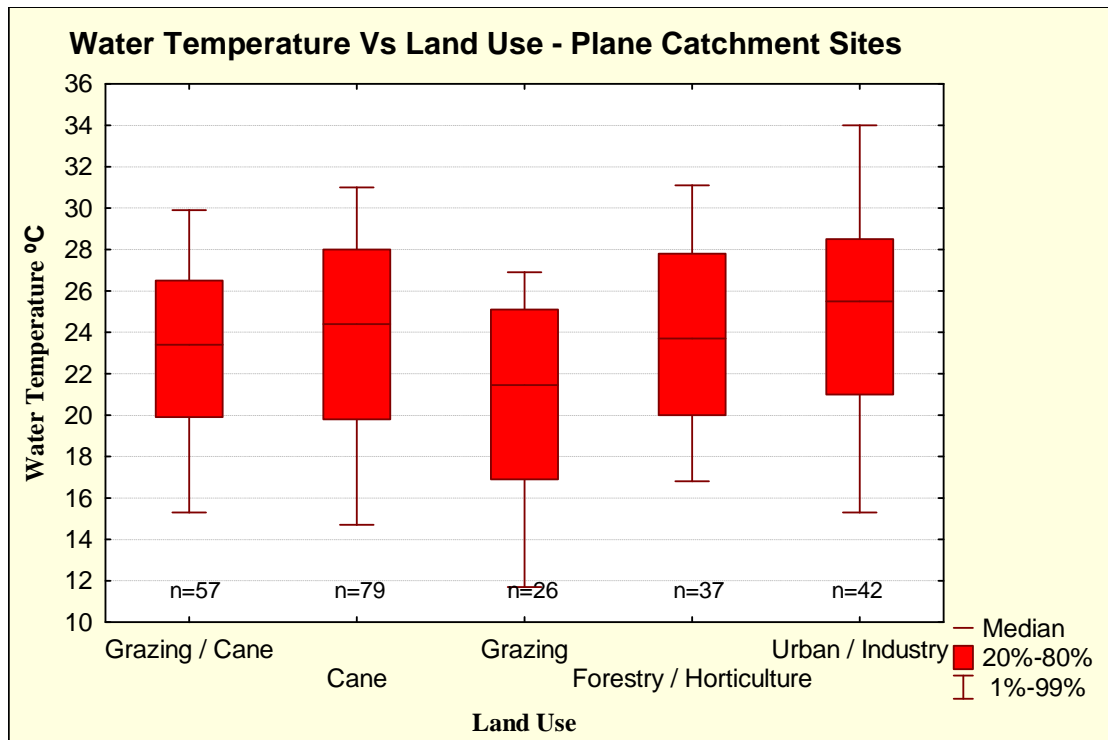


Figure 34 Water temperature Vs Land use – Plane catchment sites

### 5.3.2 Dissolved Oxygen

Jacksons Road (Carmila Creek), Campbells Road (Rocky Dam Creek), Middle Creek Dam (Plane Creek) and Plane Creek Bridge all possessed extremely low minimum oxygen levels ranging from 4.4 – 10.5% saturation. Hypoxic conditions such as these would make these sites inhospitable to the substantial majority of higher order aquatic species for periods of the year. These low oxygen levels occurred during an outbreak of the exotic weed - Water Lettuce (Figure 35). Limiting the amount of nutrient-laden runoff from neighbouring cane farms would help reduce the incidence of such unpleasant weed outbreaks.

Top Causeway (Carmila Creek), The Crossing (Rocky Dam Creek) and Rifle Range Road (Plane Creek) reached the minimum guideline value of 80% saturation, half the time. The median dissolved oxygen concentrations for all sites in the Plane catchment ranged from 40 – 88% saturation (Figure 36).

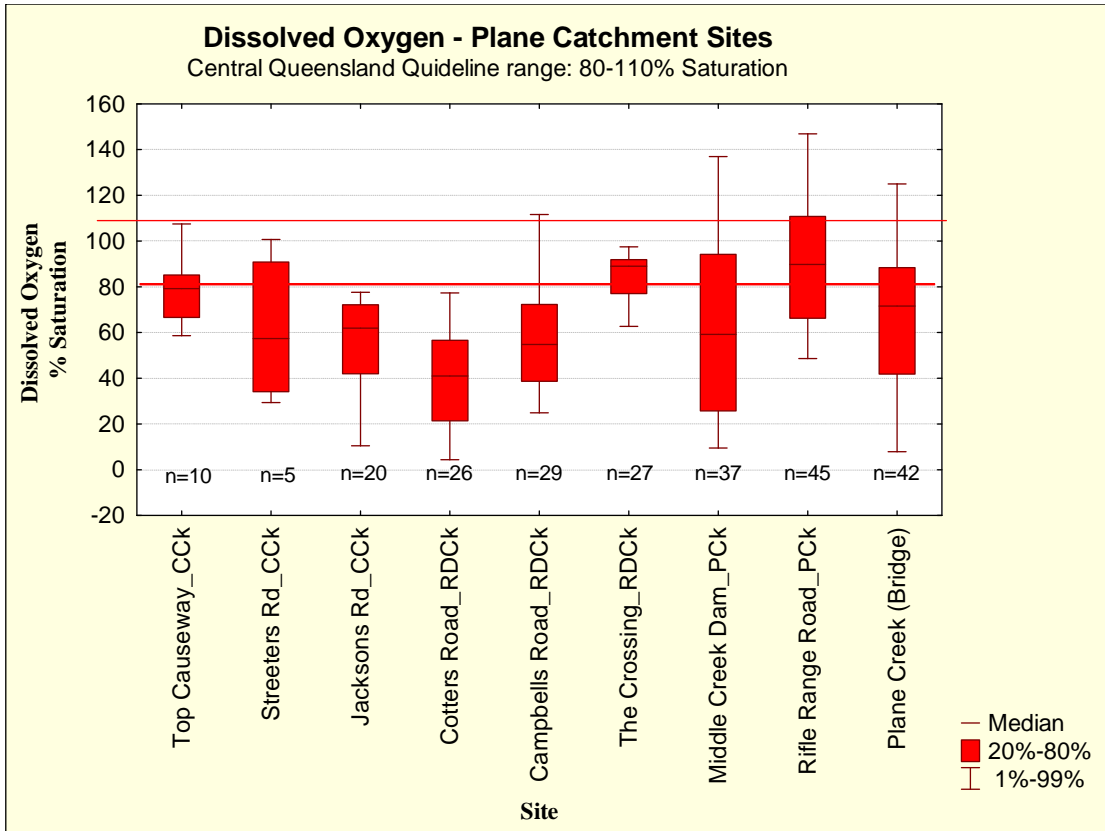


**Figure 35 Water Lettuce bloom – Plane Creek at Sarina**

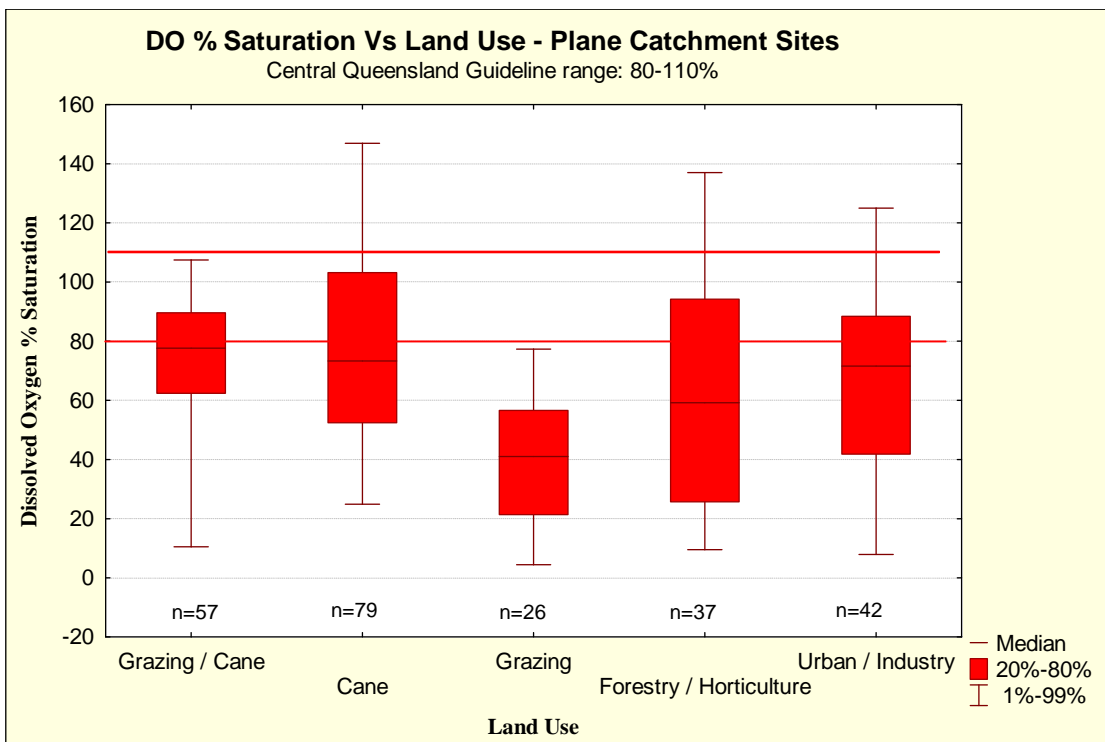
In contrast, Middle Creek Dam, Rifle Range Road and Plane Creek have exhibited results at the other end of the spectrum, possessing very high oxygen levels (upwards of 125% saturation) at certain times of the year.

Grazing / cane catchments reached the minimum guideline of 80% saturation on half the sampling occasions. Cane catchments reached 74% saturation for half of the time (Figure 37). This illustrates that grazing / cane and cane-dominated catchments in the Plane Creek catchment were no-where near as oxygen deficient as similar land uses in the Whitsunday and Pioneer catchments.

The grazing site in the Plane Creek catchment (Cotters Road - Rocky Dam Creek) rated poorly with the lowest median value of 40% saturation. Even the maximum recorded reading of 77.3% saturation for this site is less than the minimum guideline value of 80%. This site is located in the upper reaches of the catchment. Moving downstream to the Campbells Road site and “The Crossing site”, DO levels get considerably better, this may be due to an increase in photosynthesis and oxygen production. The widening of the stream would give aquatic macrophytes a greater chance to utilise the suns energy.



**Figure 36 Dissolved oxygen – Plane catchment sites**  
(Note: CCK – Carmila Creek; RDCK – Rocky Dam Creek; PCK – Plane Creek)



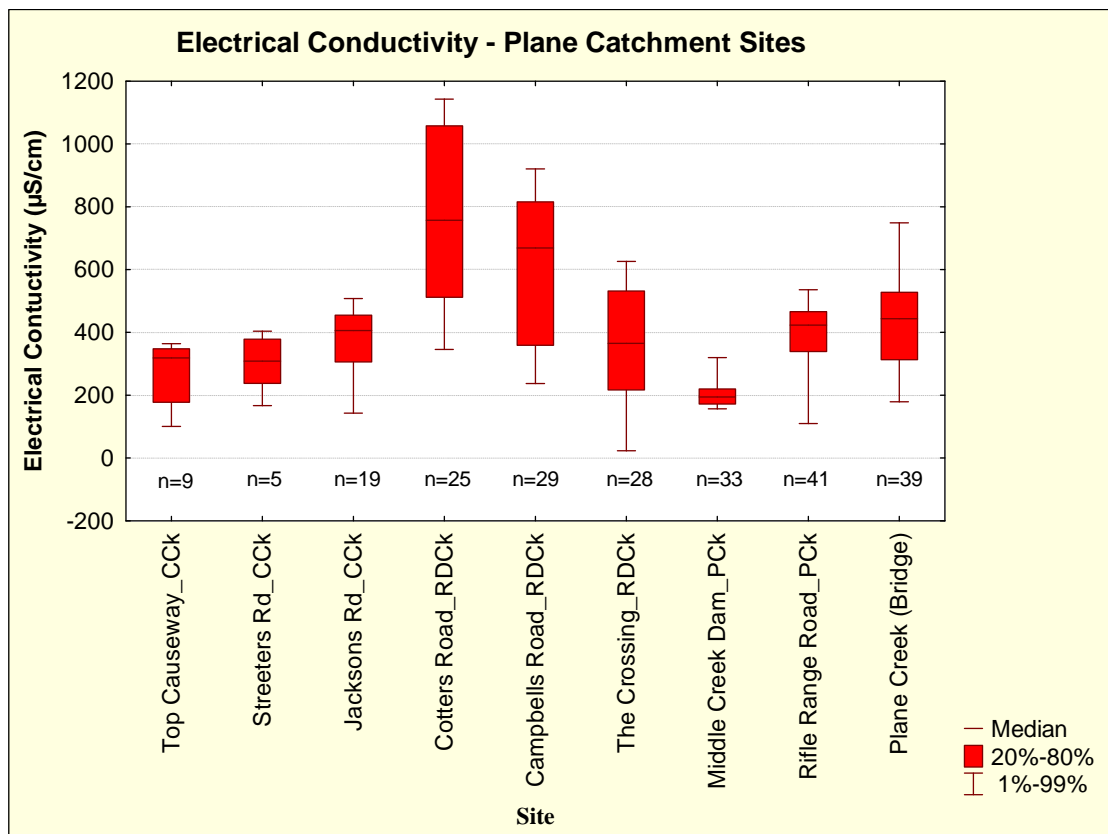
**Figure 37 Dissolved oxygen Vs Land use – Plane catchment sites**

### 5.3.3 Electrical Conductivity (EC)

Median EC readings ranged from 200 to 760  $\mu\text{S}/\text{cm}$  for sites within the Plane catchment (Figure 38). Seven of the 9 sites exhibited results between 200 and 450  $\mu\text{S}/\text{cm}$ , on 50% of occasions, the only exceptions being the Cotters Road and Campbells Road sites on Rocky Dam Creek. Cotters Road (grazing) ranged from 350 – 1150  $\mu\text{S}/\text{cm}$  with a median value of 750  $\mu\text{S}/\text{cm}$  and Campbells Road (cane) ranged from 237 – 921  $\mu\text{S}/\text{cm}$  with a median value of 671  $\mu\text{S}/\text{cm}$ . These consistently high readings at both sites are attributed to probable groundwater recharge.

Middle Creek Dam is governed by forestry and / or horticulture as the dominant land use type. A median of 200  $\mu\text{S}/\text{cm}$  is prevalent for this site. It portrayed a narrow range (157 – 320  $\mu\text{S}/\text{cm}$ ). This narrow range is indicative of freshwater and is to be expected from largely forested or bushland dominated sites. Results were consistently within this range on 33 sampling occasions.

Grazing / cane, cane and urban / industrial sites gave similar medians (350 – 450  $\mu\text{S}/\text{cm}$ ), but variable minima and maxima (Figure 39). EC readings at these 3 sites were higher early in the summer months and lower after the wet season.



**Figure 38 Electrical conductivity – Plane catchment sites**  
 (Note: CCK – Carmila Creek; RDCK – Rocky Dam Creek; PCK – Plane Creek)

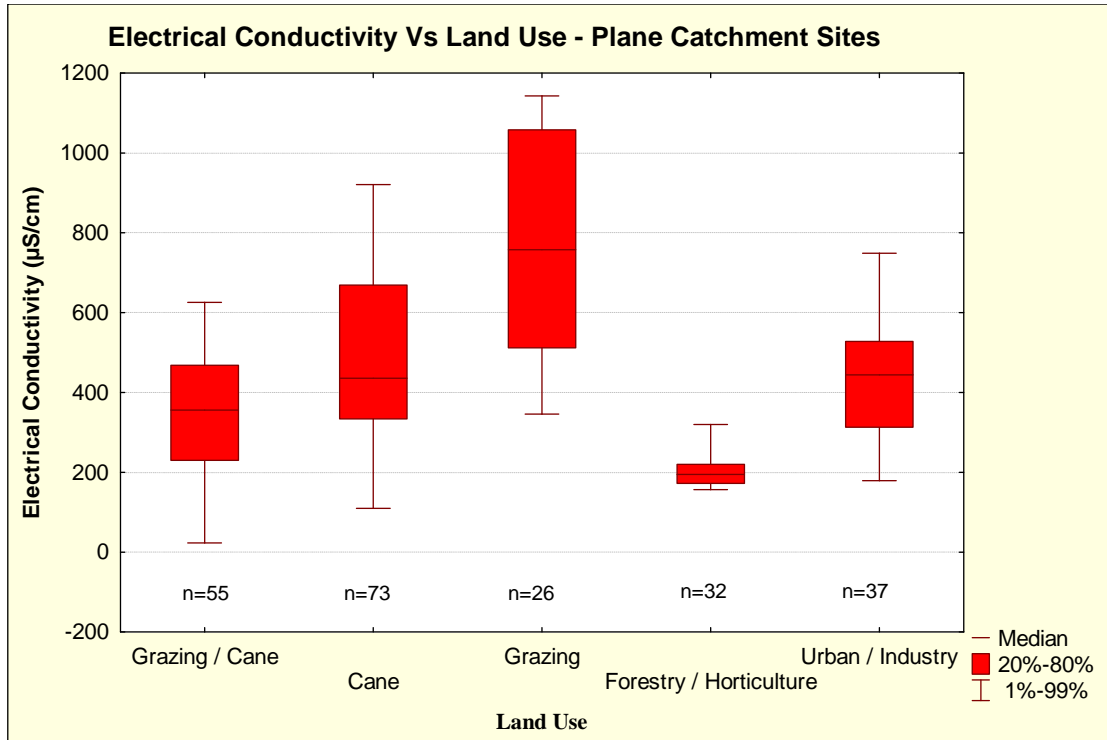


Figure 39 Electrical conductivity Vs Land use – Plane catchment sites

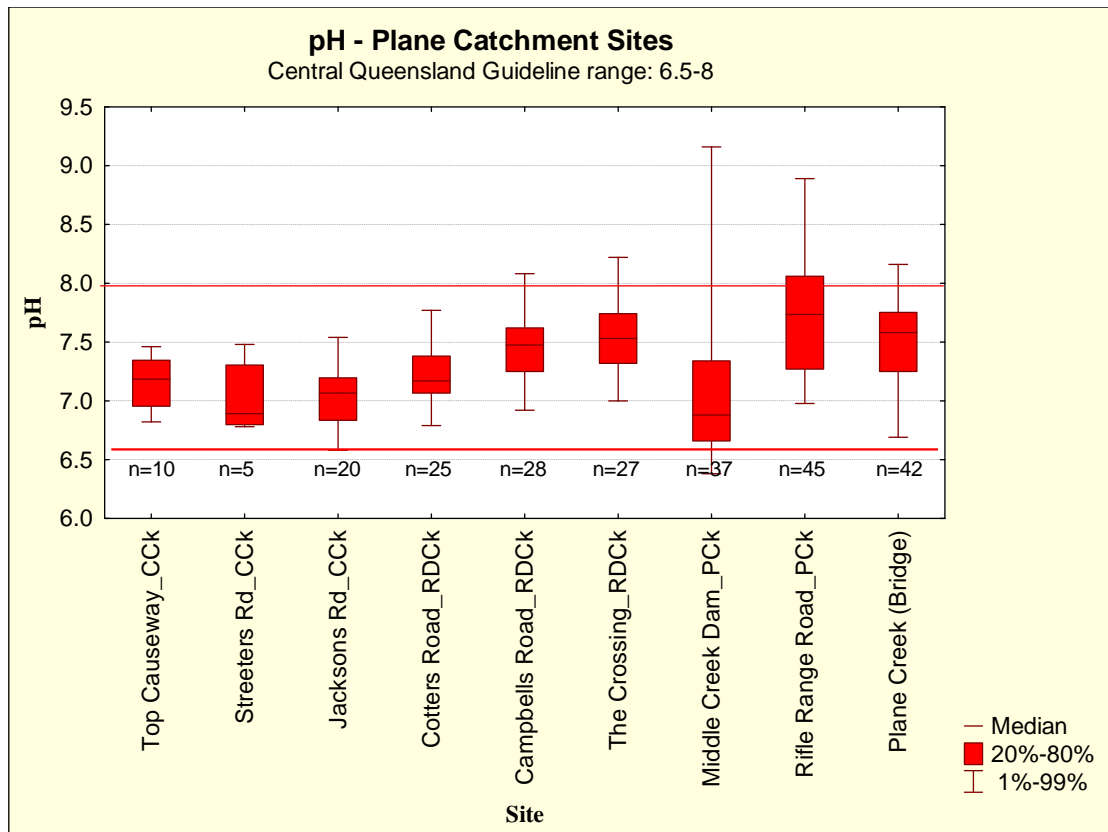
### 5.3.4 pH

pH levels in the Plane Creek catchment fell within the Central Queensland water quality range of 6.5 – 8.0 on 50% of occasions. Significant variability within this range is evident (Figure 40).

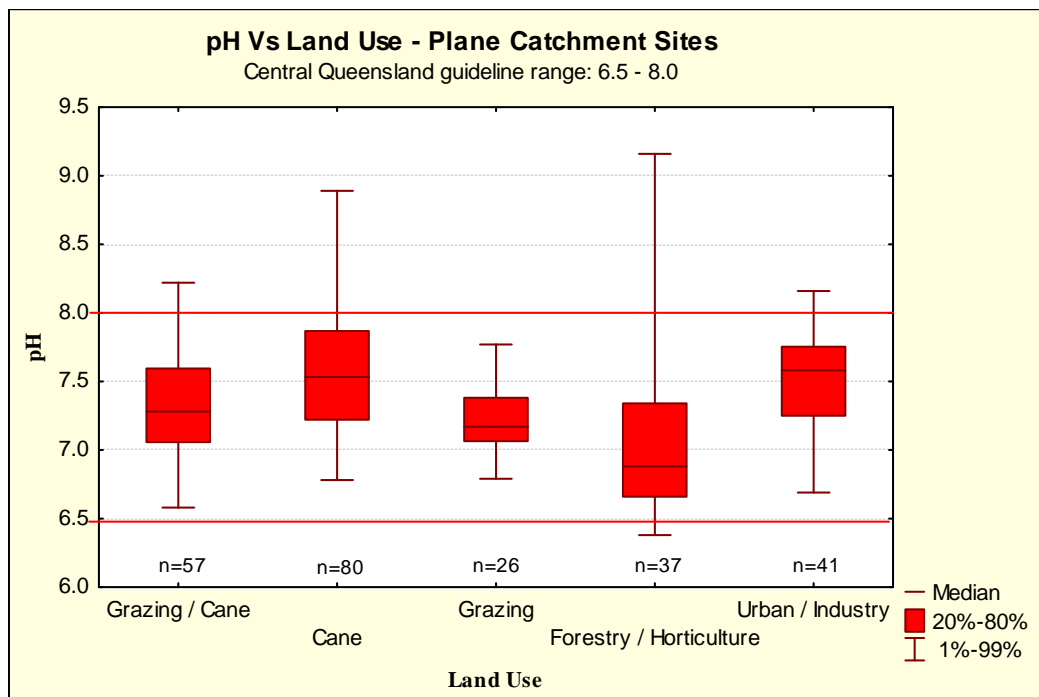
The 3 Carmila Creek sites (Top Causeway, Streeters Road and Jacksons Road) as well as the Cotters Road Site fell within the guideline range on 99% of occasions. Even though all 3 sites on Carmila Creek fell almost entirely within this guideline range, they were all slightly acidic in comparison with the other creeks in the catchment. This slightly acidic influence could be due to the Melaleuca trees which dominate the riparian zone. The abundance of Para-grass may also account for the high pH readings. This exotic nuisance traps seeds, restricts flow, decreases available habitat and lowers DO and pH levels.

Campbells Road, The Crossing and Plane Creek had maximum levels just exceeding the maximum guideline range on various occasions. Middle Creek Dam was the only site within the Plane Creek catchment which reached a minimum reading (6.38), below the minimum guideline value of 6.5.

Median values for land use types ranged between 6.88 and 7.6, with the forestry / horticulture site (Middle Creek Dam) portraying the lowest median and the urban / industry site (Plane Creek) having the highest median value (Figure 41). Middle Creek Dam on Plane Creek had the greatest pH range. The dam environment (Middle Creek Dam) experiences rapid water inundation alternating with prolonged dry periods.



**Figure 40 pH – Plane catchment sites**  
(Note: CCK – Carmila Creek; RDCK – Rocky Dam Creek; PCK – Plane Creek)



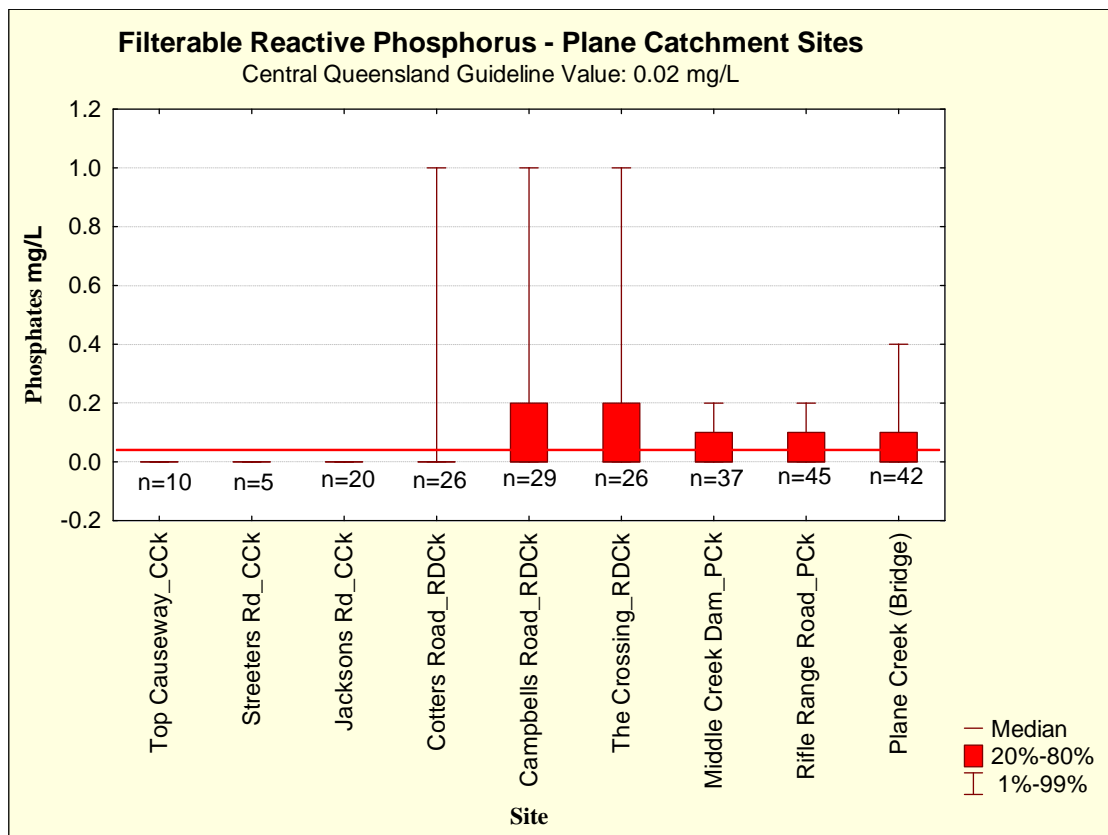
**Figure 41 pH Vs Land use – Plane catchment sites**

### 5.3.5 Filterable Reactive Phosphorus (FRP)

FRP was below detectable limits at each of the 3 Carmila Creek sites (Figure 42).

Middle Creek Dam and Rifle Range Road sites on Plane Creek exhibited FRP levels up to 0.1 mg/L, on 80% of occasions and a maximum level of 0.2 mg/L on one occasion. Rocky Dam Creek sites (Cotters Road, Campbells Road and “The Crossing”) contained high levels of FRP (1 mg/L) on occasions. FRP concentrations tended to increase downstream. Organic matter and fertilisers may be the source of this nutrient influx.

Grazing / cane, cane and grazing sites all exhibited readings of 1 mg/L at certain times of the year (Figure 43). Forestry / horticulture and urban / industry sites had readings of 0.1 mg/L for 80% of the time but reached maxima of 0.2 mg/L and 0.4 mg/L on some occasions.



**Figure 42 Filterable reactive phosphorus – Plane catchment sites**  
 (Note: CCK – Carmila Creek; RDCK – Rocky Dam Creek; PCK – Plane Creek)

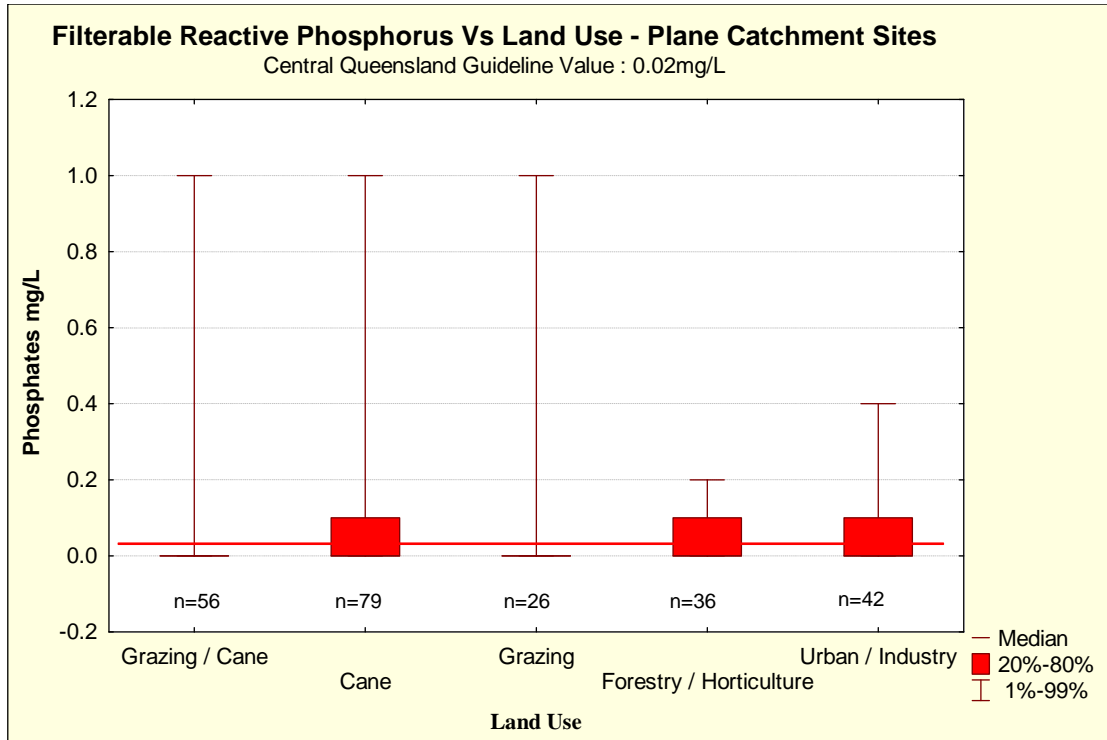


Figure 43 Filterable reactive phosphorus Vs Land use – Plane catchment sites

### 5.3.6 Clarity

Recorded comments for Carmila Creek – Streeters Road indicates that the water level was very high and turbid on March 8<sup>th</sup>, 2006. The sample had to be taken from the car due to the inundation of the usual sampling site. This was caused by 135mm of rain falling within 3 days prior to sampling. This rainfall caused the creek to rise more than 1m (Figure 44).

Carmila Creek (Streeters Road) and Plane Creek (both Rifle Range Road and Bridge Site) exhibited readings above the guideline value on various occasions (Figure 45). These occasions were correlated with rainfall events, but also excessively dry periods with low water levels.

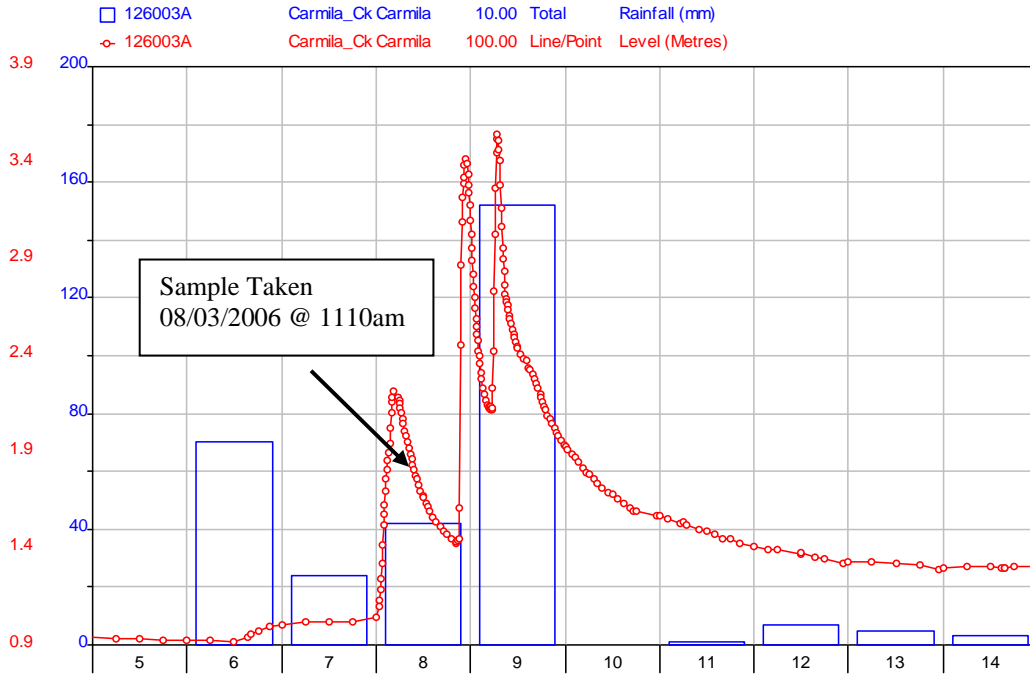
Plane Creek Bridge exhibited poor clarity levels of 85 NTU on April 20<sup>th</sup> and 70 NTU on June 15<sup>th</sup>, 2006. Volunteer comments stated that the creek had limited water with muddy islands and bars protruding. The reduction of the flowing creek to a series of muddy pools reduced the clarity of the creek.

**Qld NRW SWDB**

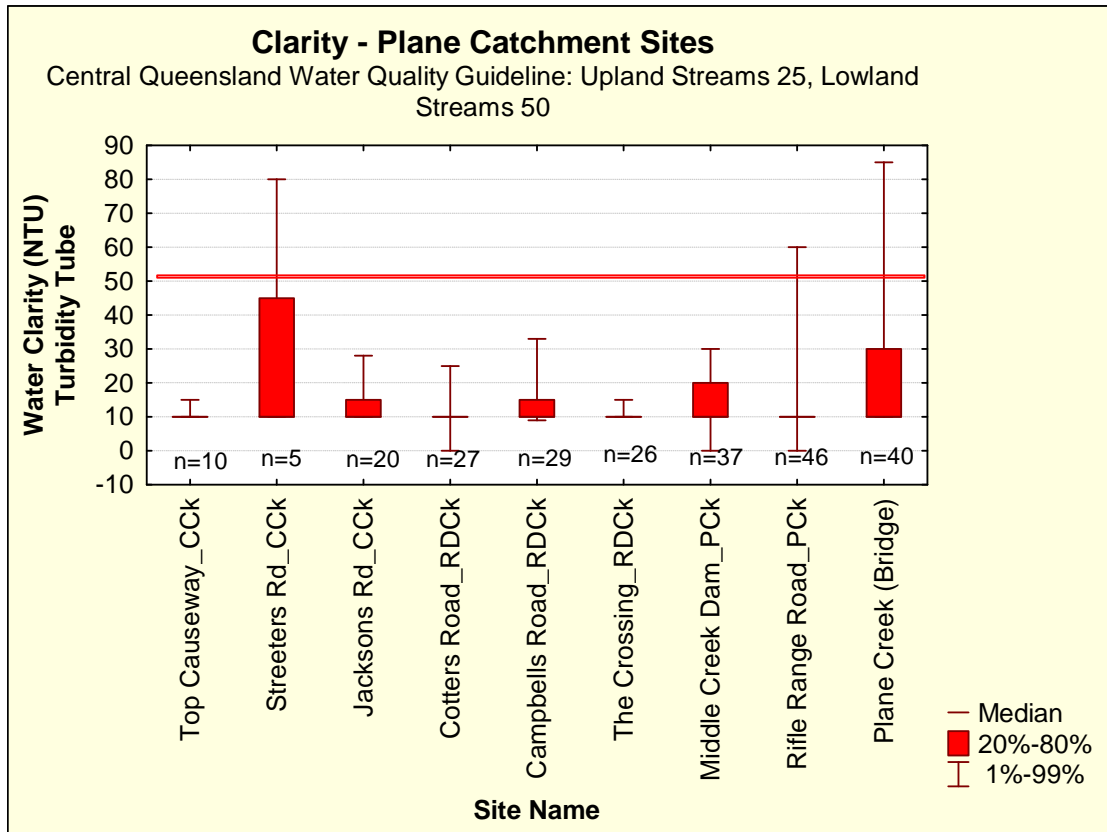
HYPLOT V132 Output 07/02/2008

Period 10 Day Plot Start 00:00\_05/03/2006  
 Interval 1 Day Plot End 00:00\_15/03/2006

2006



**Figure 44 Carmila Creek hydrograph and rainfall plot showing the point at which the sample was collected.**



**Figure 45 Clarity – Plane Catchment Sites**  
 (Note: CCK – Carmila Creek; RDCK – Rocky Dam Creek; PCK – Plane Creek)

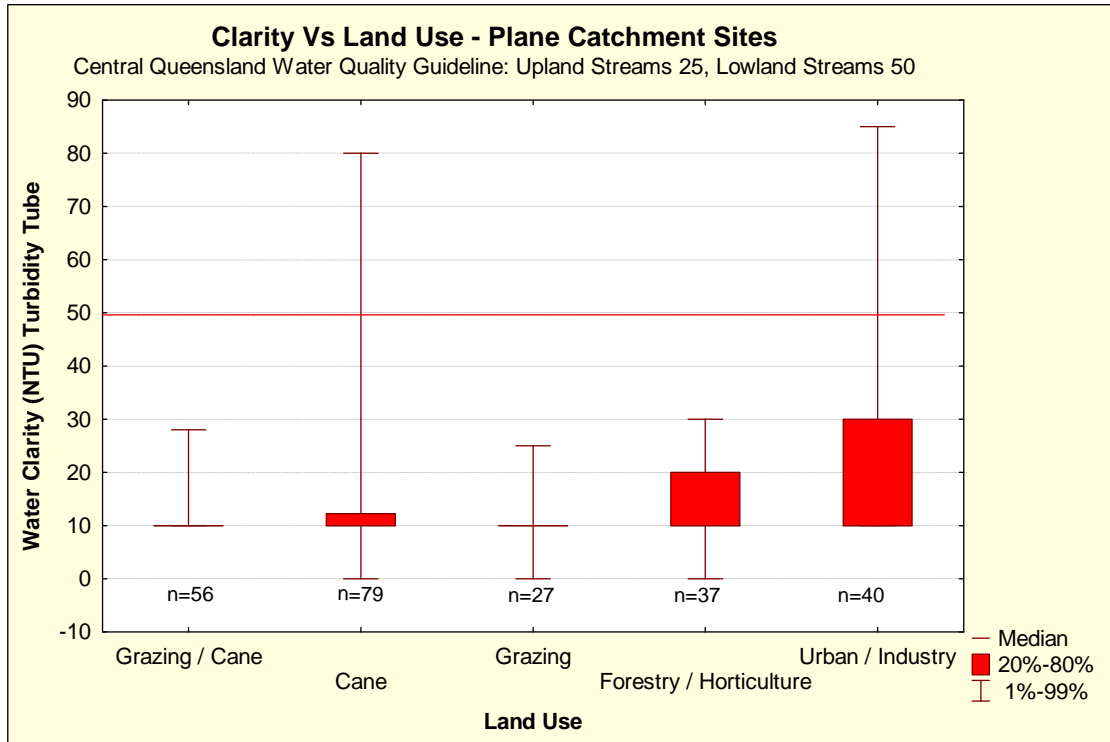


Figure 46 Clarity Vs Land Use – Plane Catchment Sites



## 6 CONCLUSIONS

Throughout the Mackay Whitsunday region:

- Relatively uniform water temperatures were present across the majority of sites and land uses. This indicates that water temperature is primarily governed by the physical structure of the waterway (water depth, river width and riparian shading) rather than surrounding land use practice.
- Low dissolved oxygen concentrations were prevalent for the vast majority of sites, with DO concentrations outside Central Queensland Water Quality Guidelines on 50% of occasions. Through these results, it is evident that the Mackay Whitsunday region exhibits behaviour of a hypoxic nature.
- Electrical conductivity (EC) varied among sites with high levels at various sites caused by groundwater influence or catchment geology.
- pH values at all sites were within the Central Queensland water quality guideline range on 50% of occasions.
- Filterable reactive phosphorus (FRP) levels were higher in urban catchments, cane / urban catchments or areas where point source pollution was an influence.
- Water clarity was consistently good across all land use types where substantial groundcover was prevalent. This is attributed to the widespread adoption of “best management practices” such as green cane trash blanketing on a paddock scale. Sites exhibiting higher clarity at various times were attributed to localised rainfall events.



## 7 REFERENCES

- ANZECC and ARMCANZ (2000) 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality.' (Australian and New Zealand Environmental and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand: Canberra)
- Arthington A, Choy S, Craigie N, Mackay S, Poplawski W, Pusey B and Werren G (2001) 'Current environmental condition and impacts of existing water resource development: Pioneer Valley Water Resource Plan.' Department of Natural Resources and Mines, Queensland Government.
- AS/NZS (1998) '5667.6:1998 Water Quality - Sampling - Guidance on sampling rivers and streams.' Standards Australia, Homebush and Standards New Zealand, Wellington.
- Brodie J (2004) 'Mackay Whitsunday Region State of the Waterways Report 2004.' James Cook University, ACTFR Report No. 02/03, Townsville.
- Brodie J, Faithful JW and Cullen K (2004) 'Community Water Quality Monitoring in the Burdekin River Catchment and Estuary, 2003 – 2004.' James Cook University, ACTFR Report No. 03/16 for The Queensland Department of Primary Industries and Fisheries and the Burdekin Dry Tropics, Townsville.
- DNR (2003) 'Water Quality Monitoring Standards.' Department of Natural Resources, Queensland Government.
- DNRM (2006) 'Health and Safety Guidelines for community-based waterway monitoring.' Queensland Department of Natural Resources and Mines, Queensland Government.
- Drewry J, Higham W and Mitchell C (2008) 'Water Quality Improvement Plan: Final report for Mackay Whitsunday region.' Mackay Whitsunday Natural Resource Management Group, Mackay, Australia.
- EPA (2006) 'Queensland Water Quality Guidelines, 2006.' Environmental Protection Agency, Queensland Government, Brisbane.
- Faithful J (2003) 'Water quality in the Whitsunday Rivers catchments.' James Cook University, ACTFR Report No. 02/13, Townsville.
- Fries N (2007a) 'Mackay Whitsunday Healthy Waterways Ambient Monitoring Plan.' Mackay Whitsunday Natural Resource Management Group, Mackay.
- Fries N (2007b) 'Mackay Whitsunday Healthy Waterways Ambient Monitoring Program Regional Report 2006.' Mackay Whitsunday Natural Resource Management Group, Mackay.
- Galea L, Peplinkhouse D, Loft F and Folkers A (2008b) 'Mackay Whitsunday Healthy Waterways Baseline Monitoring Program Regional Report.' Queensland Department of Natural Resources and Water for the Mackay Whitsunday Natural Resource Management Group, Australia.
- Masters B, Rohde K, Gurner N, Higham W and Drewry J (2008) 'Sediment, nutrient and herbicide runoff from canefarming practices in the Mackay Whitsunday region: a field-based rainfall simulation study of management practices.' Queensland Department of Natural Resources and Water for the Mackay Whitsunday Natural Resource Management Group, Australia.
- MWNRM (2005) 'Mackay Whitsunday Natural Resource Management Plan 2005.' Mackay Whitsunday Natural Resource Management Group, Inc., Mackay, Australia.
- Oldmeadow E (2004) 'Healthy Waterways Volunteer Water Quality Monitoring Program Annual Report 2003-2004.' Mackay Whitsunday Natural Resource Management Group, Mackay.

Rayment GE (2003) Water quality in sugar catchments of Queensland. *Water Science and Technology* **48**, 35-47.

Rohde K, Masters B, Brodie J, Faithful J, Noble R and Carroll C (2006) 'Fresh and Marine Water Quality in the Mackay Whitsunday Region 2004/2005.' Mackay Whitsunday Natural Resource Management Group, Mackay, Australia.

Rohde K, Masters B, Fries N, Noble R and Carroll C (2008) 'Fresh and Marine Water Quality in the Mackay Whitsunday Region 2004/05 to 2006/07.' Queensland Department of Natural Resources and Water for the Mackay Whitsunday Natural Resource Management Group, Australia.

The State of Queensland and Commonwealth of Australia (2003) 'Reef Water Quality Protection Plan: for catchments adjacent to the Great Barrier Reef World Heritage Area.' Brisbane.