



Wet Tropics water quality statistics for high and base flow conditions

Great Barrier Reef Catchment Loads Monitoring Program, Water Quality and Investigations, Environmental Monitoring and Assessment Sciences, Science Division

April 2014

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Citation

Orr, D., Turner, R.D.R., Huggins, R., Vardy, S., Warne. M. St. J. 2014, Wet Tropics water quality statistics for high and base flow conditions. Great Barrier Reef Catchment Loads Monitoring Program, Department of Science, Information Technology, Innovation and the Arts, Brisbane.

Acknowledgements

The authors gratefully acknowledge all stakeholders who assisted in the collection of water samples; including hydrographers and scientists of the Queensland Department of Natural Resource and Mines, officers of Terrain Natural Resource Management bodies, Queensland Department of Agriculture, Fisheries and Forestry and research staff of the Australian Centre for Tropical Fisheries Research at James Cook University. Thanks also go to the all members, partners and stakeholders of Reef Plan and the Paddock to Reef Program. The authors would like to acknowledge the advice provided by the Science Delivery Chemistry Centre and Queensland Health Forensic and Scientific Services. Finally, the authors wish to thank the reviewers for the valuable feedback provided on earlier drafts of this report.

Front cover image: provided by Ryan Turner.

April 2014

Executive summary

The Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) collects water quality monitoring data throughout the year at 25 sites along the east coast of Queensland. The monitoring focuses on high flow conditions (when the river height rises following rainfall) but also includes base flow (ambient) conditions. The program measures the concentrations and calculates the annual loads (total amounts) of total suspended solids, nutrients and pesticides at the sites. The GBRCLMP is well suited to provide data for deriving water quality guidelines for both base flow and high flow conditions.

In 2013, the Department of Environment and Heritage Protection (DEHP) requested that the Department of Science, Information Technology, Innovation and the Arts (DSITIA) use GBRCLMP data to calculate summary statistics of water quality under base flow and high flow conditions for rivers in the Wet Tropics Natural Resource Management (NRM) area. A report was prepared and provided to DEHP in December, 2013. DEHP subsequently requested the report be updated using GBRCLMP water quality data for 2012–2013 and from the Herbert Water Quality Monitoring Program (HWQMP). The current report summarises water quality monitoring data collected over eight years from July 1, 2005 to June 30, 2013.

In total there are appropriate water quality data for 15 sites in the Wet Tropics NRM area covering the Barron, Johnstone, Tully and Herbert River catchments. The mean daily base flow rate was calculated for each site and subsequently the base and high flow conditions were determined. The 20th, 50th and 80th percentiles of the base and high flow concentration data for total suspended solids, total nitrogen, particulate nitrogen, oxidised nitrogen, ammonia nitrogen, dissolved organic nitrogen, total phosphorus, particulate phosphorus, filterable reactive phosphorus and dissolved organic phosphorus were calculated. Some of these values may be appropriate for adoption into the Queensland Water Quality Guidelines.

The percentile values vary considerably across the various sites reflecting differences in rainfall and characteristics of the catchments. Approximately 75% of the time the percentile values were higher under high flow conditions than for base flow conditions. On average, the percentiles for high flow conditions were approximately 25% larger than the corresponding base flow values for the parameters that measure soluble pollutants (oxidised nitrogen, ammonia nitrogen, dissolved organic nitrogen, filterable reactive phosphorus and dissolved organic phosphorus). In contrast, the percentile values for high flow conditions were on average more than seven-times larger than the corresponding base flow percentiles for the parameters related to total pollutants (total suspended solids, total nitrogen, particulate nitrogen, total phosphorus and particulate phosphorus).

Similar reports for other NRM regions for which DSITIA has data could be written in future. Similarly, annual updates containing the most recent data could be generated if requested.

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Introduction

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000), hereafter referred to as the Guidelines, are a key technical document in assessing the sustainable use of Queensland waterways. The Guidelines provide guideline values to protect aquatic ecosystems and human uses of waterways. The Guidelines have a national focus and the limitations of applying them to individual water bodies are acknowledged and the development of regional or local guidelines is encouraged. In 2009 the Queensland Government published the Queensland Water Quality Guidelines (DERM 2009) which used local water quality data to derive regionally specific guideline values. The DEHP are currently updating the Queensland Water Quality Guidelines with more relevant water quality data.

In 2013, the DEHP requested that DSITIA use GBRCLMP data to calculate summary statistics of water quality under base and high flow conditions for rivers in the Wet Tropics NRM area. A report was prepared and provided to DEHP in December, 2013 (Turner et al. 2013a). DEHP subsequently requested the report be updated using GBRCLMP water quality data for 2012–2013 and from the Herbert Water Quality Monitoring Program (HWQMP). The current report summarises water quality monitoring data collected over eight years from July 1, 2005 to June 30, 2013.

This report uses water quality data collected by the Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) and the Herbert Water Quality Monitoring Program (HWQMP) from 15 sites in 4 priority catchments within the Wet Tropics Natural Resource Management (NRM) region. These data are used to derive summary statistical values (i.e., 20th, 50th and 80th percentile values of total suspended solids and nutrients) for high and base flow conditions that can be used to update the Queensland Water Quality Guidelines (DERM 2009). High flow conditions are defined as all times during which the river flow is greater than the mean daily base flow (MDBF) and base flow as being all times the river flow is less than or equal to the MDBF. The scope of this report is confined to the calculation of percentiles based on water quality data from the monitored area of each catchment. These percentile values may not represent the final values included in the updated Queensland Water Quality Guidelines.

Methods

Between 1 July, 2005 and 30 June, 2013 monitoring was undertaken at 15 sites located in four priority Wet Tropics catchments (Table 1 and Figure 1 to Figure 4). All sites were established at or near to existing Queensland Government stream gauging stations (Table 1) except the Waterfall Creek at Tomba site. GBRCLMP sites are classified as either end-of-system, sub-catchment. The HWQMP sites were not classified as their locations were selected to measure inputs from specific land-uses. End-of-system sites are defined as the lowest point in a river or creek, which does not have tidal influence and the volume of water can be accurately gauged. Sub-catchment sites are located on rivers or creeks that have different drainage basins to the major river for those catchments.

The North Johnstone River at Old Bruce Hwy Bridge (Goondi) site is located 11 kilometres downstream from the North Johnstone River at Tung Oil site and is occasionally used due to occupational health and safety or site access reasons. The flow from the North Johnstone River at Tung Oil site is used for the North Johnstone at Old Bruce Hwy Bridge (Goondi) site. Similarly, Nash's Crossing is not located at a Department of Natural Resources and Mines (DNRM) gauging station. The flow for Herbert River at Abergowrie (gauging station 116006B) was used for Nash's Crossing. The Herbert River at Abergowrie gauging station is located 28 kilometres downstream of Nash's Crossing.

There were a number of HWQMP sites that were not located near suitable DNRM gauging stations. These include: Mill Creek at Jossan's, Wondecla; Nettle Creek at Herbert River Road; Waterfall Creek at Vellas; Boundary Creek at Guazzo's; Gangemi's Road Drain at Hawkins Creek; Forresthome (Urban) Drain at Darymple Street; Waterview Creek at Yuruga Road and Waterfall Creek at Tomba's (Terrain NRM 2011). For all these sites flow data were not available and as a result they have not been included in this report. The exception being Waterfall Creek at Tomba's which was included due to its importance as a reference site. As we were unable to monitor flow at this site, MDBF calculations were not possible. The 20th, 50th and 80th percentile values for this site were calculated from the full set of data and not separated into base and high flow conditions.

Concentration data for the Herbert River at Ingham (gauging stations 116001E and 116001F) were collected by the Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP). Concentration values for all other Herbert catchment sites were provided by the HWQMP. Data from the HWQMP are being used as presented and have not undergone any additional quality control measures by the Department of Science, Information Technology, Innovation and the Arts (DSITIA).

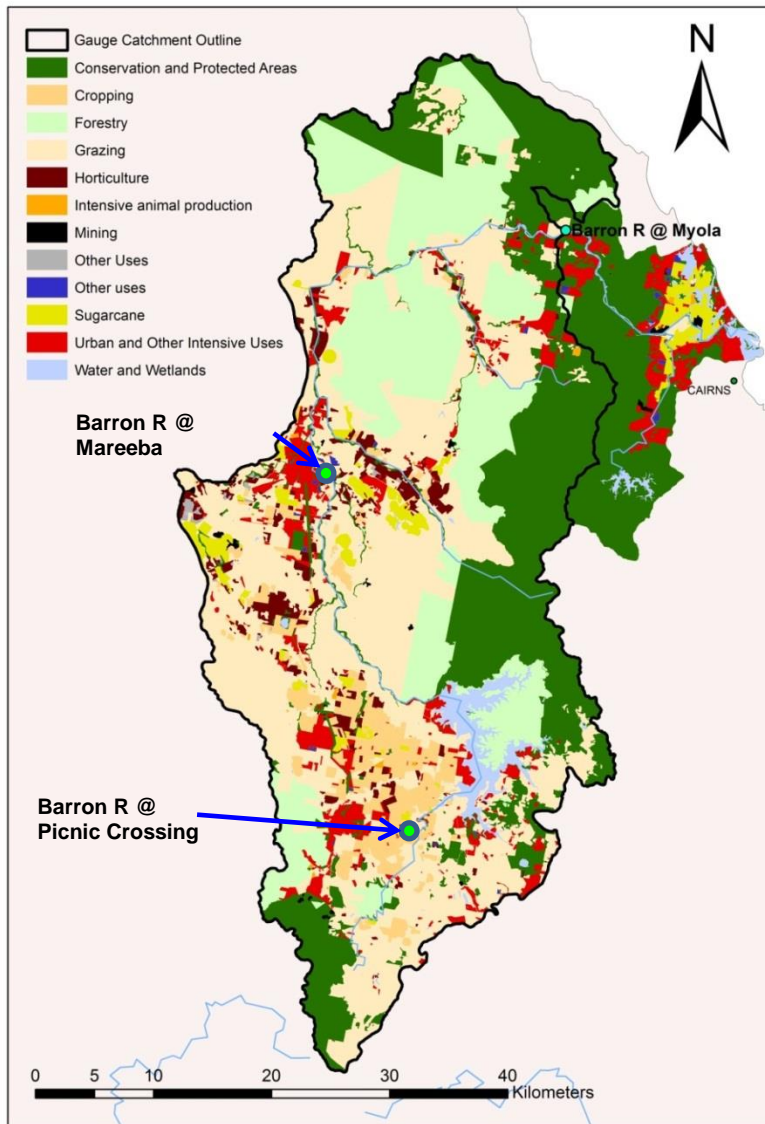


Figure 1 Map indicating the boundaries and land-uses of the Barron River catchment and the location of the Great Barrier Reef Catchment Loads Monitoring Program sites

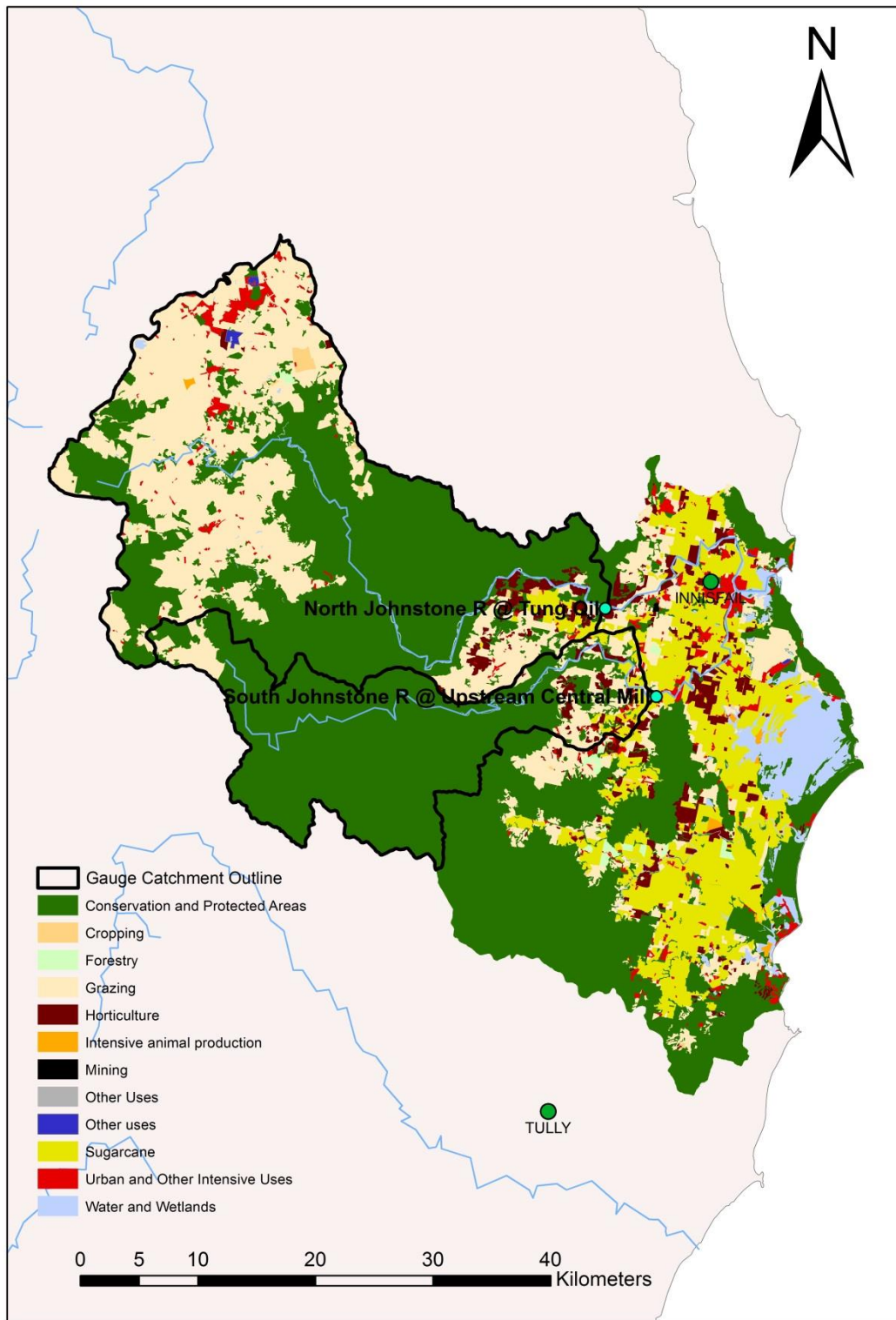


Figure 2 Map indicating the boundaries and land-uses of the Johnstone rivers catchment and the location of the Great Barrier Reef Catchment Loads Monitoring Program sites

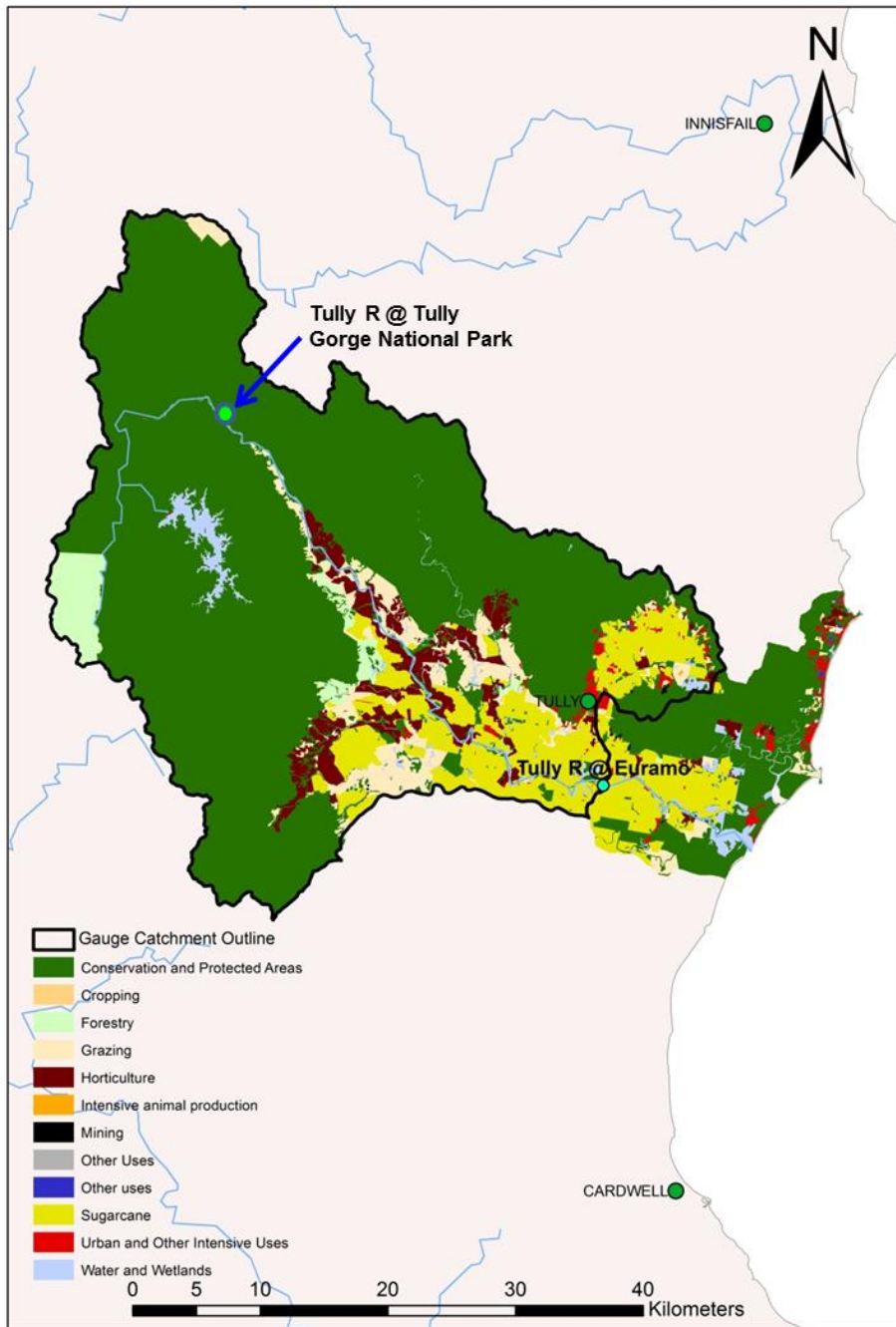


Figure 3 Map indicating the boundaries and land-uses of the Tully River catchment and the location of the Great Barrier Reef Catchment Loads Monitoring Program sites

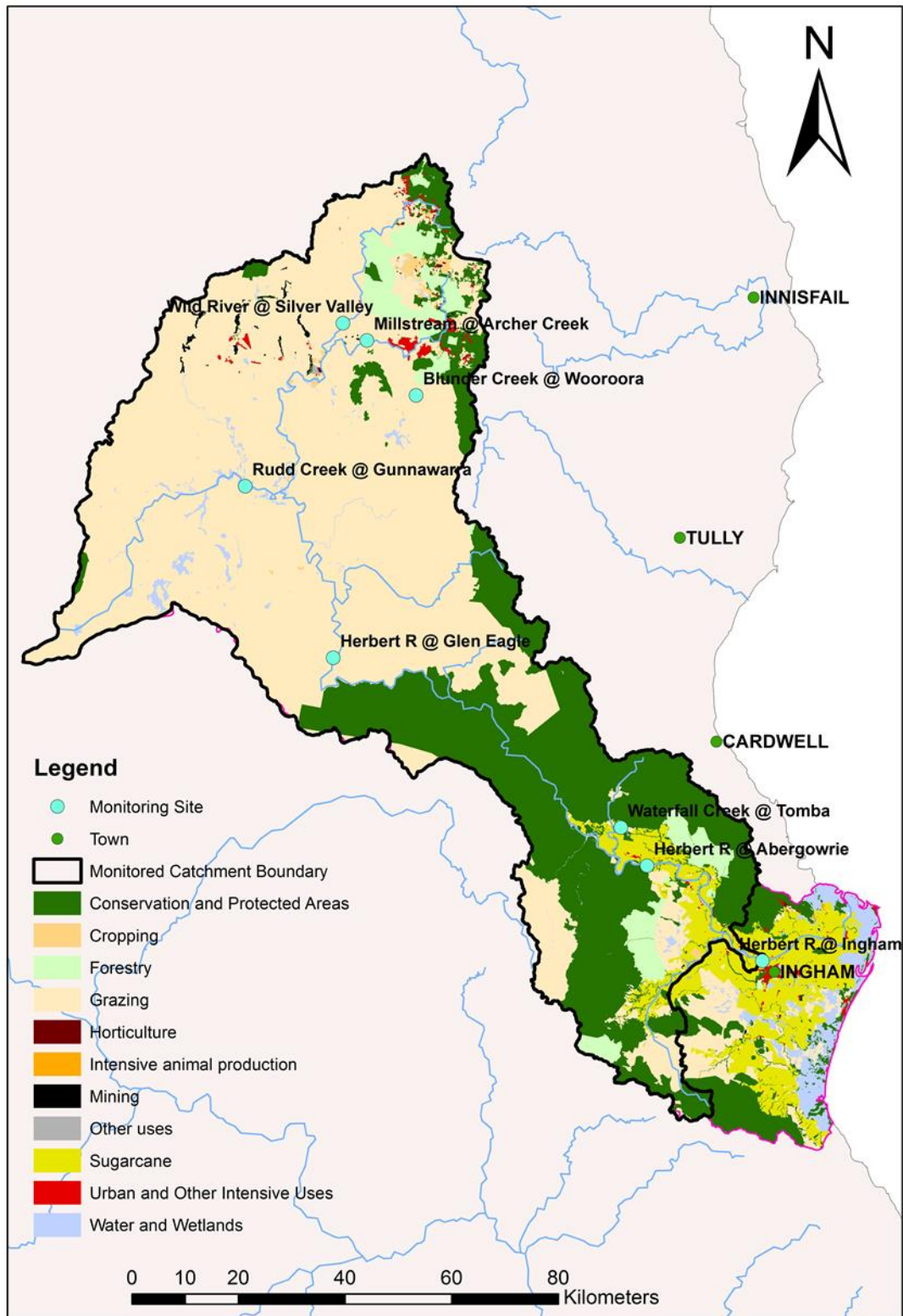


Figure 4 Map indicating the boundaries and land-uses of the Herbert River catchment and the location of the Great Barrier Reef Catchment Loads Monitoring Program site

Table 1 Summary information on sites for the period 1 July 2005 and 30 June 2013

NRM region	Catchment	Gauging station	River and site name	Type of site	Analysed parameter	Sample collection method	Latitude (decimal degrees)	Longitude (decimal degrees)
Wet Tropics	Barron	110001D	Barron River at Myola	EoS	TSS, N	Manual, Automatic	-16.79983	145.61211
		110002A	Barron River at Mareeba	S-C	TSS, N	Manual, Automatic	-17.00224	145.42926
		110003A	Barron River at Picnic Crossing	S-C	TSS, N	Manual, Automatic	-17.25911	145.53858
	Johnstone	112004A and 1120049	North Johnstone River at Tung Oil and North Johnstone River at Old Bruce Hwy Bridge (Goondi)	S-C	TSS, N	Manual	-17.54564 -17.50594	145.93253 145.99197
		112101B	South Johnstone River at Upstream Central Mill	S-C	TSS, N, PSII	Manual, Passive	-17.61056	145.97889
	Tully	113006A	Tully River at Euramo	EoS	TSS, N, PSII	Manual, Automatic, Passive	-17.99361	145.94111
		113015A	Tully River at Tully Gorge National Park	S-C	TSS, N	Manual, Automatic	-17.77265	145.65065
	Herbert	116001E and 116001F	Herbert River at Ingham	EoS	TSS, N	Manual, Van Dorn	-18.63611 -18.63275	146.14194 146.14267
		116004C	Herbert River at Glen Eagle	not classified	TSS, N, PSII	Manual	-18.1926	145.3321
		116006B	Herbert River at Abergowrie	not classified	TSS, N, PSII	Manual	-18.49417	145.92111
		116013A	Millstream at Archer Creek	not classified	TSS, N, PSII	Manual	-17.6523	145.3409
		116014A	Wild River at Silver Valley	not classified	TSS, N, PSII	Manual	-17.6266	145.2959
		116015A	Blunder Creek at Wooroora	not classified	TSS, N, PSII	Manual	-17.7371	145.4363
		116016A	Rudd Creek at Gunnawarra	not classified	TSS, N, PSII	Manual	-17.9162	145.1497
			Waterfall Creek at Tomba	not classified	TSS, N, PSII	Manual	-18.43383	145.86833

(EoS = end of system site, S-C = sub-catchment site, TSS = total suspended solids, N = nutrients, PSII = photosystem II inhibitor herbicides)

Water quality sampling

Water quality samples were collected according to the methods outlined in the Environmental Protection (Water) Policy Monitoring and Sampling Manual (DERM 2009) in accordance with the Australian and New Zealand standard (AS/NZS 5667.6:1998). Water quality samples were collected between 1 July, 2005 and 30 June, 2013. Three different sampling methods were used to collect water samples, depending on equipment availability and suitability for use at each site. The three methods used were; manual grab sampling, automatic grab sampling (ISCO refrigerated automatic pump samplers), and Van Dorn sampling.

Intensive sampling (daily or every few hours) occurred during high flow conditions and reduced sampling (monthly) was undertaken during base flow conditions. Total suspended solids (TSS) and nutrients samples were collected concurrently.

Water quality sample analysis

The TSS and nutrient analyses were undertaken by the Science Division Chemistry Centre (Indooroopilly and Dutton Park, Queensland) according to Standard Methods 2540 D, 4500-NO₃ I, 4500-NH₃ H, 4500-N_{org} D and 4500-P G (APHA-AWWA-WEF 2005). The laboratory is accredited by the National Association of Testing Authorities (Australia) for the analyses conducted. Table 2 provides a summary of all analysed parameters and the corresponding practical quantitation limits. The TSS samples were analysed by a gravimetric methodology and nutrient samples were analysed via Flow Injection Analysis (colourimetric techniques).

If the water quality concentration values were below the practical quantitation limit (PQL) specified by the Science Division Chemistry Centre, the results were adjusted to a value of 50 per cent of the PQL (Turner et al. 2013b). The PQL is the lowest concentration a laboratory will quantify a chemical.

Table 2 Summary information for each parameter analysed and the corresponding practical quantitation limit

Monitored Pollutants	Abbreviation	Analysed Parameter	Practical Quantitation Limit
Sediments			
Total Suspended Solids	TSS	Total suspended solids	1 mg L ⁻¹
Nutrients			
Total Nitrogen	TN	Total nitrogen as N	0.03 mg L ⁻¹
Particulate Nitrogen	PN	Total nitrogen (suspended) as N	0.03 mg L ⁻¹
Dissolved Organic Nitrogen	DON	Organic nitrogen (dissolved) as N	0.03 mg L ⁻¹
Ammonia Nitrogen	NH ₃	Ammonium nitrogen as N	0.002 mg L ⁻¹
Oxidised Nitrogen	NO _x	Oxidised nitrogen as N	0.001 mg L ⁻¹
Total Phosphorus	TP	Total Kjeldahl Phosphorus as P	0.01 mg L ⁻¹
Particulate Phosphorus	PP	Total phosphorus (suspended) as P	0.01 mg L ⁻¹
Dissolved Organic Phosphorus	DOP	Organic phosphorus (dissolved) as P	0.01 mg L ⁻¹
Filterable Reactive Phosphorus	FRP	Phosphate phosphorus as P	0.001 mg L ⁻¹

River discharge

River flow data (hourly-interpolated flow, m³s⁻¹) were extracted from the DNRM Surface Water Database using the Hydstra pre-programmed script (<http://watermonitoring.derm.qld.gov.au/host.htm>). The preference was to use data with a quality code of 10 to 30, based on the DNRM hydrographic methodology for quality rating flow data (DERM 2011). If such data were not available due to a gauging station error, flows with a quality code of 60 were used. The method used to calculate discharge by the Surface Water Database is presented in Appendix A.

Flow files for the; Tully River at Tully Gorge National Park (gauging station 113015A), Herbert River at Ingham (gauging stations 116001E and 116001F), Millstream at Archer Creek (gauging station 116013A), Wild River at Silver Valley (gauging station 116014A) and Rudd Creek Gunnawarra (gauging station 116016A) sites contained data gaps ranging from 1 to 94 days. These gaps were filled using the River Analysis Package's Time Series Manager function (eWater CRC 2012) and conducting a linear interpolation.

Flow data were not available for the Tully River at Euramo site (gauging station 113006A) between 22 July, 2011 and 16 November, 2012. Due to the large gap in data, two separate base flow analyses were conducted for the periods before and after the data gap. As the 1 July, 2005 to 22 July, 2011 period of data is more extensive than that from 16 November, 2012 to 1 July, 2013, it is more likely to accurately represent the true MDBF for the Tully River at Euramo site. As a result the

MDBF for that period ($61.2 \text{ m}^3\text{s}^{-1}$) was used to in-fill the missing discharge data, prior to another base flow analysis covering the entire 1 July, 2005 to 1 July, 2013 period.

Data analysis

The total record for flow data was downloaded for each site and entered into the River Analysis Package (eWater CRC 2012). Base flow analyses of the flow data were conducted using a default Base Flow Index (α value) of 0.975 (eWater CRC 2012) (for details refer to Appendix C) to produce a MDBF. This also generated a representative graph of the base flow compared to the total flow for each site (Appendix B). The MDBF (see Appendix C for definition) was used to differentiate between base and high flow samples.

The 20th, 50th and 80th percentile concentrations were then calculated for both base and high flow conditions for each water quality parameter. All percentile values were rounded off to three significant figures. Percentiles which are based on less than 10 data points are not reliable and should be interpreted cautiously.

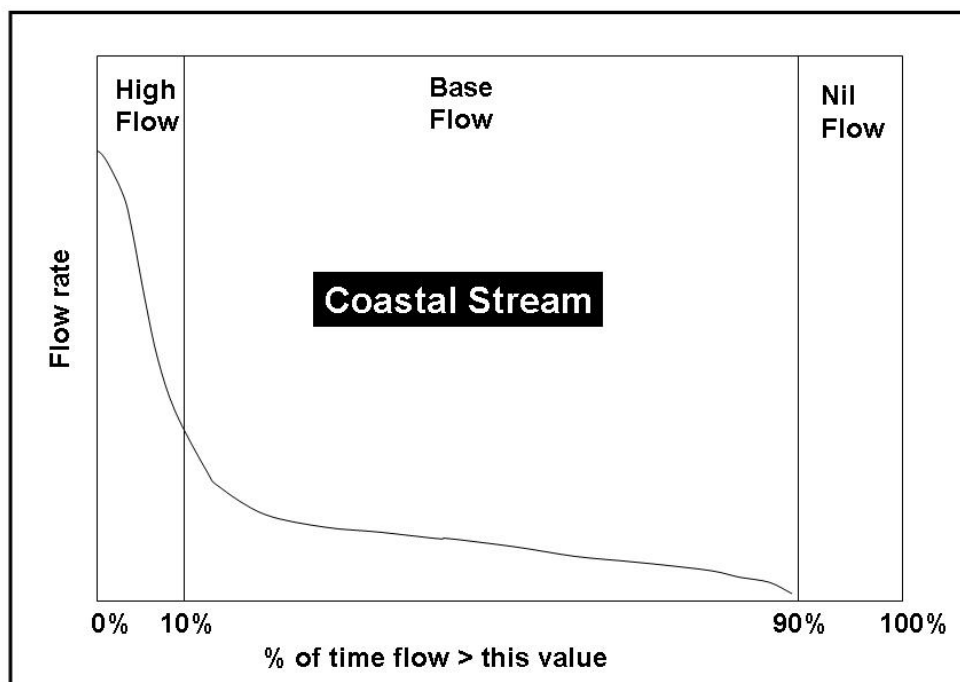


Figure 5 Generic flow duration curve for stream in a wetter coastal area of Queensland (DERM, 2009)

Results and discussion

Table 3 presents summary information for the 15 sites examined in this report, the number of data on which the percentile values were calculated and the base flow cut off values. Base flow cut-offs ranged from $1.12 \text{ m}^3\text{s}^{-1}$ to $61.22 \text{ m}^3\text{s}^{-1}$ (Table 3) and reflect the rainfall patterns and the size and characteristics of the catchments monitored by each site. The accuracy and reliability (representivity) of the calculated percentile values depends on the percentage of the catchment that is monitored by the site, the number of samples upon which the percentiles are based and the duration and quality of the flow data attributed to that site. The end-of-system sites for the Barron, Herbert and Tully rivers all monitor more than 86 per cent of the catchment and there is at least an average of 35 data points for each measured parameter in each of the monitoring years (Table 3). The two Johnstone River sites (North and South Johnstone) combined only monitor 57% of the total Johnstone River catchment (Table 3). In addition, there are only 201 data points for the North Johnstone for the entire period examined (Table 3). Also there are only 71 data points for the Barron River at Mareeba (Table 3). Due to these limitations the percentiles for the North and South Johnstone rivers and the Barron River at Mareeba should be used cautiously. All HWQMP sites were limited to between 15 and 36 samples (Table 3). The monitored surface area of the catchments for the HWQMP sites ranged from 76 per cent at the Herbert River at Abergowrie to less than 1 per cent at Waterfall Creek at Tomba. The calculated percentiles for these monitoring sites should also be used cautiously.

The 20th, 50th and 80th percentile values for all parameters at all fifteen sites under both high and base flow conditions are presented in Tables 4–34. In some instances once the base and high flow periods have been separated, there were insufficient data to calculate the 20th, 50th and 80th percentile values for all parameters (i.e., Table 26, Table 28 and Table 30). The base flow analysis for the Tully River at Tully Gorge National Park site (gauging station 113015A) appeared to result in an over-estimation of the base flow curve (Table 43 and Figure 14). This is probably caused by the shorter flow record available for that site. Amending the Base Flow Index to 0.99 resulted in a base flow curve that better fitted the total flow graph (Table 44 and Figure 15).

For sites with more than 10 base flow and 10 high flow samples, the Tully River site at Tully Gorge National Park generally had the lowest concentrations for the 20th, 50th and 80th percentiles for the parameters examined for both base and high flow conditions (Table 4–Table 34). This is not surprising as the site is located relatively high in the catchment in a national park, above all major agriculture. Other sites that also had some of the lowest values for the percentiles were the Tully River at Euramo and the North Johnstone River at both Tung Oil and Old Bruce Hwy Bridge (Goondi). These results indicate that these sites are the least polluted of the eight sites examined in the Wet Tropics with extensive data. In contrast, the Barron River at Picnic Crossing had most of the highest values for the 20th, 50th and 80th percentiles for the examined parameters under both flow conditions. The other sites within the Barron River catchment (Myola and Mareeba) also had a number of the highest values for the percentiles under both flow conditions. Each of the other sites had the highest values for certain monitored parameters. At the South Johnstone at Upstream Central Mill and Tully River at Euramo, however, these only occurred under high flow conditions. The Tully River at Tully Gorge National Park site recorded the equal highest 50th percentile value for dissolved organic phosphorus, 0.01 mg L^{-1} , under base flow conditions. The Herbert River at Ingham site had the highest values for the 80th percentile for oxidised nitrogen (0.343 mg L^{-1}) and ammonia nitrogen (0.038 mg L^{-1}) under base flow conditions, and dissolved organic phosphorus (0.023 mg L^{-1}) during high flow periods for sites with extensive datasets. The 80th percentile value for oxidised nitrogen under base flow conditions at the Herbert River at Abergowrie (0.461 mg L^{-1}),

and dissolved organic phosphorus under high flow conditions at the Herbert River at Glen Eagle (0.030 mg L^{-1}) were higher than the corresponding values at the Herbert River at Ingham site, however with a smaller data set these results are likely to be less reliable.

In 76% of cases, high flow conditions resulted in larger percentile values than under base flow conditions (Table 4–Table 33). The cases where the base flow percentiles were larger than the corresponding high flow percentiles, and the sample numbers were above 10, all occurred for the soluble parameters (oxidised nitrogen, ammonia nitrogen, dissolved organic nitrogen, dissolved organic phosphorus and filterable reactive phosphorus) with the exception of a single case for total phosphorus (Herbert River at Ingham, Table 20 and Table 21). Under high flow conditions the total phosphorus percentiles at the Tully River Euramo and Tully Gorge National Park sites were similar (Table 15 and 19).

On average the high flow percentiles for the soluble parameters were 1.24 times larger than the corresponding base flow percentiles. In contrast, for the total parameters (total suspended solids, particulate nitrogen, total nitrogen, total phosphorus and particulate phosphorus) the high flow percentiles were on average 7.22 times larger than the corresponding base flow percentiles.

Table 3 Total catchment surface area, the percentage of the catchment monitored, the number of samples collected and the base flow cut off values for the 15 monitored Wet Tropics sites between 2005 and 2013. Sites in bold are end-of-system sites

NRM Region	Catchment	Gauging station	Site name	Total catchment surface area (km ²)	Monitored surface area (km ²)	Monitored surface area of catchment (%)	Number of samples (n)	Base flow cut-off (m ³ s ⁻¹)
Wet Tropics	Barron	110001D	Barron River at Myola	2188	1945	89	476	8.23
		110002A	Barron River at Mareeba		836	38	71	4.82
		110003A	Barron River at Picnic Crossing		228	10	385	2.26
	Johnstone	112004A and 1120049	North Johnstone River at Tung Oil and North Johnstone River at Old Bruce Hwy Bridge (Goondi)	2325	925	40	201	31.58
		112101B	South Johnstone River at Upstream Central Mill		400	17	495	15.03
	Tully	113006A	Tully River at Euramo	1683	1450	86	1113	61.22
		113015A	Tully River at Tully Gorge National Park		482	29	310	21.30 $\alpha=0.975$ 19.80 $\alpha=0.99$
	Herbert	116001E and 116001F	Herbert River at Ingham	9844	8581	87	305	44.21
		116004C	Herbert River at Glen Eagle		5236	53	30	10.24
		116006B	Herbert River at Abergowrie		7454	76	36	26.68
		116013A	Millstream at Archer Creek		308	3	15	2.33
		116014A	Wild River at Silver Valley		591	6	17	1.17
		116015A	Blunder Creek at Wooroora		127	1	16	1.12
		116016A	Rudd Creek at Gunnawarra		1450	15	30	1.38
		Waterfall Creek at Tomba	<100	<1	21	N/A		

Table 4 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Barron River at Myola site (gauging station 110001D)

110001D	Barron River at Myola								Base flow cut off (m ⁻³ s ⁻¹)	8.23
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	57	0.194	0.615	0.066	0.022	0.369	0.08	0.016	0.01	0.05
50th %ile	7.5	0.07	0.302	0.027	0.010	0.191	0.04	0.007	0.005	0.018
20th %ile	4	0.015	0.197	0.003	0.004	0.145	0.01	0.005	0.005	0.005
No. of samples	44	42	42	44	44	42	44	44	42	42
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 5 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Barron River at Myola site (gauging station 110001D)

110001D	Barron River at Myola								Base flow cut off (m ⁻³ s ⁻¹)	8.23
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	288.2	0.83	1.26	0.094	0.016	0.434	0.23	0.019	0.016	0.2
50th %ile	135.5	0.45	0.88	0.053	0.01	0.34	0.13	0.009	0.01	0.1
20th %ile	50	0.19	0.59	0.033	0.007	0.252	0.06	0.005	0.005	0.04
No. of samples	432	389	389	425	425	403	398	425	403	389
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 6 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Barron River at Mareeba site (gauging station 110002A)

110002A	Barron River at Mareeba								Base flow cut off (m ⁻³ s ⁻¹)	4.82
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	17.8	0.137	0.443	0.155	0.014	0.243	0.068	0.025	0.005	0.036
50th %ile	6	0.05	0.32	0.095	0.01	0.18	0.03	0.014	0.005	0.02
20th %ile	4	0.015	0.251	0.02	0.007	0.115	0.026	0.011	0.005	0.01
No. of samples	27	27	27	27	27	27	27	27	27	27
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 7 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Barron River at Mareeba site (gauging station 110002A)

110002A	Barron River at Mareeba								Base flow cut off (m ⁻³ s ⁻¹)	4.82
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	129	0.4	0.842	0.188	0.016	0.414	0.22	0.047	0.017	0.161
50th %ile	29.5	0.16	0.610	0.099	0.010	0.276	0.08	0.024	0.005	0.04
20th %ile	7	0.085	0.394	0.062	0.006	0.173	0.03	0.01	0.005	0.011
No. of samples	44	44	44	44	44	44	44	44	44	44
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 8 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Barron River at Picnic Crossing site (gauging station 110003A)

110003A	Barron River at Picnic Crossing								Base flow cut off (m ⁻³ s ⁻¹)	2.26
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	20	0.196	0.661	0.269	0.023	0.250	0.08	0.014	0.019	0.056
50th %ile	11	0.157	0.572	0.203	0.018	0.193	0.06	0.011	0.01	0.030
20th %ile	6	0.048	0.517	0.153	0.011	0.137	0.04	0.009	0.005	0.02
No. of samples	46	46	46	46	46	46	46	46	46	46
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 9 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Barron River at Picnic Crossing site (gauging station 110003A)

110003A	Barron River at Picnic Crossing								Base flow cut off (m ⁻³ s ⁻¹)	2.26
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	152	0.53	1.074	0.21	0.038	0.386	0.3	0.018	0.021	0.27
50th %ile	67.5	0.3	0.802	0.161	0.02	0.312	0.18	0.014	0.015	0.15
20th %ile	39.6	0.18	0.681	0.127	0.014	0.259	0.12	0.011	0.005	0.1
No. of samples	332	299	299	334	334	311	299	334	311	299
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 10 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the North Johnstone River at Tung Oil (gauging station 112004A) and North Johnstone River at Old Bruce Hwy Bridge (Goondi) (gauging station 1120049) sites

112004A and 1120049	North Johnstone River at Tung Oil and North Johnstone River at Old Bruce Hwy Bridge (Goondi)								Base flow cut off (m ⁻³ s ⁻¹)	31.58
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	7	0.072	0.274	0.086	0.010	0.155	0.026	0.009	0.008	0.021
50th %ile	3	0.04	0.19	0.056	0.005	0.085	0.01	0.007	0.005	0.01
20th %ile	1.4	0.032	0.167	0.009	0.003	0.060	0.007	0.002	0.005	0.005
No. of samples	11	11	11	11	11	11	11	11	11	11
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 11 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the North Johnstone River at Tung Oil (gauging station 112004A) and North Johnstone River at Old Bruce Hwy Bridge (Goondi) (gauging station 1120049) sites

112004A and 1120049	North Johnstone River at Tung Oil and North Johnstone River at Old Bruce Hwy Bridge (Goondi)								Base flow cut off (m ⁻³ s ⁻¹)	31.58
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	82	0.53	0.788	0.193	0.009	0.16	0.192	0.01	0.012	0.17
50th %ile	25	0.15	0.43	0.152	0.006	0.1	0.06	0.008	0.01	0.05
20th %ile	10	0.06	0.31	0.119	0.005	0.064	0.03	0.006	0.005	0.01
No. of samples	190	189	189	188	188	189	188	188	189	189
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 12 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the South Johnstone River at Upstream Central Mill site (gauging station 112101B)

112101B	South Johnstone River at Upstream Central Mill								Base flow cut off (m ⁻³ s ⁻¹)	15.03
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	39.8	0.159	0.634	0.106	0.020	0.302	0.064	0.013	0.01	0.040
50th %ile	8	0.07	0.326	0.031	0.008	0.179	0.03	0.007	0.005	0.015
20th %ile	4	0.031	0.211	0.005	0.005	0.132	0.02	0.005	0.005	0.005
No. of samples	77	73	73	77	77	73	77	77	73	73
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 13 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the South Johnstone River at Upstream Central Mill site (gauging station 112101B)

112101B	South Johnstone River at Upstream Central Mill								Base flow cut off (m ⁻³ s ⁻¹)	15.03
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	284.2	0.844	1.264	0.111	0.015	0.432	0.23	0.017	0.016	0.204
50th %ile	135.5	0.46	0.88	0.055	0.01	0.33	0.13	0.009	0.01	0.102
20th %ile	52	0.2	0.58	0.036	0.007	0.221	0.07	0.005	0.005	0.05
No. of samples	418	377	377	411	411	391	384	411	391	377
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 14 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Tully River at Euramo site (gauging station 113006A)

113006A	Tully River at Euramo								Base flow cut off (m ⁻³ s ⁻¹)	61.22
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	23.8	0.141	0.463	0.184	0.008	0.158	0.028	0.003	0.01	0.023
50th %ile	6	0.06	0.34	0.135	0.004	0.125	0.01	0.002	0.005	0.01
20th %ile	3	0.015	0.248	0.106	0.003	0.086	0.01	0.001	0.005	0.005
No. of samples	25	23	23	25	25	23	25	25	23	23
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 15 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Tully River at Euramo site (gauging station 113006A)

113006A	Tully River at Euramo								Base flow cut off (m ⁻³ s ⁻¹)	61.22
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	60	0.24	0.63	0.261	0.012	0.19	0.08	0.009	0.01	0.06
50th %ile	28	0.11	0.463	0.2	0.007	0.13	0.04	0.005	0.01	0.03
20th %ile	15	0.046	0.36	0.144	0.004	0.08	0.01	0.002	0.005	0.01
No. of samples	1086	973	1041	990	990	973	1044	990	973	973
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 16 80th, 50th and 20th percentile values and summary information for parameters during base flow ($\alpha=0.975$) conditions at the Tully River at Tully Gorge National Park site (gauging station 113015A)

113015A	Tully River at Tully Gorge National Park								Base flow cut off (m^3s^{-1})	21.30
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	3	0.175	0.238	0.100	0.013	0.144	0.01	0.007	0.01	0.01
50th %ile	1	0.015	0.161	0.046	0.006	0.098	0.01	0.002	0.01	0.01
20th %ile	0.5	0.015	0.118	0.026	0.004	0.06	0.01	0.001	0.005	0.005
No. of samples	18	18	18	18	18	18	18	18	18	18
Start Date	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 17 80th, 50th and 20th percentile values and summary information for parameters during high flow ($\alpha=0.975$) conditions at the Tully River at Tully Gorge National Park site (gauging station 113015A)

113015A	Tully River at Tully Gorge National Park								Base flow cut off (m^3s^{-1})	21.30
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	52.6	0.385	0.67	0.101	0.013	0.148	0.07	0.004	0.01	0.046
50th %ile	20	0.155	0.37	0.066	0.008	0.106	0.02	0.003	0.005	0.01
20th %ile	4	0.05	0.23	0.05	0.004	0.073	0.01	0.001	0.005	0.005
No. of samples	291	266	289	266	266	266	289	266	266	266
Start Date	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 18 80th, 50th and 20th percentile values and summary information for parameters during base flow ($\alpha=0.99$) conditions at the Tully River at Tully Gorge National Park site (gauging station 113015A)

113015A	Tully River at Tully Gorge National Park								Base flow cut off ($m^{-3}s^{-1}$)	19.80
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	3	0.054	0.241	0.072	0.014	0.145	0.01	0.007	0.01	0.01
50th %ile	1	0.015	0.16	0.045	0.005	0.1	0.01	0.003	0.01	0.01
20th %ile	0.5	0.015	0.117	0.025	0.004	0.06	0.01	0.001	0.005	0.005
No. of samples	17	17	17	17	17	17	17	17	17	17
Start Date	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 19 80th, 50th and 20th percentile values and summary information for parameters during high flow ($\alpha=0.99$) conditions at the Tully River at Tully Gorge National Park site (gauging station 113015A)

113015A	Tully River at Tully Gorge National Park								Base flow cut off ($m^{-3}s^{-1}$)	19.80
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	52.4	0.384	0.668	0.101	0.013	0.148	0.07	0.004	0.01	0.045
50th %ile	20	0.153	0.37	0.066	0.008	0.106	0.02	0.003	0.005	0.01
20th %ile	4	0.05	0.229	0.05	0.004	0.072	0.01	0.001	0.005	0.005
No. of samples	292	267	290	267	267	267	290	267	267	267
Start Date	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009	24/12/2009
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 20 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Herbert River at Ingham site (gauging station 116001E and 116001F)

116001E and 116001F	Herbert River at Ingham								Base flow cut off (m ⁻³ s ⁻¹)	44.21
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	5	0.09	0.509	0.343	0.038	0.162	0.02	0.011	0.01	0.01
50th %ile	3	0.055	0.362	0.166	0.01	0.12	0.01	0.005	0.01	0.01
20th %ile	2	0.015	0.23	0.042	0.006	0.069	0.01	0.002	0.005	0.005
No. of samples	24	24	24	24	24	24	24	24	24	24
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 21 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Herbert River at Ingham site (gauging station 116001E and 116001F)

116001E and 116001F	Herbert River at Ingham								Base flow cut off (m ⁻³ s ⁻¹)	44.21
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	126.6	0.36	0.822	0.220	0.015	0.270	0.11	0.012	0.023	0.082
50th %ile	57	0.19	0.55	0.114	0.008	0.2	0.06	0.008	0.01	0.04
20th %ile	18.6	0.080	0.412	0.061	0.005	0.126	0.032	0.005	0.005	0.01
No. of samples	277	258	258	267	267	258	280	267	258	258
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 22 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Herbert River at Glen Eagle site (gauging station 116004C)

116004C	Herbert River at Glen Eagle								Base flow cut off (m ⁻³ s ⁻¹)	10.24
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	9.86	0.341	0.486	0.033	0.015	0.394	0.086	0.065	0.011	0.015
50th %ile	3	0.208	0.436	0.018	0.009	0.09	0.021	0.006	0.008	0.004
20th %ile	1.52	0.044	0.174	0.006	0.006	0.044	0.009	0.002	0.006	0.001
No. of samples	5	4	4	4	4	4	4	4	4	4
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 23 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Herbert River at Glen Eagle site (gauging station 116004C)

116004C	Herbert River at Glen Eagle								Base flow cut off (m ³ s ⁻¹)	10.24
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	108	0.223	0.685	0.097	0.016	0.424	0.096	0.014	0.030	0.052
50th %ile	56	0.090	0.471	0.048	0.010	0.28	0.046	0.007	0.006	0.030
20th %ile	13	0.051	0.332	0.031	0.005	0.216	0.027	0.004	0.004	0.013
No. of samples	25	22	23	23	22	23	22	23	21	22
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 24 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Herbert River at Abergowrie site (gauging station 116006B)

116006B	Herbert River at Abergowrie								Base flow cut off (m ⁻³ s ⁻¹)	26.68
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	5.18	0.200	0.881	0.461	0.035	0.389	0.041	0.008	0.017	0.024
50th %ile	2.2	0.076	0.375	0.029	0.004	0.193	0.023	0.004	0.002	0.012
20th %ile	1.76	0.019	0.257	0.015	0.002	0.119	0.011	0.003	0.001	0.006
No. of samples	7	7	7	7	7	7	7	7	6	7
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 25 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Herbert River at Abergowrie site (gauging station 116006B)

116006B	Herbert River at Abergowrie								Base flow cut off (m ³ s ⁻¹)	26.68
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	42	0.172	0.688	0.198	0.012	0.292	0.037	0.01	0.009	0.026
50th %ile	9.5	0.048	0.392	0.079	0.007	0.23	0.02	0.006	0.005	0.011
20th %ile	3.1	0.022	0.267	0.031	0.004	0.125	0.012	0.002	0.002	0.005
No. of samples	29	29	29	29	29	29	29	29	27	29
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 26 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Millstream at Archer Creek site (gauging station 116013A)

116013A	Millstream at Archer Creek								Base flow cut off (m ⁻³ s ⁻¹)	2.33
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	3	0.073	0.248	N/A	0.034	0.227	0.048	0.013	0.015	0.028
50th %ile	1.85	0.016	0.128	0.016	0.010	0.083	0.03	0.004	0.008	0.017
20th %ile	1.3	0.01	0.079	N/A	0.005	0.028	0.01	0.002	0.003	0.001
No. of samples	4	4	4	3	4	4	4	4	4	4
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 27 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Millstream at Archer Creek site (gauging station 116013A)

116013A	Millstream at Archer Creek								Base flow cut off (m ⁻³ s ⁻¹)	2.33
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	31.6	0.237	0.5	0.072	0.015	0.23	0.070	0.012	0.021	0.053
50th %ile	8	0.121	0.347	0.051	0.007	0.187	0.051	0.004	0.005	0.026
20th %ile	3.18	0.060	0.256	0.024	0.004	0.134	0.015	0.003	0.003	0.006
No. of samples	11	11	11	11	10	11	11	11	11	11
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 28 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Wild River at Silver Valley site (gauging station 116014A)

116014A	Wild River at Silver Valley								Base flow cut off (m ³ s ⁻¹)	1.17
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50th %ile	2.7	0.255	0.346	0.017	0.005	0.125	0.017	0.007	0.012	0.003
20th %ile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No. of samples	3	3	3	3	3	3	3	3	3	3
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 29 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Wild River at Silver Valley site (gauging station 116014A)

116014A	Wild River at Silver Valley								Base flow cut off (m ⁻³ s ⁻¹)	1.17
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	41	0.127	0.435	0.063	0.004	0.305	0.044	0.008	0.023	0.031
50th %ile	9	0.078	0.331	0.044	0.002	0.167	0.026	0.004	0.008	0.014
20th %ile	3.3	0.039	0.212	0.020	0.002	0.130	0.018	0.002	0.003	0.007
No. of samples	14	12	12	12	12	12	12	12	9	12
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 30 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Blunder Creek at Wooroora site (gauging station 116015A)

116015A	Blunder Creek at Wooroora								Base flow cut off (m ³ s ⁻¹)	1.12
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50th %ile	3	0.349	0.405	0.026	0.005	0.025	0.008	0.002	0.006	N/A
20th %ile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No. of samples	1	1	1	1	1	1	1	1	1	0
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 31 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Blunder Creek at Wooroora site (gauging station 116015A)

116015A	Blunder Creek at Wooroora								Base flow cut off (m ⁻³ s ⁻¹)	1.12
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	23.8	0.130	0.37	0.081	0.012	0.244	0.033	0.004	0.006	0.027
50th %ile	14	0.074	0.315	0.062	0.006	0.146	0.014	0.003	0.003	0.009
20th %ile	9.44	0.047	0.223	0.024	0.004	0.113	0.011	0.001	0.001	0.004
No. of samples	15	13	14	14	14	14	13	13	14	13
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 32 80th, 50th and 20th percentile values and summary information for parameters during base flow conditions at the Rudd Creek at Gunnawarra site (gauging station 116016A)

116016A	Rudd Creek at Gunnawarra								Base flow cut off (m ³ s ⁻¹)	1.38
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	28.6	0.45	0.643	0.026	0.028	0.457	0.092	0.041	0.042	0.011
50th %ile	5.2	0.316	0.508	0.004	0.008	0.140	0.070	0.028	0.032	0.008
20th %ile	2.28	0.061	0.366	0.001	0.003	0.064	0.028	0.005	0.015	0.008
No. of samples	5	4	4	4	4	4	4	4	4	4
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 33 80th, 50th and 20th percentile values and summary information for parameters during high flow conditions at the Rudd Creek at Gunnawarra site (gauging station 116016A)

116016A	Rudd Creek at Gunnawarra								Base flow cut off (m ³ s ⁻¹)	1.38
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	150	0.265	0.720	0.055	0.011	0.409	0.116	0.042	0.012	0.057
50th %ile	42	0.106	0.464	0.036	0.007	0.321	0.058	0.011	0.006	0.034
20th %ile	21.6	0.056	0.320	0.021	0.004	0.198	0.026	0.005	0.003	0.017
No. of samples	25	24	25	25	25	25	24	25	24	24
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Table 34 80th, 50th and 20th percentile values and summary information for parameters at the Waterfall Creek at Tomba site

	Waterfall Creek at Tomba								Base flow cut off (m ⁻³ s ⁻¹)	N/A
	Total Suspended Solids (mg/L)	Particulate Nitrogen (mg/L)	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Dissolved Organic Nitrogen (mg/L)	Total Phosphorus (mg/L)	Filterable Reactive Phosphorus (mg/L)	Dissolved Organic Phosphorus (mg/L)	Particulate Phosphorus (mg/L)
80th %ile	10.2	0.188	0.916	0.522	0.013	0.305	0.026	0.006	0.012	0.017
50th %ile	2.7	0.039	0.553	0.313	0.005	0.109	0.016	0.004	0.002	0.005
20th %ile	1.42	0.019	0.353	0.15	0.002	0.037	0.007	0.002	0.001	0.002
No. of samples	21	21	21	21	20	21	21	21	20	19
Start Date	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005	1/07/2005
End Date	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013	1/07/2013

Conclusion

Water quality data generated by the Great Barrier Reef Catchment Loads Monitoring Program and the Herbert Water Quality Monitoring Program between 2006–07 and 2012–2013 were used to determine the mean daily base flow at 14 sites in the Barron, Johnstone, Tully and Herbert river catchments. This was used along with the recorded discharge at those sites, to separate high flow from base flow conditions using the River Analysis Package program. The 20th, 50th and 80th percentile values for; total suspended solids, total nitrogen, particulate nitrogen, oxidised nitrogen, ammonia nitrogen, dissolved organic nitrogen, total phosphorus, particulate phosphorus, filterable reactive phosphorus and dissolved organic phosphorus were calculated for high flow and base flow conditions. There is considerable variability in the percentile values across the various sites reflecting differences in rainfall and characteristics of the catchments. On average the high flow percentiles for the soluble parameters were 33% larger than the corresponding base flow percentiles. In contrast, for the total parameters (total suspended solids, particulate nitrogen, total nitrogen, total phosphorus and particulate phosphorus) the high flow percentiles were on average more than seven-times larger than the corresponding base flow percentiles. The percentile values derived in this report could be used to inform the Queensland Water Quality Guidelines.

Similar reports for other NRM regions for which DSITIA has data could be written if requested by the Department of Environment and Heritage Protection. Similarly, annual updates for the Wet Tropics could be generated if requested.

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Appendix

Appendix A

Calculation of discharge

Discharge as contained in the Queensland Government surface water database was calculated using the following equation:

$$q = va$$

where, q is the discharge (m^3/s), v = average velocity of the flow in the cross-sectional area and a = the cross-sectional area of the river.

Discharge is calculated for sub-sectional areas of the river channel and summed to determine the discharge across the whole cross-sectional area. Sub-sectional areas were calculated from a known width multiplied by the river gauge height at time t . River gauge height was recorded by gauging stations using a float or a pressure sensor at intervals of approximately fifteen minutes. Flow velocity was determined for each cross-sectional area at time t using a current meter. Flow records were extracted for each end-of-system from the Queensland Government electronic data management system (Hydstra).

Appendix B

River Analysis Package outputs

Table 35 River Analysis Package output table for Barron River at Myola (gauging station 110001D)

Barron River at Myola	110001D
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	8.234

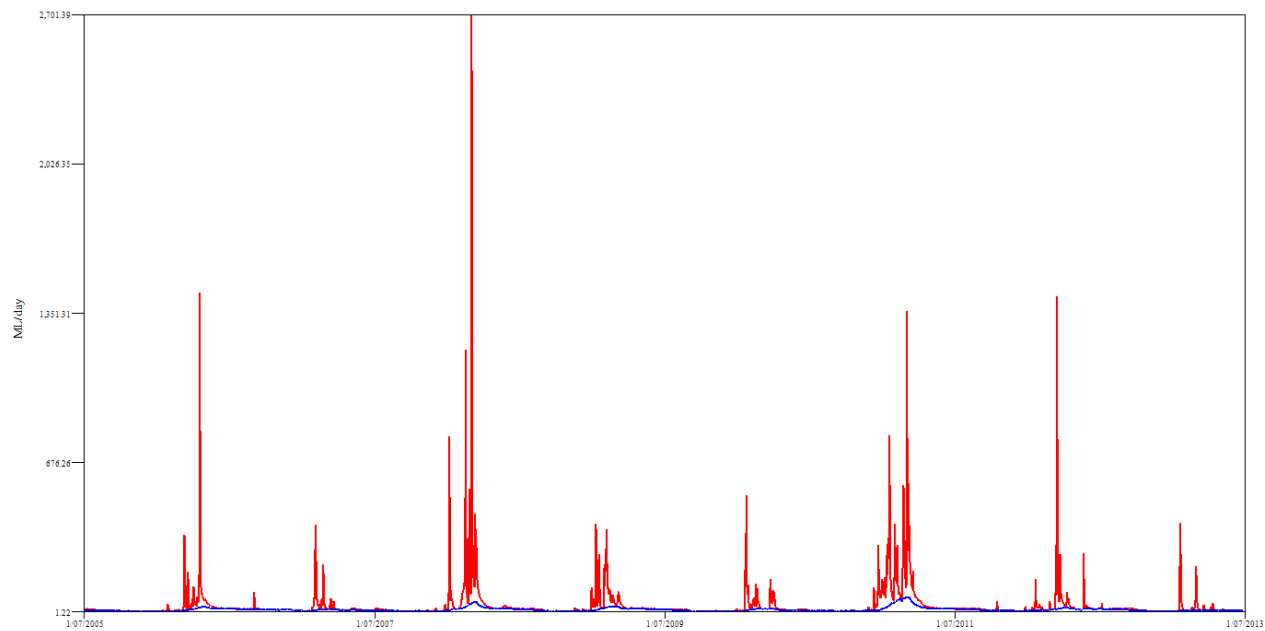


Figure 6 River Analysis Package output graph of total flow (red) and base flow (blue) for Barron River at Myola (gauging station 110001D)

Table 36 River Analysis Package output table for Barron River at Mareeba (gauging station 110002A)

Barron River at Mareeba	110002A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	4.822

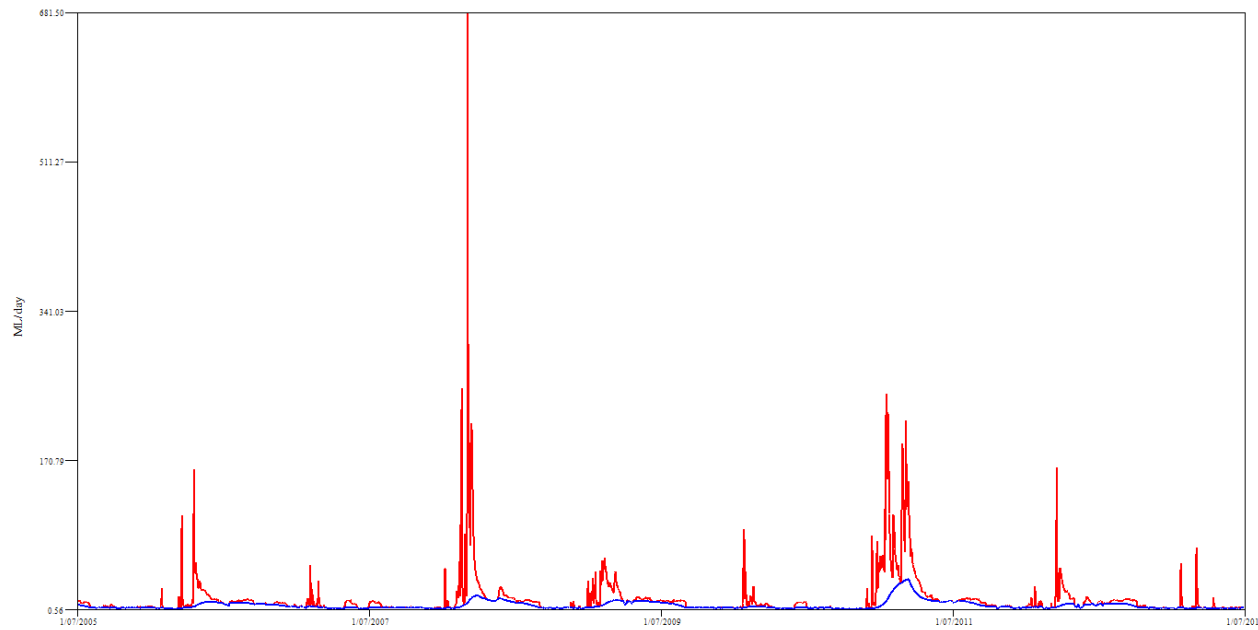
**Figure 7 River Analysis Package output graph of total flow (red) and base flow (blue) for Barron River at Mareeba (gauging station 110002A)**

Table 37 River Analysis Package output table for Barron River at Picnic Crossing (gauging station 110003A)

Barron River at Picnic Crossing	110003A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	2.262

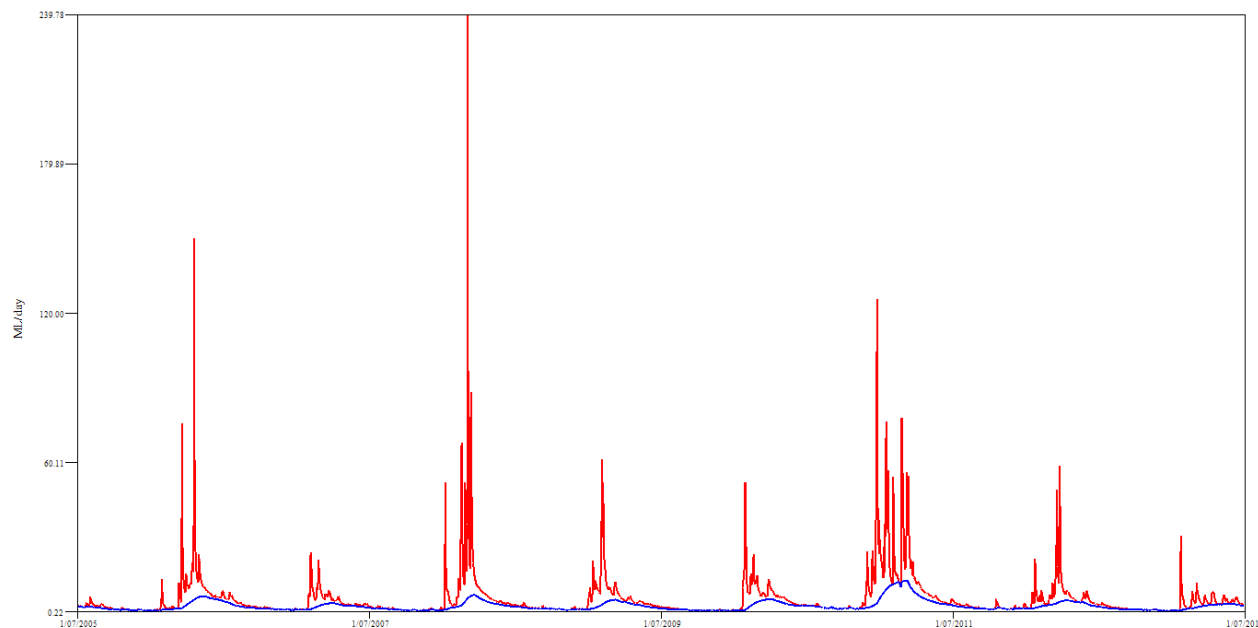


Figure 8 River Analysis Package output graph of total flow (red) and base flow (blue) for Barron River at Picnic Crossing (gauging station 110003A)

Table 38 River Analysis Package output table for North Johnstone River at Tung Oil (gauging station 112004A) used also for North Johnstone River at Old Bruce Hwy Bridge (Goondi) (gauging station 1120049)

North Johnstone River at Tung Oil	112004A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	31.579

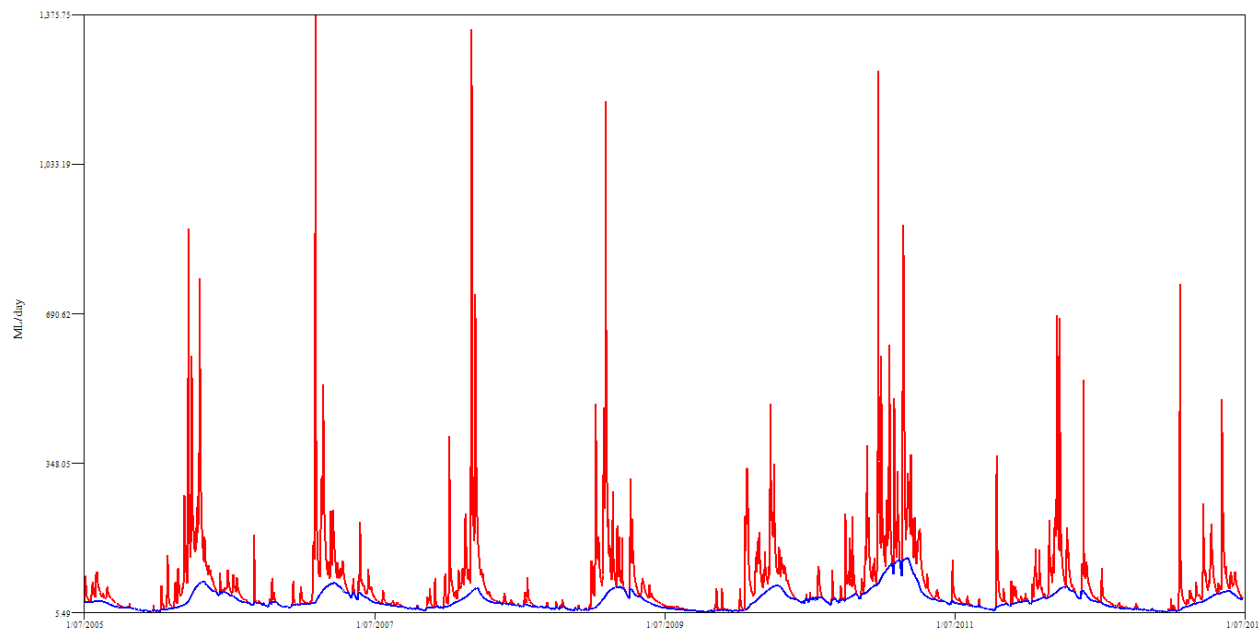


Figure 9 River Analysis Package output graph of total flow (red) and base flow (blue) for North Johnstone River at Tung Oil (gauging station 112004A) used also for North Johnstone River at Old Bruce Hwy Bridge (Goondi) (gauging station 1120049)

Table 39 River Analysis Package output table for South Johnstone River at Upstream Central Mill (gauging station 112101B)

South Johnstone River at Upstream Central Mill	112101B
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	15.025

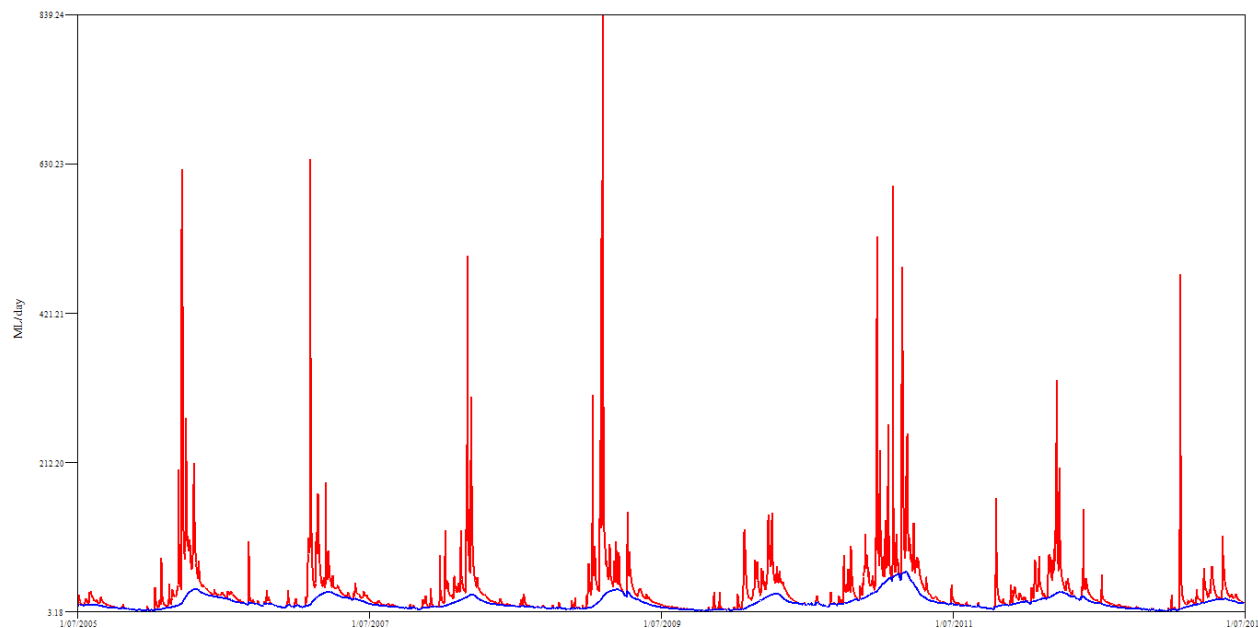


Figure 10 River Analysis Package output graph of total flow (red) and base flow (blue) for South Johnstone River at Upstream Central Mill (gauging station 112101B)

Table 40 River Analysis Package output table for Tully River at Euramo (gauging station 113006A) from 1 July, 2005 until 22 July, 2011

Tully River at Euramo	113006A
Flow Start Date	1/07/2005
Flow End Date	22/07/2011
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	61.874

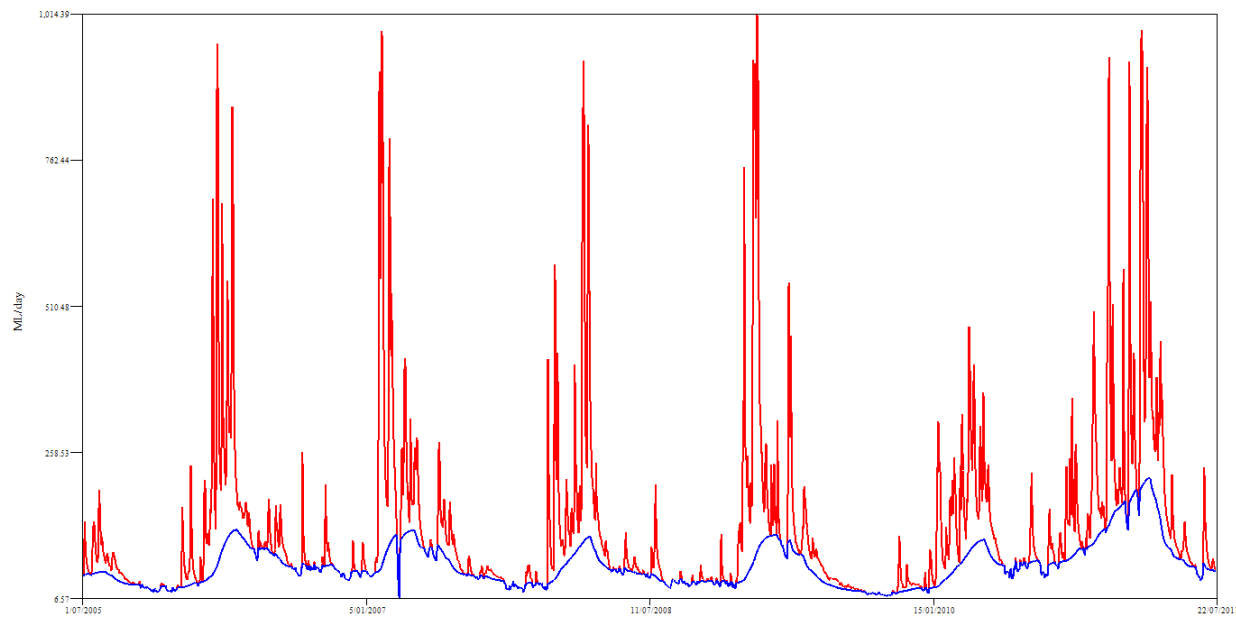
**Figure 11 River Analysis Package output graph of total flow (red) and base flow (blue) for Tully River at Euramo (gauging station 113006A) from 1 July, 2005 until 22 July, 2011**

Table 41 River Analysis Package output table for Tully River at Euramo (gauging station 113006A) from 16 November, 2012 until 1 July, 2013

Tully River at Euramo	113006A
Flow Start Date	16/11/2012
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	54.545

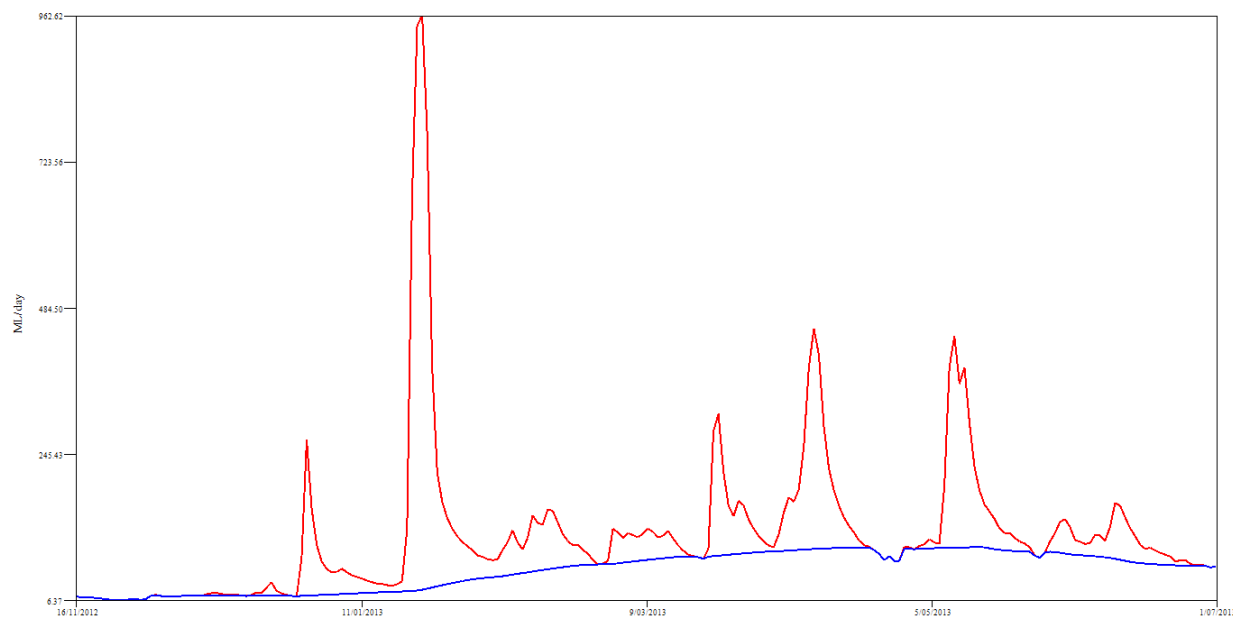


Figure 12 River Analysis Package output graph of total flow (red) and base flow (blue) for Tully River at Euramo (gauging station 113006A) from 16 November, 2012 until 1 July, 2013

Table 42 River Analysis Package output table for Tully River at Euramo (gauging station 113006A) with data between 22 July, 2011 and 16 November, 2012 in-filled with a MDBF of $61.875 \text{ m}^3 \text{ s}^{-1}$

Tully River at Euramo	113006A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow ($\text{m}^3 \text{ s}^{-1}$)	61.222

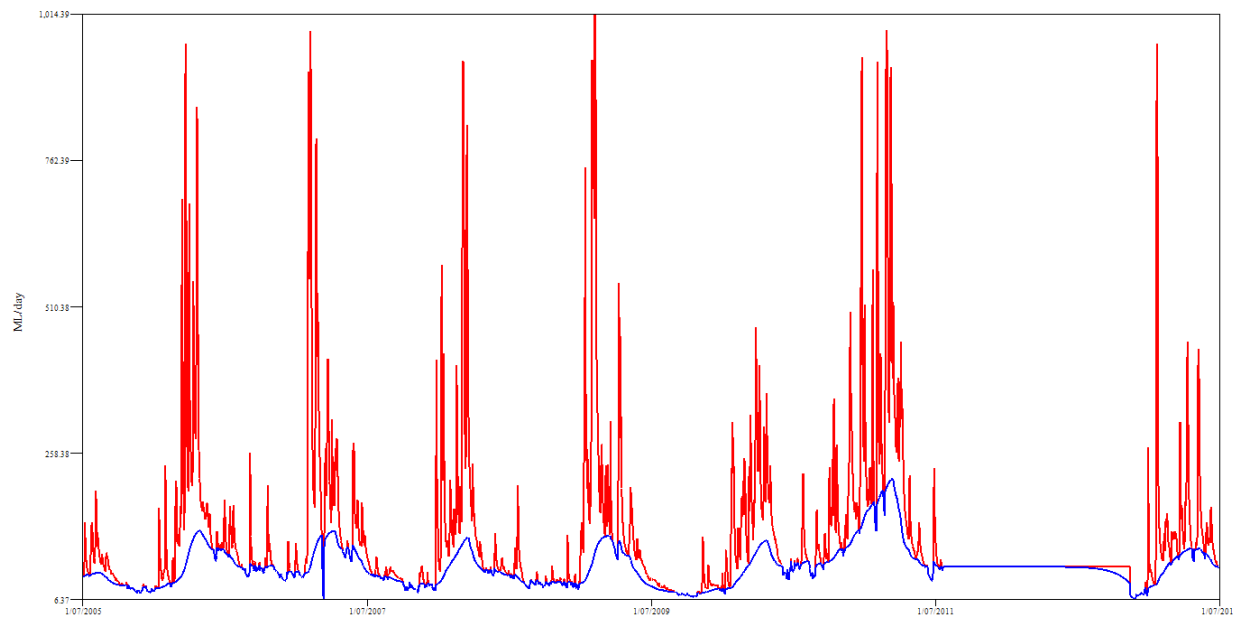


Figure 13 River Analysis Package output graph of total flow (red) and base flow (blue) for Tully River at Euramo (gauging station 113006A) with data between 22 July, 2011 and 16 November, 2012 in-filled with a MDBF of $61.875 \text{ m}^3 \text{ s}^{-1}$

Table 43 River Analysis Package output table for Tully River at Tully Gorge National Park – $\alpha=0.975$ (gauging station 113015A)

Tully River at Tully Gorge National Park	113015A
Flow Start Date	24/12/2009
Flow End Date	01/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	21.3

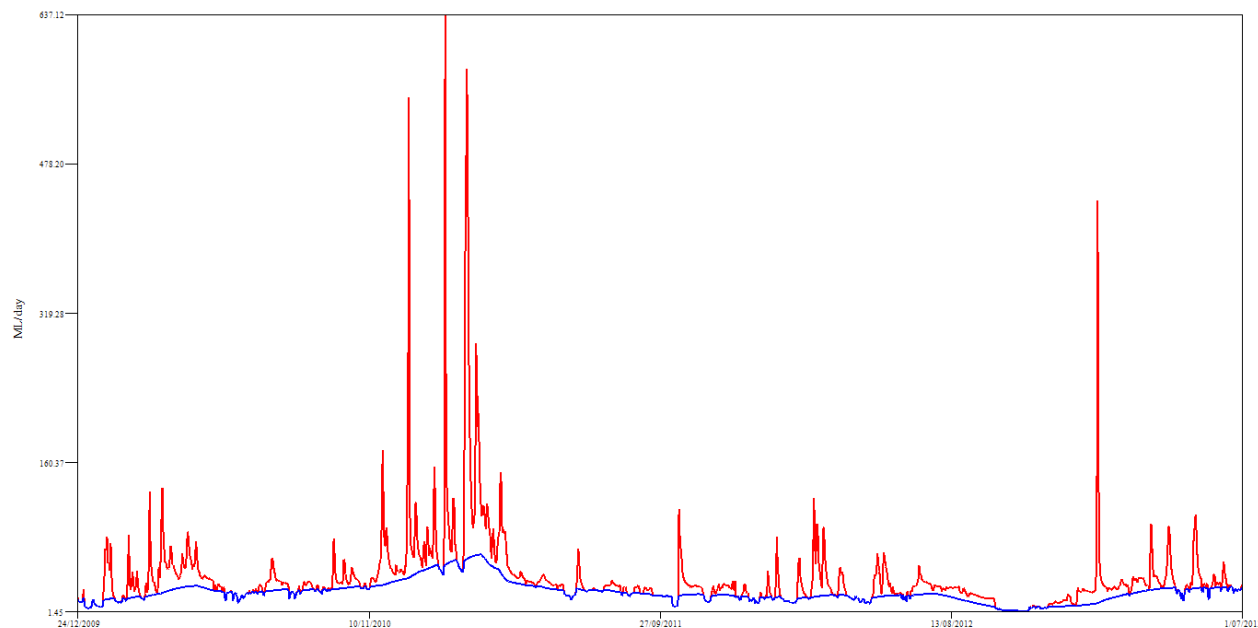


Figure 14 River Analysis Package output graph of total flow (red) and base flow (blue) for Tully River at Tully Gorge National Park – $\alpha =0.975$ (gauging station 113015A)

Table 44 River Analysis Package output table for Tully River at Tully Gorge National Park – $\alpha=0.99$ (gauging station 113015A)

Tully River at Tully Gorge National Park	113015A
Flow Start Date	24/12/2009
Flow End Date	01/07/2013
Base Flow α Value	0.99
Mean Daily Base Flow (m^3s^{-1})	19.796

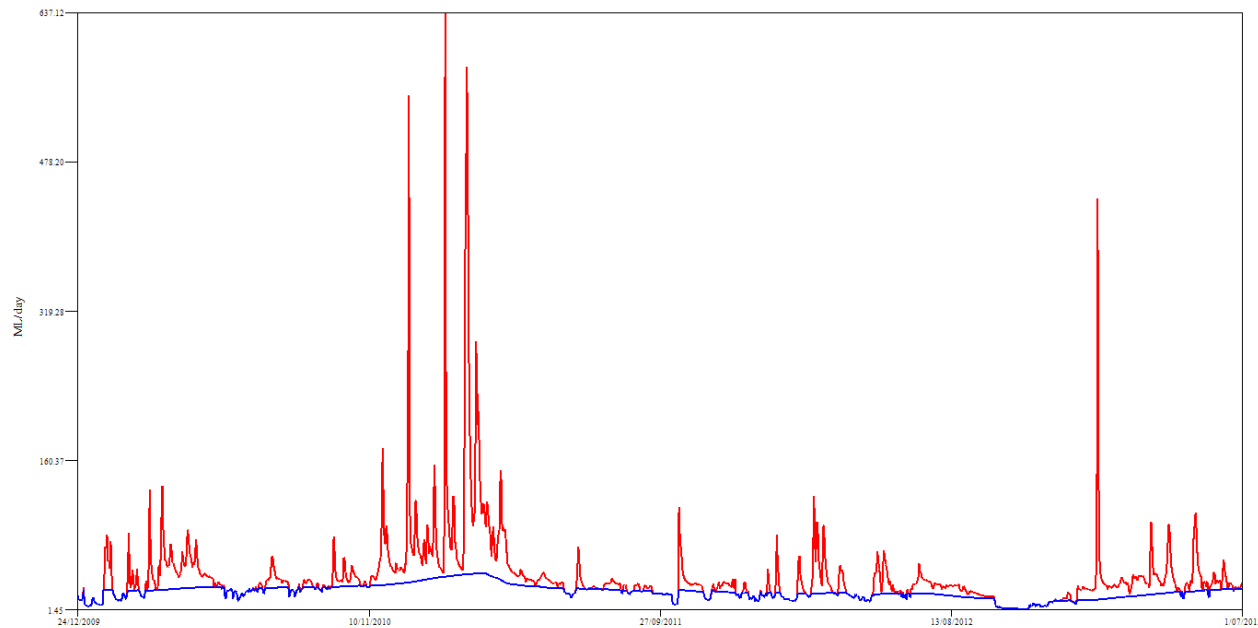
**Figure 15 River Analysis Package output graph of total flow (red) and base flow (blue) for Tully River at Tully Gorge National Park – $\alpha =0.99$ (gauging station 113015A)**

Table 45 River Analysis Package output table for Herbert River at Ingham (gauging station 116001E and 116001F)

Herbert River at Ingham	116001E and 116001F
Flow Start Date	01/07/2005
Flow End Date	01/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	44.209

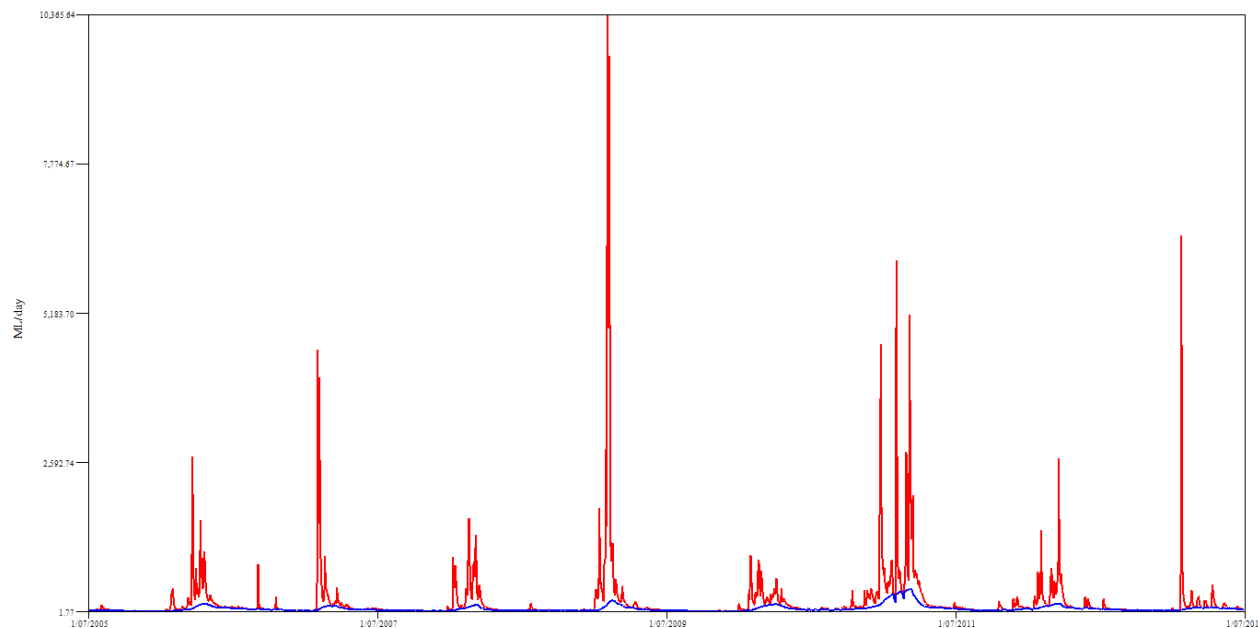


Figure 16 River Analysis Package output graph of total flow (red) and base flow (blue) for Herbert River at Ingham (gauging station 116001E and 116001F)

Table 46 River Analysis Package output table for Herbert River at Glen Eagle (gauging station 116004C)

Herbert River at Glen Eagle	116004C
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	10.241

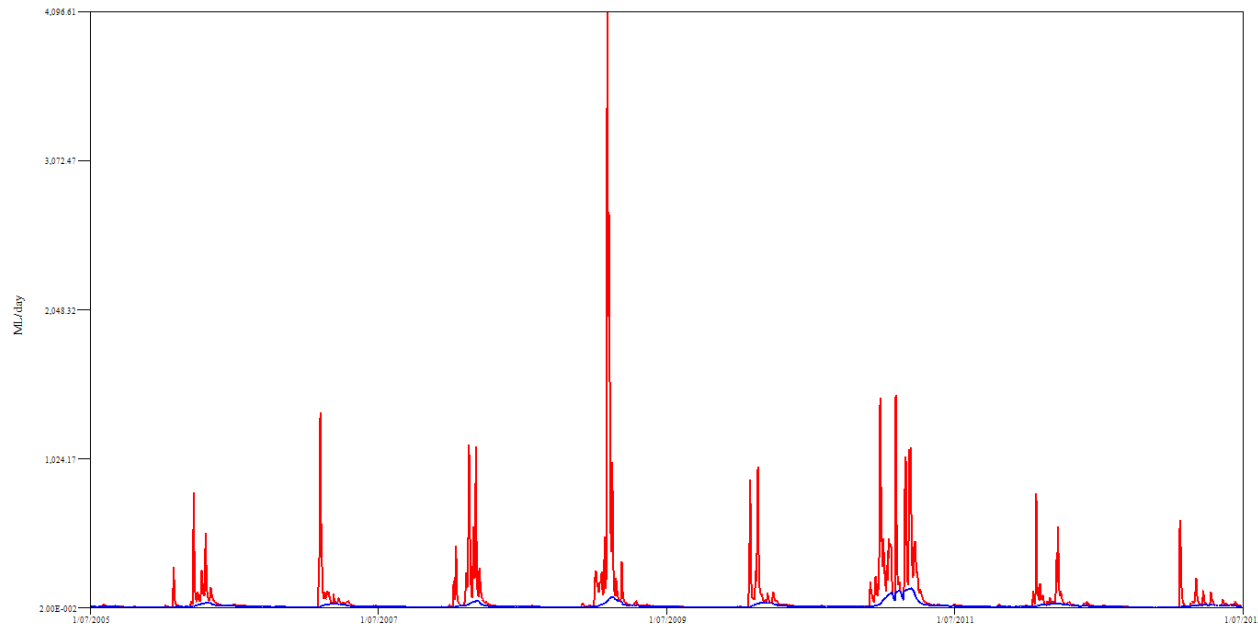
**Figure 17 River Analysis Package output graph of total flow (red) and base flow (blue) for Herbert River at Glen Eagle (gauging station 116004C)**

Table 47 River Analysis Package output table for Herbert River at Abergowrie (gauging station 116006B)

Herbert River at Abergowrie	116006B
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	26.68

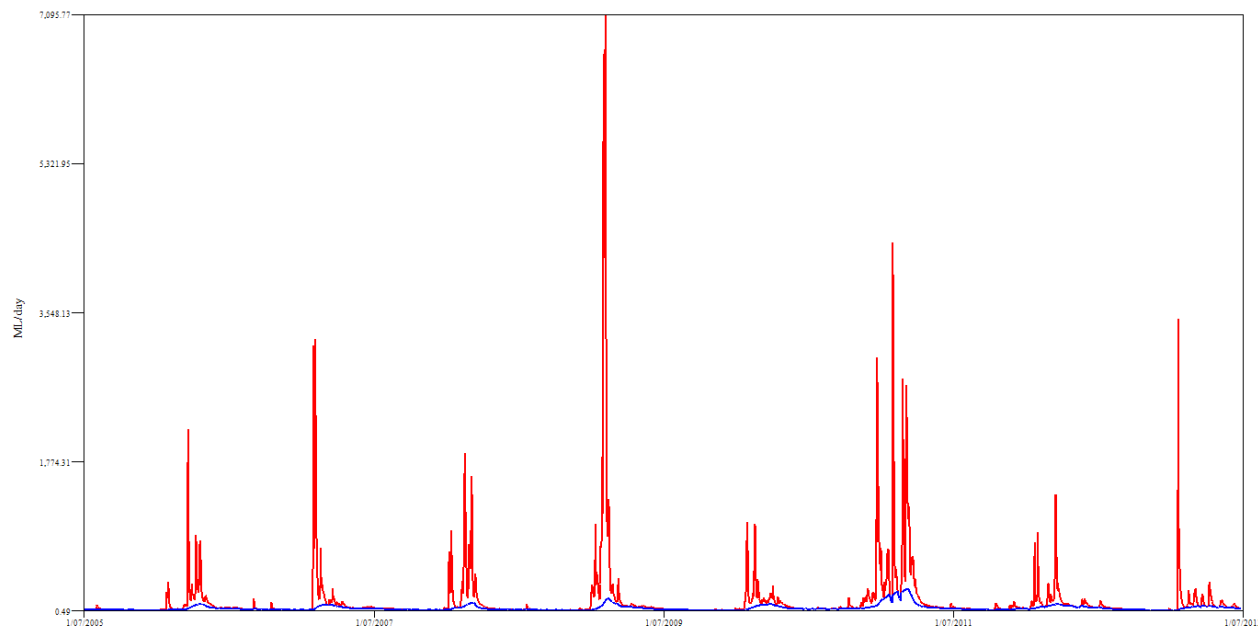


Figure 18 River Analysis Package output graph of total flow (red) and base flow (blue) for Herbert River at Abergowrie (gauging station 116006B)

Table 48 River Analysis Package output table for Millstream at Archer Creek (gauging station 116013A)

Millstream at Archer Creek	116013A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	2.33

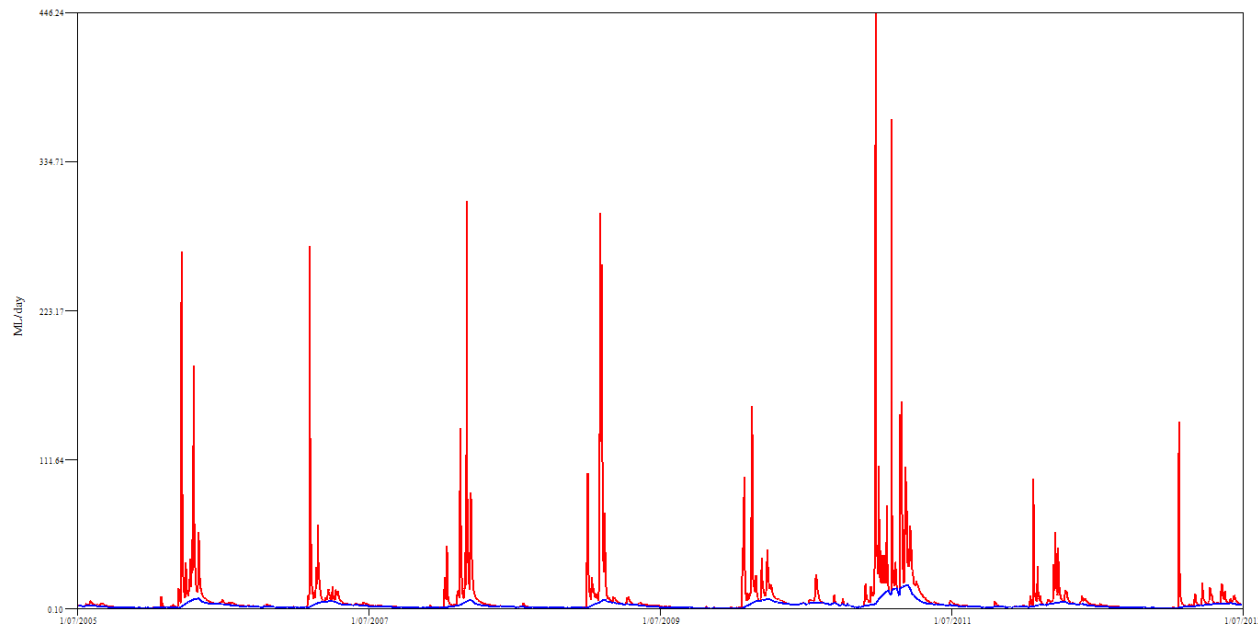
**Figure 19 River Analysis Package output graph of total flow (red) and base flow (blue) for Millstream at Archer Creek (gauging station 116013A)**

Table 49 River Analysis Package output table for Wild River at Silver Valley (gauging station 116014A)

Wild River at Silver Valley	116014A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	1.173

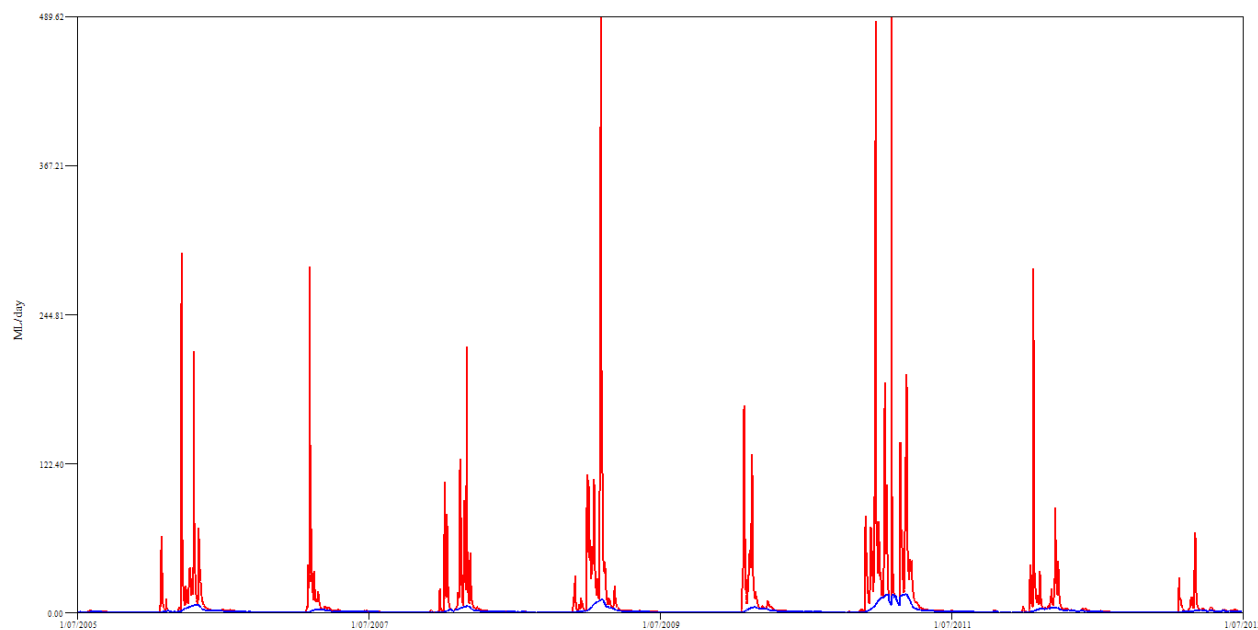


Figure 20 River Analysis Package output graph of total flow (red) and base flow (blue) for Wild River at Silver Valley (gauging station 116014A)

Table 50 River Analysis Package output table for Blunder Creek at Wooroora (gauging station 116015A)

Blunder Creek at Wooroora	116015A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow (m^3s^{-1})	1.117

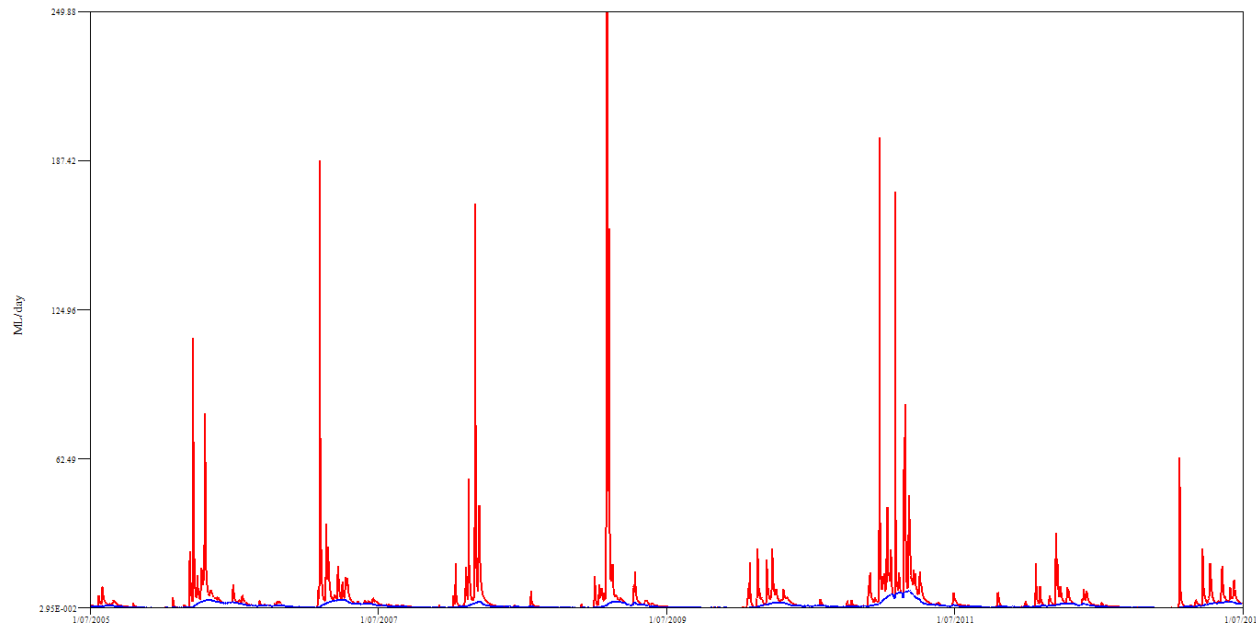
**Figure 21 River Analysis Package output graph of total flow (red) and base flow (blue) for Blunder Creek at Wooroora (gauging station 116015A)**

Table 51 River Analysis Package output table for Rudd Creek at Gunnawarra (gauging station 116016A)

Rudd Creek at Gunnawarra	116016A
Flow Start Date	1/07/2005
Flow End Date	1/07/2013
Base Flow α Value	0.975
Mean Daily Base Flow ($m^3 s^{-1}$)	1.378

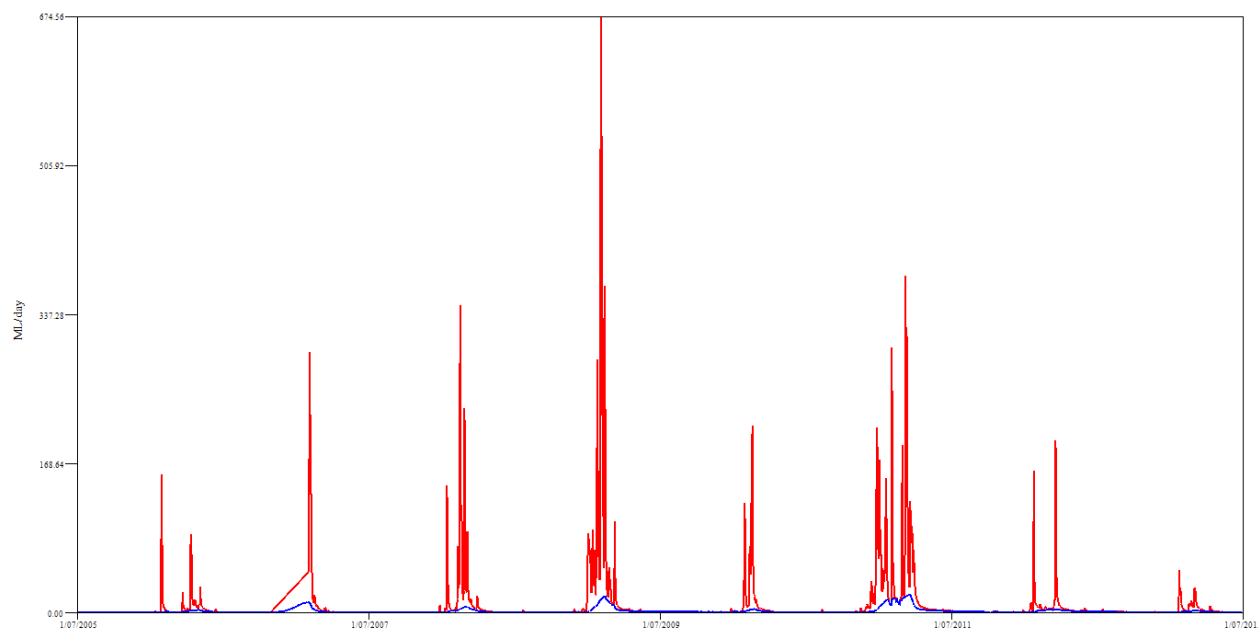


Figure 22 River Analysis Package output graph of total flow (red) and base flow (blue) for Rudd Creek at Gunnawarra (gauging station 116016A)

Appendix C

Base Flow Analysis

The purpose of base flow analysis is to divide the hydrograph into the base flow and high flow component parts. Base flow is considered here to be that flow which occurs in the absence of runoff due to rainfall events. A hydrograph will generally have long periods of relatively consistent low flow when the stream is groundwater fed interspersed with periods of high flow due to storm.

The method of calculating the base flow component of the hydrograph is through the use of a 3 way digital filter as described in (Grayson et al. 1996). The purpose of the digital filters is to create a relatively smooth transition from the period of base flow before a storm event to the usually elevated base flow following the storm event. In practice there is no way to accurately describe the base flow during periods of runoff, however the Lyn and Holick method is generally accepted as a suitable approximation (Grayson et al. 1996).

Mean Daily Base Flow

The daily base flow is calculated as the total base flow component of the hydrograph divided by the number of days of the record.