Water Quality of the Lindis and Cardrona rivers

SURFACE WATER

Otago Regional Council

Water Quality of the Lindis and Cardrona Rivers

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Chairperson's Foreword – Water Quality of the Lindis and Cardrona Rivers

Otago's natural water quality is of very high quality and this has come to be expected from our rural communities, urban dwellers and visitors. However, in some locations water quality is under pressure from intensive or changing land use.

To help protect water quality, the Otago Regional Council carries out long-term water quality monitoring as part of a State of the Environment programme. To supplement this information, targeted and detailed short-term monitoring programmes are also implemented in some catchments. This report provides the results from one of these more detailed investigations carried out on the Cardrona and Lindis Rivers between September 2004 and February 2005.

The Cardrona and Lindis Rivers are both in the upper Clutha Valley and drain typical Otago high country landscapes. Tussock and low producing grassland dominate in the higher catchment areas, whilst high producing exotic grassland dominates the lower catchments. The principle activity on the tussock is sheep and beef farming.

This report forms a baseline study from which to work with the local community through Catchment Programmes, an initiative developed by the Otago Regional Council which aims to sustain and improve water quality by encouraging environmentally sound land use and water management practices.

Executive Summary

Between September 2005 and March 2006 a monthly water quality monitoring programme was undertaken at six sites on the Cardrona River and nine sites on the Lindis River. Water was tested for a range of physico-chemical and microbiological parameters. This report provides more detailed information to that gathered for the State of Environment programme which has been carried out since the late 1980's.

Monitoring results indicate that water quality is extremely good, with no marked deterioration in water quality with distance downstream or as the summer progressed. Median water quality results did not exceed relevant guideline values and elevated nutrient and bacteriological levels were only found after significant rainfall.

The main pressure affecting both these rivers is that both rivers dry up in their lower reaches during the summer period.

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1. Introduction

The Otago Regional Council carries out State of the Environment surface water quality monitoring throughout the Otago region to fulfil its responsibilities under the Resource Management Act (1991), the Regional Policy Statement for Otago and the Regional Plan: Water for Otago (2004). This monitoring is undertaken to assess the condition (state) of a site and/or to detect trends over a period of time.

To build on the understanding gained from the State of the Environment monitoring programme, more detailed sampling is carried out in targeted catchments. This report presents the results and findings of a water quality monitoring programme undertaken in the Cardrona and Lindis Rivers between September 2004 and February 2005.

Specific objectives of this programme included:

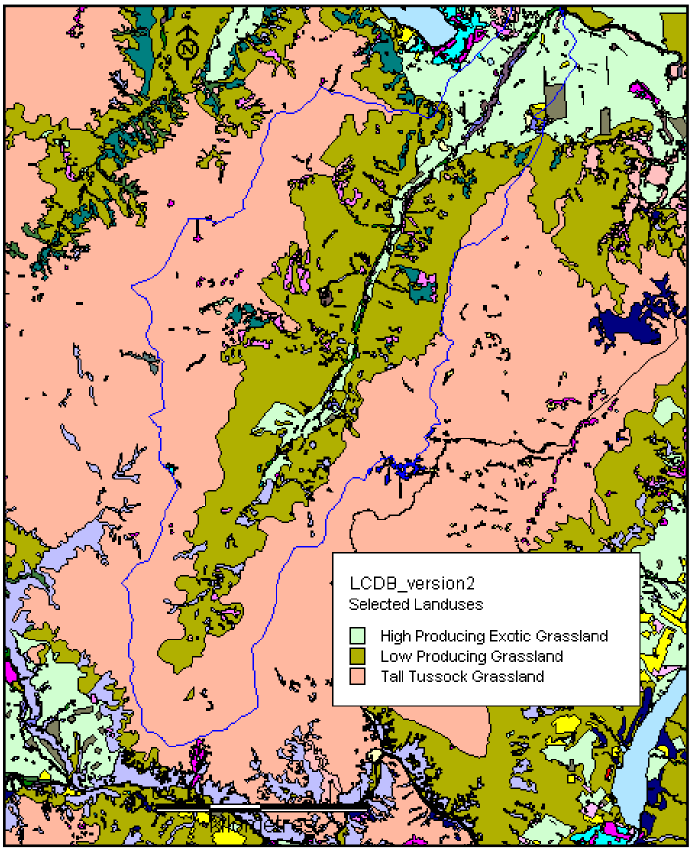
- To determine the state (health) of water quality through comparison of water quality data against the Australia and New Zealand Conservation Council Water Quality Guidelines (2000).
- To examine spatial and temporal trends in water quality in two Central Otago catchments in order to establish baseline water quality.
- To identify any sites of poor water quality and attempt to identify the causes of water quality problems.

2. Background Information

2.1 Catchment descriptions

2.1.1 Cardrona

The Cardrona River has a total catchment area of 337km^2 and flows north for 40km down the steep narrow Cardrona Valley into the Clutha River/Matau-au at Albert Town. The catchment is contained by the Crown Range to the south and west, dividing it from the Wakatipu basin, and the Criffel Range to the east.



The catchment consists of a steep river valley at an elevation of between 300m at it's confluence with the Clutha and 1000m at the top of the Crown Range. The Land Cover Data Base gives a breakdown of land use in the area. Figure 2.1 shows that tussock and low producing grassland dominate in the higher catchment, whilst in the lower catchment, high producing exotic grassland predominates. Agribase 2000 gives a detailed breakdown of the type of farming activities in the catchment. The catchment is dominated by sheep and beef farming on tussock, and high producing grasslands in the lower catchment support some deer farming.

Figure 2.1 Land cover of the Cardrona Catchment

The Cardrona River experiences low flows in its lower catchment, and most years, water dries up in some sections of the river, particularly downstream of Mt Barker.

2.1.2 Lindis

The Lindis River has a total catchment area of 1063km^2 and flows south for approximately 55km through the Lindis Pass (between Otago and the Mackenzie Basin in Canterbury) into the Clutha River/Matau-au upstream of Lake Dunstan. The catchment is contained by the Dunstan Mountains and Chain Hills to the east and the Chain Hills to the west dividing it from the Hawea basin.

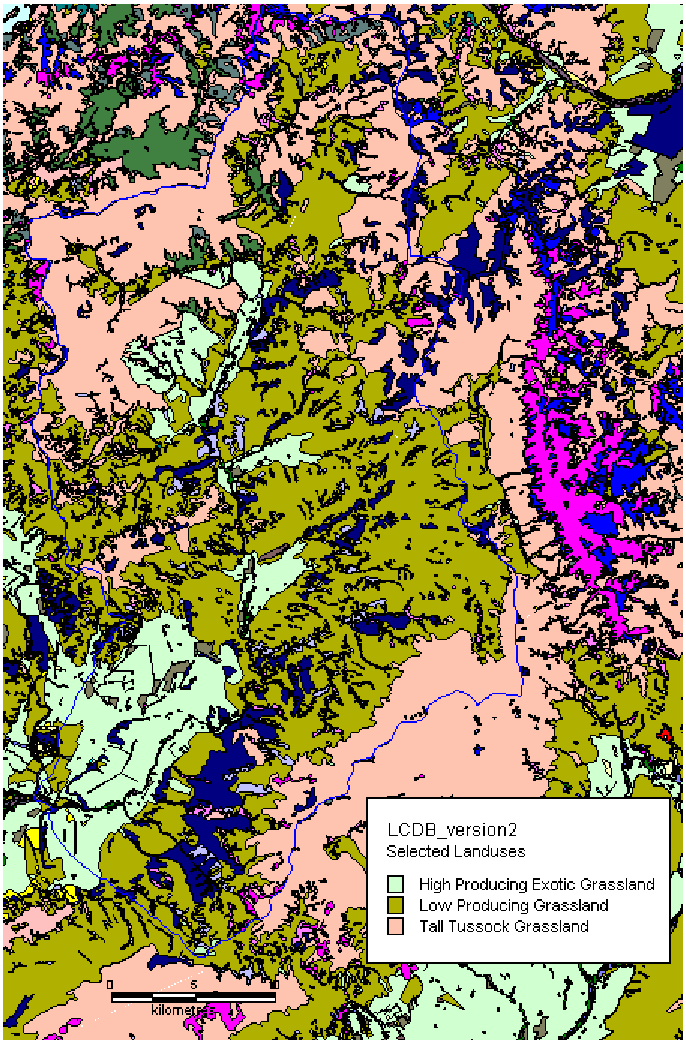


Figure 2.2 Land cover of the Lindis Catchment

The catchment consists of a steep river valley at an elevation of between 300m at it's confluence with the Clutha and 1000m at the top of the Dunstan Mountains. The Land Cover Data Base gives a breakdown of land use in the area. Figure 2.2 shows that tussock and low producing grassland dominate in the higher catchment, whilst in the lower catchment, high producing exotic grassland predominates. Agribase 2000 gives a detailed breakdown of the type of farming activities in the catchment. The catchment is totally dominated by sheep and sheep/beef farming.

The Lindis River experiences low flows in its lower catchment, and most years water dries up in some sections of the river, particularly below Ardgour Road.

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2.2 Physico-chemical, microbiological and biological monitoring

The Otago Regional Council has monitored the Cardrona and Lindis Rivers for physico-chemical and microbiological water quality parameters since December 1989 as part of its State of Environment monitoring programme.

Between September 2004 and March 2005 spot sampling was conducted at sites shown in Figure 2.3. Water samples were stored on ice upon collection and transported to the Otago Regional Council's contracted laboratories for analysis within 24 hours of collection. Field measurements (dissolved oxygen, temperature and conductivity) were taken using approved water quality meters.

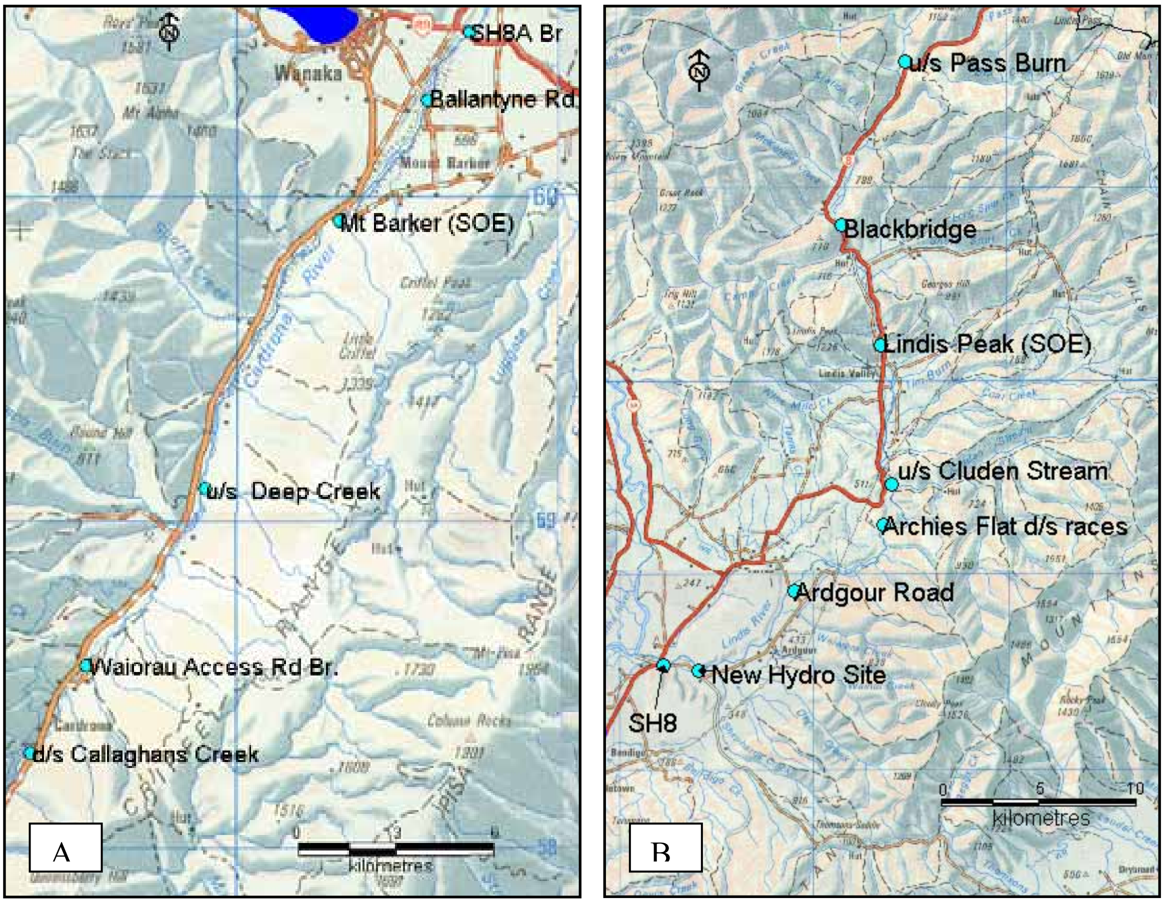


Figure 2.3 Location of water quality monitoring sites sampled between September 2005 and March 2006. A. Cardrona River. B. Lindis River

Water samples were tested for a range of physico-chemical and microbiological parameters. These included dissolved oxygen (DOO, temperature (temp), conductivity (cond), pH, suspended solids (SS), turbidity (turb), faecal coliforms (FC), *Escherichia coli (E. coli*), ammoniacal nitrogen (NH_4), nitrite-nitrate nitrogen (NNN), total nitrogen (TN), dissolved reactive phosphorus (DRP) and total phosphorus (TP).

2.3 Rainfall

The amount of rainfall 72 hours prior to each sampling period was determined at the Wanaka Department of Conservation (DOC) rain-gauge (E 220443, N 5605331). Limited rainfall fell during this period and amounts are detailed in Table 2.1.

Table 2.1 Total daily rainfall recorded at the Wanaka DOC rain-gauge 24 hrs, 48 hrs and 72 hrs prior to each sampling run

Cardrona	19-Sep-2005	25-Oct-2005	14-Nov-2005	19-Dec-2005	10-Jan-2006	08-Feb-2006	07-Mar-2006
24hrs	0	0	1	0	0	7.7	0.2
24-48 hrs	0	0	0	0	0	0	0
48-72 hrs	0.1	0	0	0	0	0	0
Total	0.1	0	1	0	0	7.7	0.2
Lindis	20-Sep-2005	25-Oct-2005	15-Nov-2005	20-Dec-2005	09-Jan-2006	07-Feb-2006	08-Mar-2006
24hrs	0	0	0	15.8	0	0	2.3
24-48 hrs	0	0	0	0	0	0	0
48-72 hrs	0.1	0	0	0	0	0	0

2.4 Flows

ORC have telemetered flow gauges on the Cardrona River at Mt Barker and the Lindis River at Ardgour Road. The gauge at Ardgour Road has only been operating since mid November. The Lindis results shown in Table 2.2 for September through to November are taken from the Lindis at Lindis Peak.

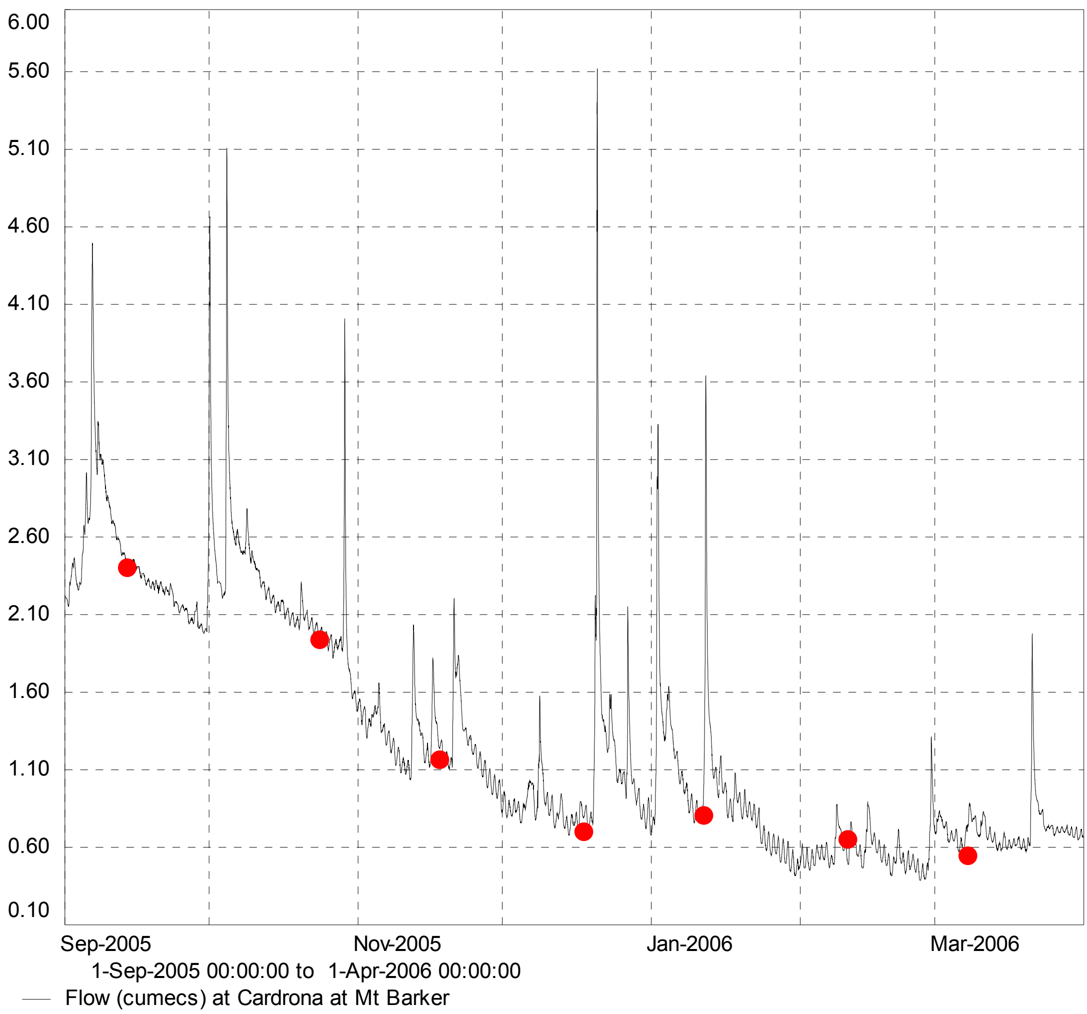


Figure 2.4 Flow (cumecs) at Mt Barker, Cardrona River. The red spots indicate days when water quality samples were taken

Table 2.2 Daily mean flows recorded at Lindis Peak and Mt Barker

	Sep 2005	Oct 2005	Nov 2005	Dec 2005	Jan 2006	Feb 2006
Lindis at Lindis Peak	4.937	3.725	2.509	1.326	0.930	0.412
Cardrona at Mt Barker	2.441	2.249	1.295	1.018	0.961	0.573

Figure 2.4 and Figure 2.5 graphically depict mean daily flows recorded at Mt Barker (Cardrona River) and Lindis Peak (Lindis River). The red spots indicate days when water quality samples were taken. Figure 2.4 shows that the February sample for the Cardrona River was taken when flows had risen after the 7.7mm rainfall, and Figure 2.5 clearly shows that the December sample was taken when flows were rising after the 15.5mm rainfall recorded in the previous 24 hrs. It is expected that this will have some bearing on water quality results.

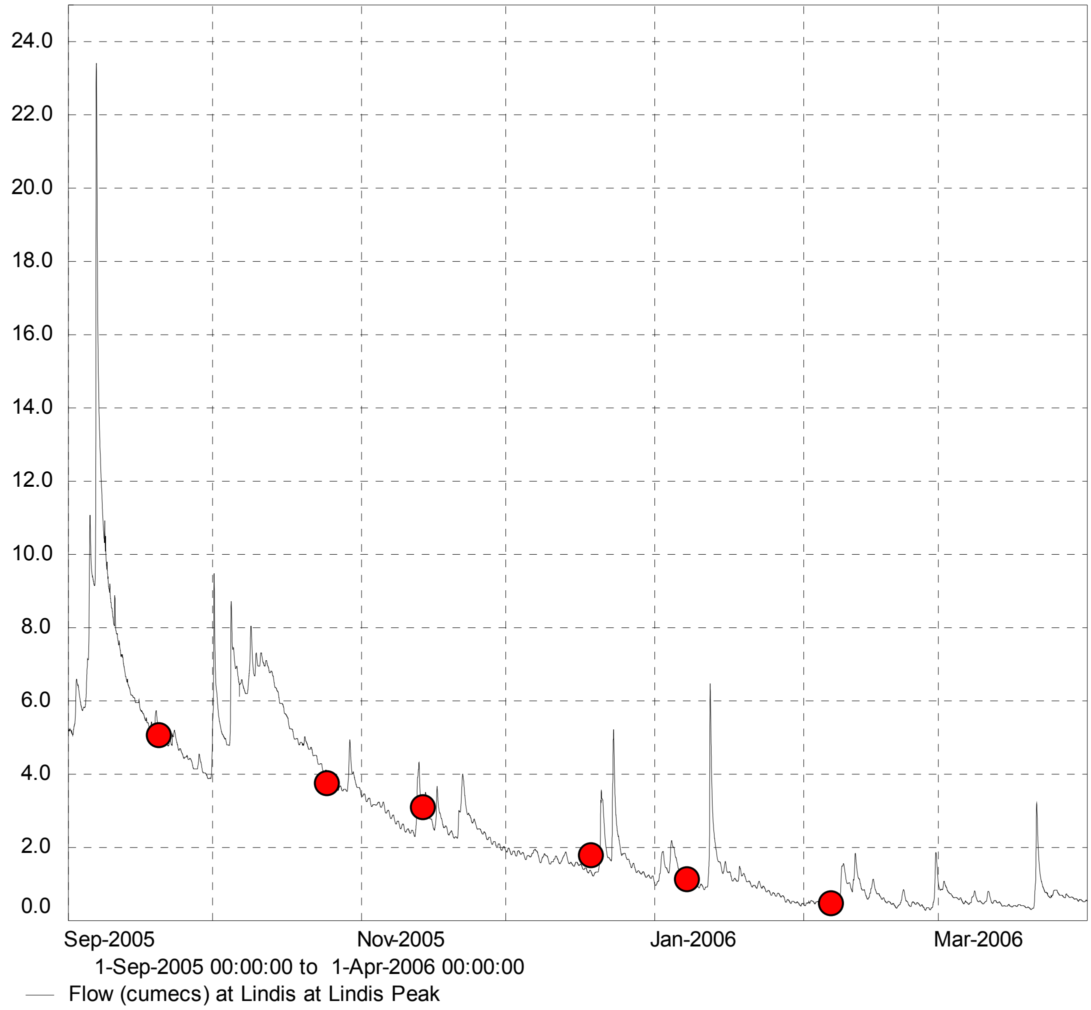


Figure 2.5 Flow (cumecs) at Lindis Peak, Lindis River. The red spots indicate days when water quality samples were taken

2.5 Discharges and takes

Figure 2.6 shows the location of discharges and takes from the Cardrona and Lindis Rivers. Neither river has significant discharges of waste water. However, both rivers have significant takes, particularly in their lower reaches and both rivers dry up in their lower reaches most years. Figure 2.7 shows the Lindis River at SH87.

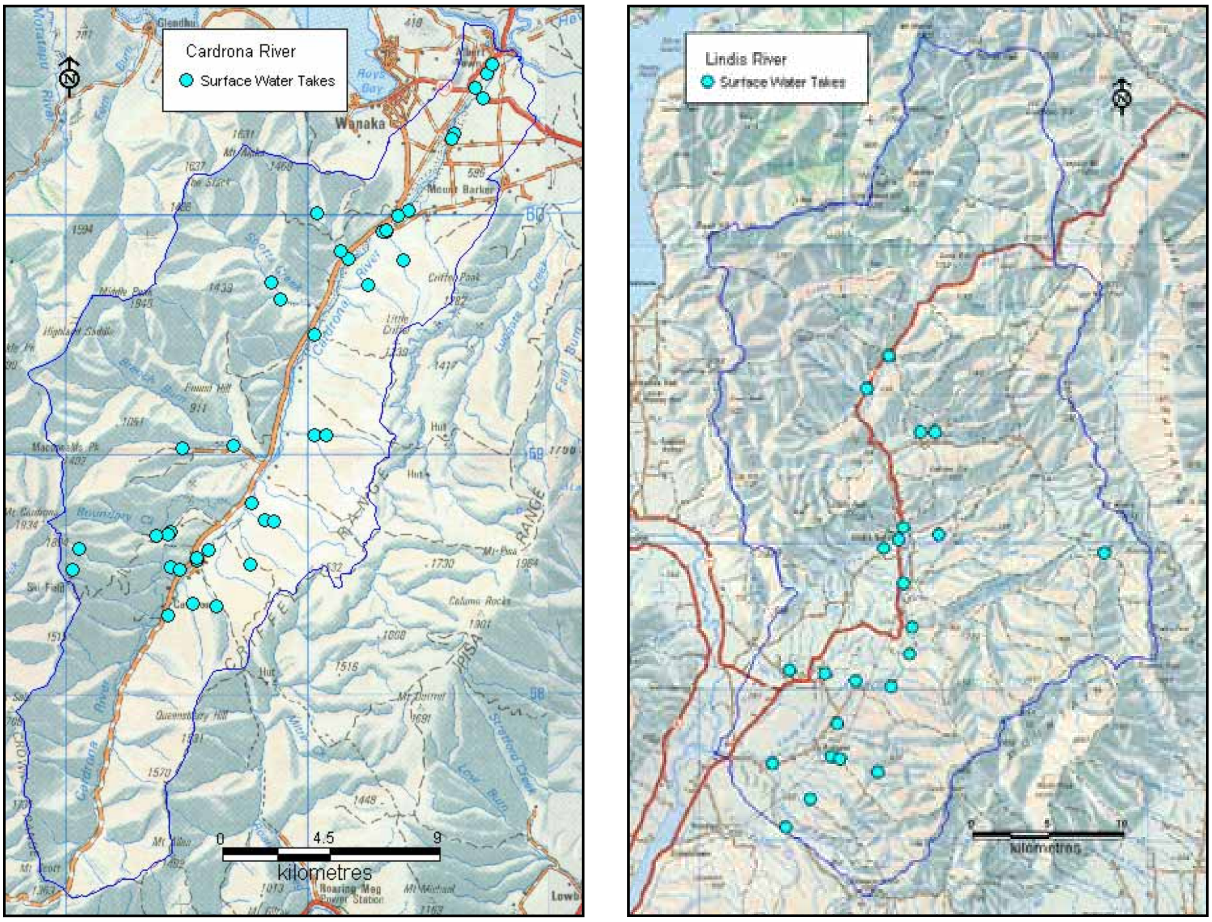


Figure 2.6 Location of discharges and takes in the Cardrona and Lindis Catchments

Figure 2.7 Lindis River at SH8, 21 February 2006

3. Water Quality

3.1 Cardrona River

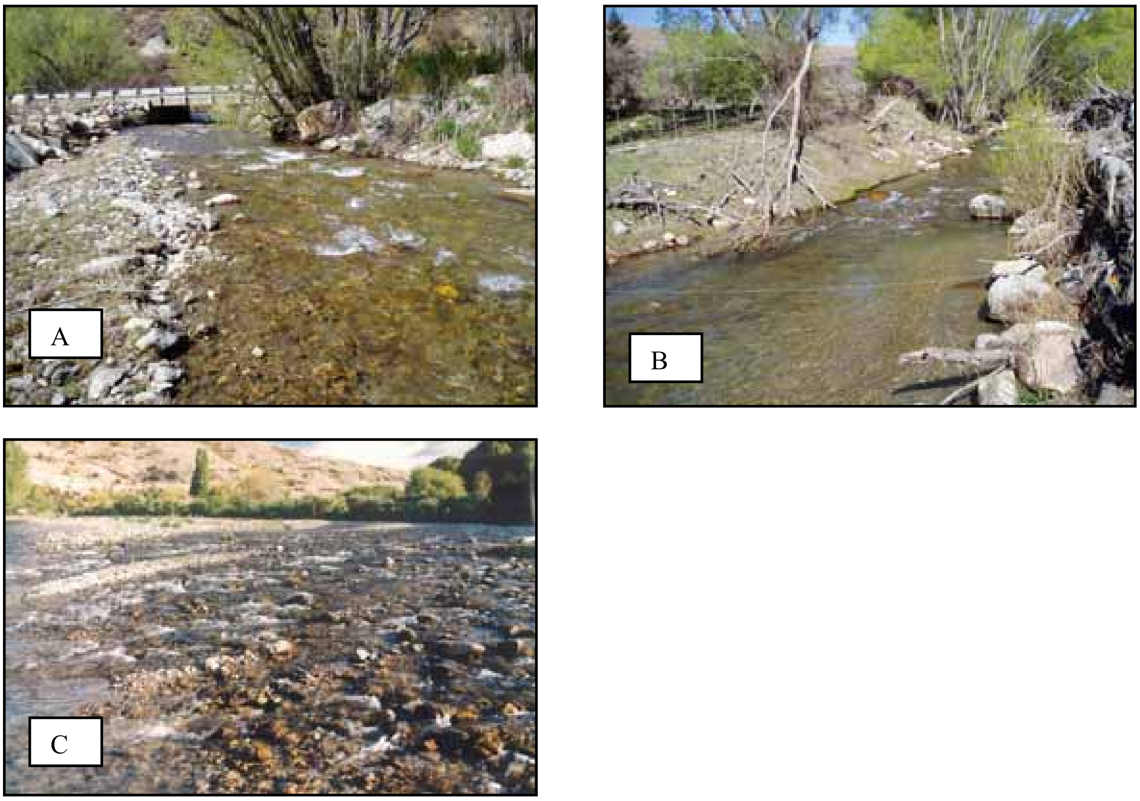


Figure 3.1 Sampling sites on Cardrona River Stream: A - Callaghans Creek; B - Waiorau Bridge; C - Mt Barker

Routine water quality monitoring began at Mt Barker in December 1989. A summary of the water quality results for the Cardrona River is shown in Table 3.1. Full results are located in Appendix 1.

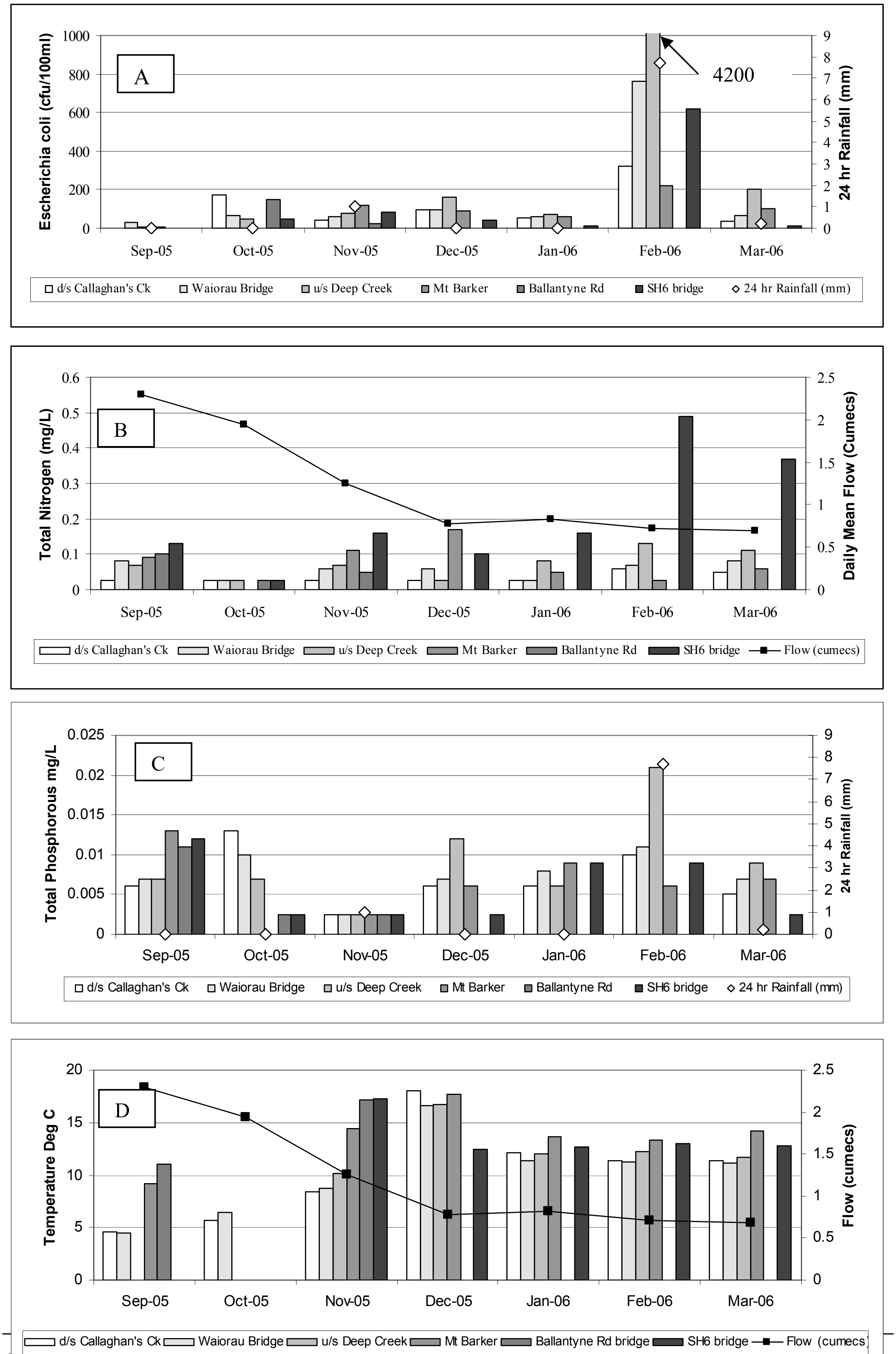
Table 3.1 Median water quality results for the Cardrona Catchment, September 2005-March 2006. Long-term medians for Mt Barker indicated in italics

Site	Turbidity (NTU)	E. coli (n/100ml)	Ammonia N (mg/l)	Nitrite-Nitrate N (mg/l)	Total N (mg/l)	Dissolved Reactive P (mg/l)	Total P (mg/l)
*ANZECC 2000 **	4.1	550†	0.01	0.167	0.295	0.009	0.026
Cardrona River							
Callaghans Ck (*n* =7)	0.85	52	0.005	0.0025	0.025	0.005	0.006
Waiorau Rd (*n* =7)	1.3	66	0.005	0.011	0.06	0.005	0.007
Deep Creek (*n* =7)	1.3	76	0.005	0.007	0.07	0.005	0.007
Mt Barker (*n* =6)	0.88 (1.9)	94 (86)	0.005 (0.005)	0.022 (0.041)	0.075 (0.105)	0.005 (0.0025)	0.0065 (0.01)
Ballantyne Rd (*n* =3)	2.3	22	0.005	0.01	0.05	0.005	0.0025
SH8 (*n* =7)	0.955	40	0.01	0.111	0.16	0.006	0.0025

† Action/Red Mode - Ministry for Environment/Ministry of Health 2003 Recreational Water Quality Guidelines

*Default Trigger Value for Upland Rivers

Table 3.1 shows that median levels for nutrients at all sites in the Cardrona River are below the ANZECC default trigger guidelines for upland rivers. However, Figure 3.2 looks at individual sites and sampling dates and whilst generally the river is of good quality, water quality deteriorates in times of rainfall, as it would in most rivers.



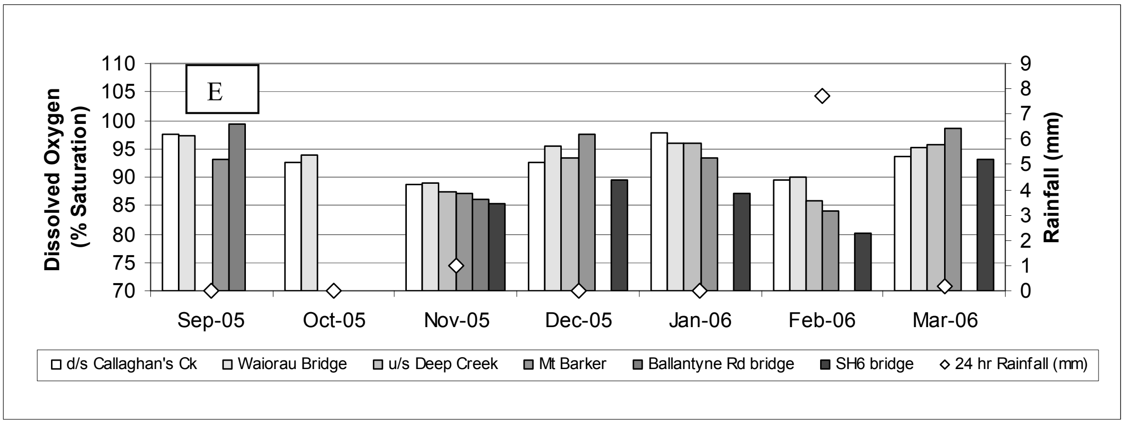


Figure 3.2 Cardrona River water quality. Samples taken at monthly intervals between September 2005 and March 2006. A - *Escherichia coli;* B - Total nitrogen; C - Total phosphorus; D - Temperature; E - Dissolved Oxygen

The deterioration due to rainfall is illustrated in Figure 3.2A. This shows that the February sampling run was associated with elevated *E. coli* concentrations which exceeded the surveillance/green mode of the MfE/MoH 2003 Recreational Water Quality Guideline (<260 *E.coli*/100ml). Deep Creek recorded a particularly elevated *E.coli* concentration of 4200 cfu/100ml. In the same sampling run, TN was noticeably elevated at SH6 Bridge and TP exceeded the ANZECC default trigger value for upland rivers at Ballantyne Road.

Figure 3.2 does not show a marked deterioration of water quality over the summer period. However, in some sampling runs a deterioration downstream can be noted, specifically Figure 3.2B and C where the September run shows an increase of TN and TP downstream. Figure 3.2E shows that in January and February DO levels decrease with distance downstream, but are still above the bottom line of 80% saturation (as specified in the Third Schedule of the RMA).

The contaminant concentrations were so low that it was not possible to correlate higher temperatures with higher contaminant levels, as would be expected if irrigation losses were a key to water quality deterioration. As the Cardrona River has been monitored by the Otago Regional Council in the State of Environment monitoring programme at various times between December 1989 and March 2006, a regression analysis was undertaken on all samples, the results of which did not show a statistically significant relationship between temperature and any of the nutrients (TP, DRP, TN, NH_4).

3.2 Lindis River

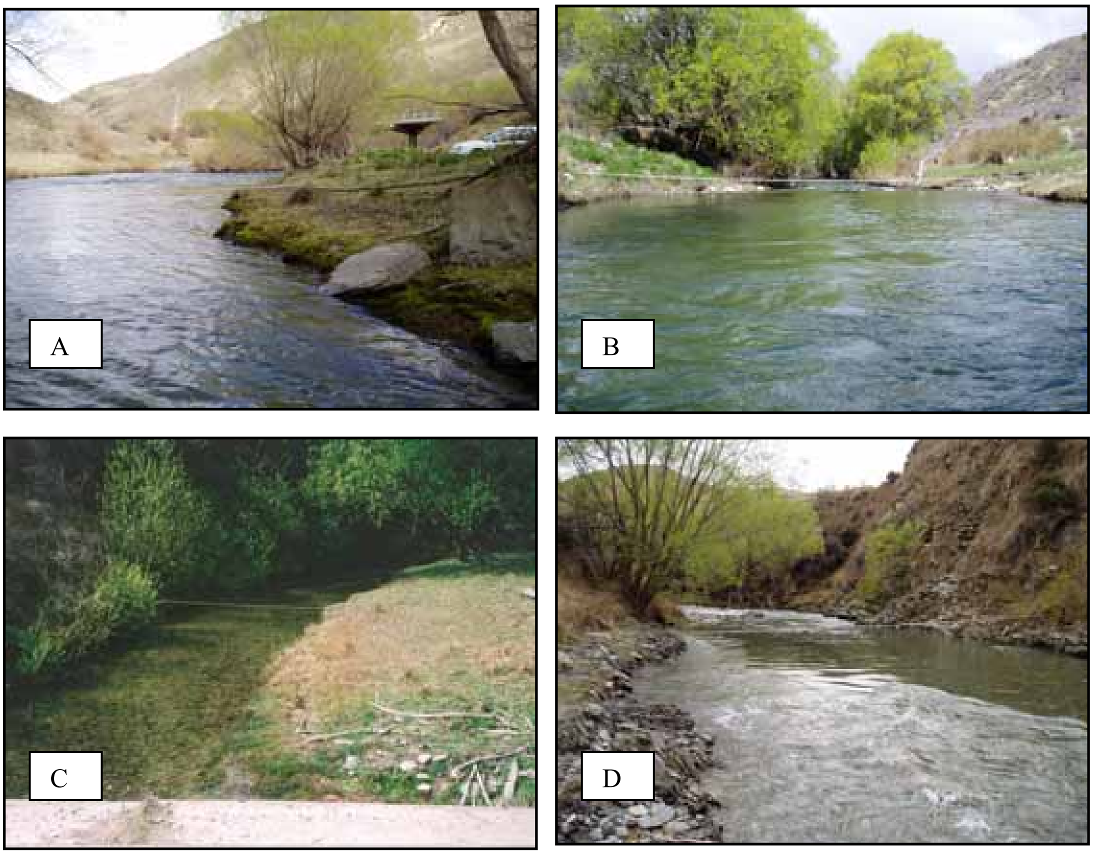


Figure 3.3 Sampling sites on Lindis River: A – Blackbridge; B - Lindis Peak; C - Cluden Stream; D - Passburn

Table 3.2 Median water quality results for the Lindis Catchment, September 2005-March 2006. Long-term medians for Lindis Peak indicated in italics

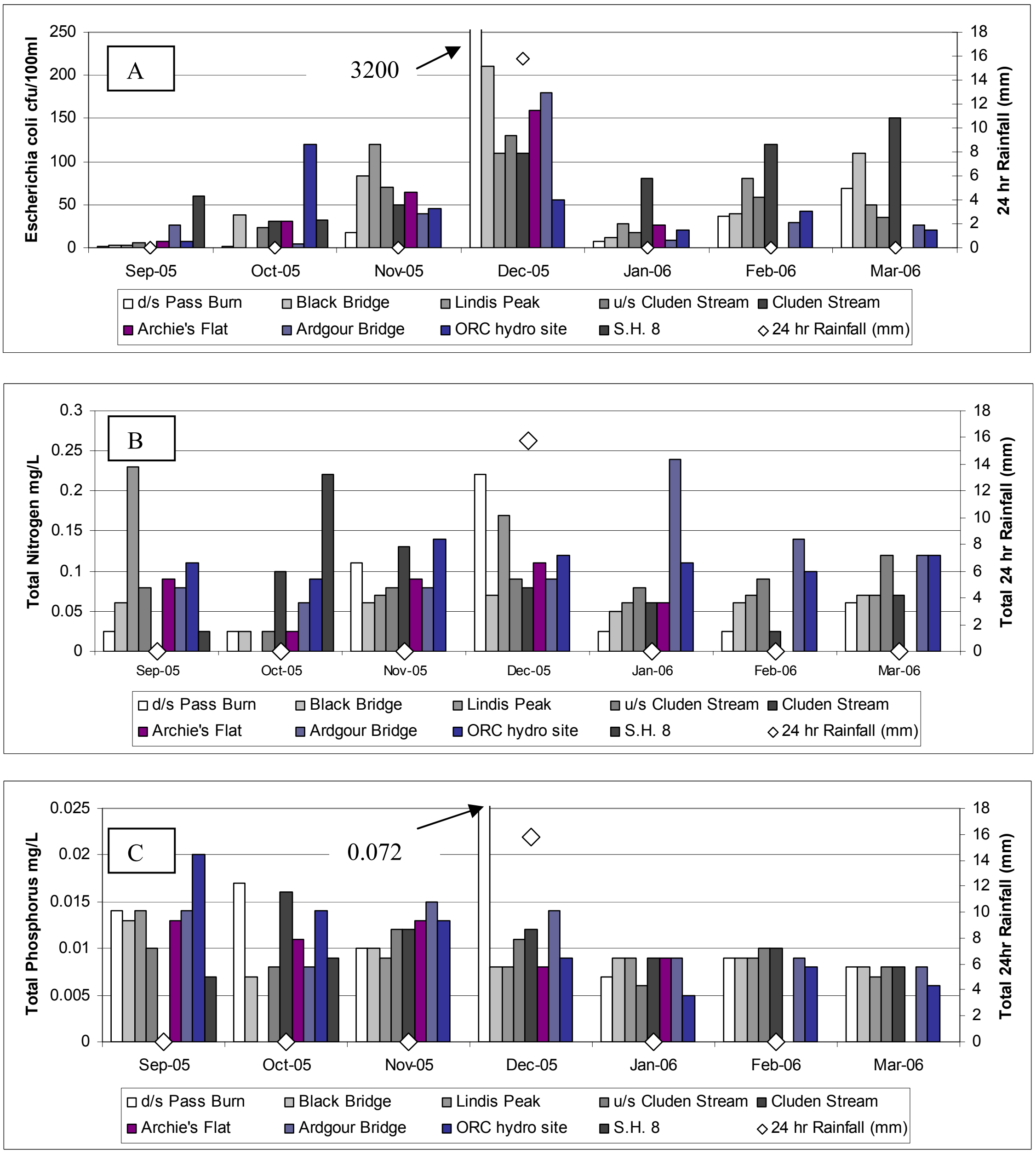
Site	Turbidity (NTU)	E. coli (n/100ml)	Ammonia N (mg/l)	Nitrite-Nitrate N (mg/l)	Total N (mg/l)	Dissolved Reactive P (mg/l)	Total P (mg/l)
ANZECC 2000	4.1	550†	0.01	0.167	0.295	0.009	0.026
Lindis River							
Passburn (*n* =7)	0.75	18	0.005	0.0025	0.025	0.007	0.008
Blackbridge (*n* =7)	0.51	40	0.01	0.015	0.06	0.007	0.009
Lindis Peak (*n* =6)	0.625 *(0.95)*	65 *(24)*	0.01 *(0.005)*	0.006 *(0.01)*	0.07 *(0.07)*	0.0055 *(0.0025)*	0.009 *(0.009)*
U/s Cluden Stm (*n* =7)	0.47	35	0.01	0.029	0.08	0.007	0.01
Archies Flat (*n* =5)	0.7	30	0.01	0.007	0.09	0.006	0.011
Ardgour Road (*n* =7)	0.61	27	0.01	0.02	0.09	0.007	0.009
Hydro Site (*n* =7)	0.39	43	0.01	0.068	0.11	0.006	0.009
SH8 (*n* =2)	1.48	46	0.0075	0.0225	0.1225	0.006	0.009
Cluden Stream (*n* =6)	0.42	95	0.01	0.0025	0.075	0.007	0.011

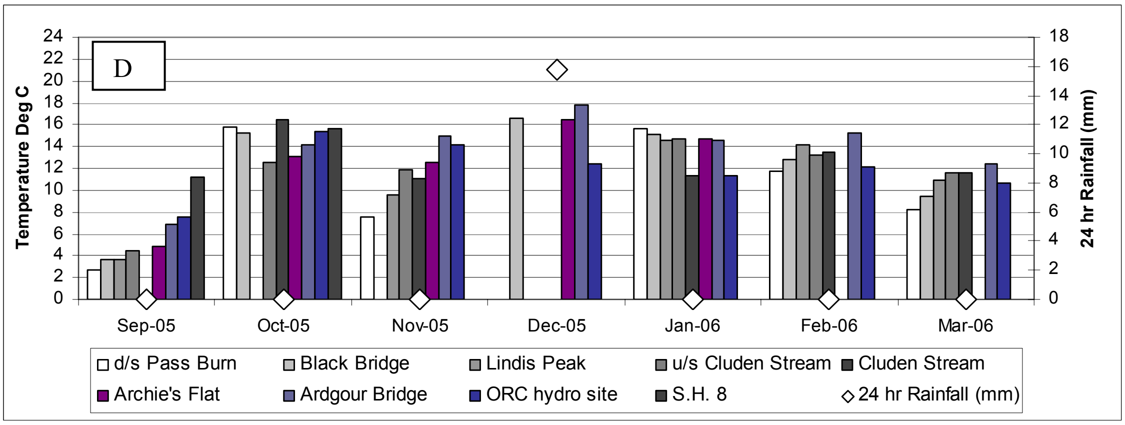
† Surveillance/Green Mode - Ministry for Environment/Ministry of Health 2003 Recreational Water Quality Guidelines

* Default Trigger Value for Upland Rivers

Routine water quality monitoring at Lindis Peak began in December 1989 and a summary of the water quality is shown in Table 3.2. Full results are located in Appendix 1.

Table 3.2 shows that median levels for all water quality parameters, at all sites in the Lindis River, are below the ANZECC default trigger guidelines for upland rivers. However, Figure 3.4 looks at individual sites and sampling dates and whilst generally the river is of good quality, water quality deteriorates in times of rainfall.





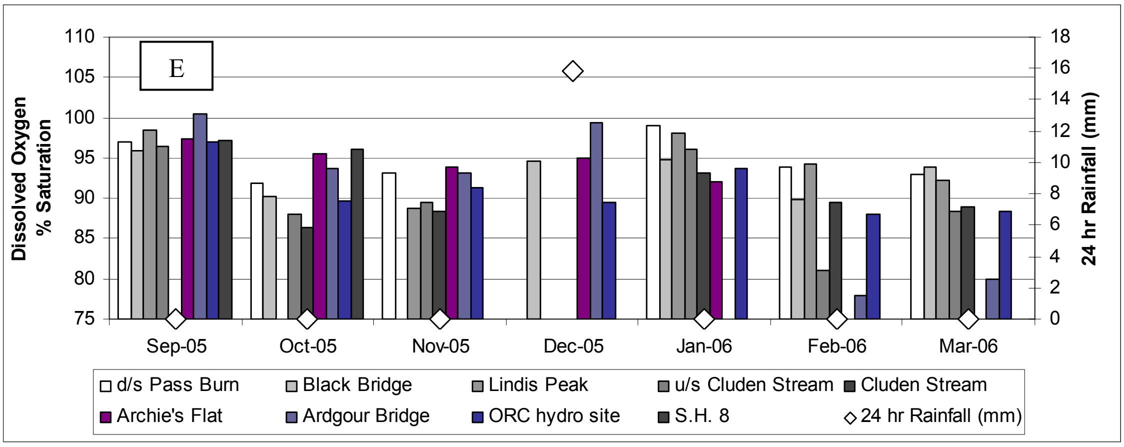


Figure 3.4 Lindis River water quality. Samples taken at monthly intervals between September 2005 and March 2006. A - *Escherichia coli;* B - Total nitrogen; C - Total phosphorus; D - Temperature; E - Dissolved Oxygen

In December 2005, rainfall of 15.5mm fell in the 24 hrs prior to sampling. This resulted in elevated *E. coli* concentrations at all the upstream sites. Figure 3.4A shows that only Passburn exceeded the surveillance/green mode of the MfE/MoH 2003 Recreational Water Quality Guideline (<260 *E.coli*/100ml). Passburn also recorded a particularly high TP result on the same sampling run.

Figure 3.4C shows that TP looks as if it decreases over the summer period, other than the one high reading at Passburn taken just after the rainfall event. It was not expected to find elevated concentrations of phosphorus as the most common cause of elevated phosphorus in watercourses is sediment being washed from paddocks into the stream by heavy rain, and each sampling round was undertaken after periods of dry weather (other than in December). When disregarding the high Passburn result, the P-value of the F-test is less than 0.05, showing a statistically significant difference between the means of the 7 variables at the 95.0% confidence level. This does not occur with TN. In terms of phosphorus, water quality seems to improve over the summer period.

Figure 3.4E shows that DO concentrations remain above 80% at all sites and dates, other than at Ardgour Bridge where levels dropped just below this threshold on 7 February.

Lindis River at Lindis Peak has been monitored by the Otago Regional Council in the State of Environment monitoring programme at various times between December 1989 and March 2006. Regression analysis undertaken on all samples showed no statistically significant relationship between temperature and nutrients, confirming that it was unlikely that irrigation losses had an effect on water quality.

4. Discussion

Over the period from September 2005 to March 2006 water quality was good in both catchments. There was no obvious increase in contaminants over the summer period and no increase in contaminants with distance downstream. However, the Cardrona River was dry at Ballantyne Road Bridge and the Lindis River was dry at SH8 from December to April.

After significant rainfall, water quality deteriorates. For example, in December the Lindis River at Passburn exceeded the ANZECC guideline for total phosphorous as well as exceeding the green/surveillance mode of the MfE.MoH2003 Recreational Water Quality Guideline (<260 *E.coli*/100ml). On this sampling date elevated levels of *E. coli* were also seen at all sites downstream.

The Cardrona River also showed elevated *E.coli* concentrations after significant rainfall in February, and the ANZECC guideline was breached for TN and TP at SH6 in February.

Overall, the rivers have good water quality during dry weather. However, as in most catchments, water quality is compromised during times of rainfall and higher flows. Water quality will always reflect land use practices and the extensive nature of farming in the Lindis and Cardrona Catchments mean that a *severe* degradation in water quality attributable to land use is unlikely.

5. Conclusion

The results of the water quality monitoring programme indicate that water quality in both the Cardrona and the Lindis Rivers is good during dry weather, and did not deteriorate over the summer period, or with distance downstream.

The major environmental consideration is that both rivers generally dry up in their lower reaches during the summer period.

6. References

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Appendix 1

Water quality of the Cardrona and Lindis Rivers.
September 2005 to March 2006.

Cardrona

Site Name	Date	NH4	Cond	DO%	DRP	Ecoli	NNN	pH	SS	Temp	TN	TP	Turb
		mg/L	mS/cm	%sat	mg/L	cfu/100ml	mg/L	pH	mg/L	Deg C	mg/L	mg/L	NTU
SH6 bridge	20-Sep-05	0.005			0.005	2	0.032	7.4	5		0.13	0.012	1.6
SH6 bridge	25-Oct-05	0.005			0.006	46	0.031	7.4	3		0.025	0.0025	2.3
SH6 bridge	14-Nov-05	0.01	0.0976	85.3	0.0025	84	0.039	7.4	1.5	17.3	0.16	0.0025	0.27
SH6 bridge	19-Dec-05	0.01	0.07	89.6	0.009	40	0.111	6.91	1.5	12.45	0.1	0.0025	0.14
SH6 bridge	10-Jan-06	0.005	0.073	87.2	0.006	11	0.154	7.3	1.5	12.64	0.16	0.009	
SH6 bridge	08-Feb-06	0.19	0.052	80.2	0.068	620	0.23	7	8	12.97	0.49	0.091	9.6
SH6 bridge	07-Mar-06	0.01	0.0996	93.2	0.008	9	0.324	6.6	1.5	12.8	0.37	0.0025	0.31
	Median	**0.01**	**0.073**	**87.2**	**0.006**	**40**	**0.111**	**7.3**	**1.5**	**12.8**	**0.16**	**0.0025**	**0.955**
Ballantyne Rd	20-Sep-05	0.005	0.065	99.3	0.005	2	0.029	7.7	6	11	0.1	0.011	2.3
Ballantyne Rd	25-Oct-05	0.005			0.006	150	0.01	7.7	1.5		0.025	0.0025	2.5
Ballantyne Rd	14-Nov-05	0.005	0.0993	86.2	0.0025	22	0.0025	8.2	1.5	17.2	0.05	0.0025	0.73
	Median	**0.005**	**0.08215**	**92.75**	**0.005**	**22**	**0.01**	**7.7**	**1.5**	**14.1**	**0.05**	**0.0025**	**2.3**
Mt Barker	20-Sep-05	0.005	0.062	93	0.006	7	0.042	7	7	9.13	0.09	0.013	2.2
Mt Barker	14-Nov-05	0.005	0.0994	87.2	0.005	120	0.024	7.7	4	14.4	0.11	0.0025	1.3
Mt Barker	19-Dec-05	0.01	0.0824	97.5	0.006	88	0.02	7.31	1.5	17.66	0.17	0.006	0.88
Mt Barker	10-Jan-06	0.005	0.0827	93.5	0.0025	62	0.022	7.3	1.5	13.69	0.05	0.009	
Mt Barker	08-Feb-06	0.005	0.0822	84	0.005	220	0.022	7.16	1.5	13.36	0.025	0.006	0.25
Mt Barker	07-Mar-06	0.005	0.0992	98.7	0.0025	100	0.022	7.2	1.5	14.2	0.06	0.007	0.66
	Median	**0.005**	**0.08255**	**93.25**	**0.005**	**94**	**0.022**	**7.25**	**1.5**	**13.945**	**0.075**	**0.0065**	**0.88**
Deep Creek	19-Sep-05	0.005			0.005	6	0.014	6.8	4		0.07	0.007	1.2
Deep Creek	25-Oct-05	0.005			0.005	50	0.01	7.4	58		0.025	0.007	3.4

Site Name	Date	NH4	Cond	DO%	DRP	Ecoli	NNN	pH	SS	Temp	TN	TP	Turb
		mg/L	mS/cm	%sat	mg/L	cfu/100ml	mg/L	pH	mg/L	Deg C	mg/L	mg/L	NTU
Deep Creek	14-Nov-05	0.005	0.1009	87.5	0.0025	76	0.007	7.6	1.5	10.2	0.07	0.0025	0.5
Deep Creek	19-Dec-05	0.01	0.0886	93.3	0.005	160	0.007	7.41	1.5	16.7	0.025	0.012	1.4
Deep Creek	10-Jan-06	0.005	0.0865	96.1	0.0025	74	0.007	7.3	1.5	12.03	0.08	0.006	
Deep Creek	08-Feb-06	0.005	0.0876	85.9	0.005	4200	0.0025	7.09	20	12.27	0.13	0.021	2.3
Deep Creek	07-Mar-06	0.005	0.1067	95.8	0.005	200	0.0025	7.3	1.5	11.7	0.11	0.009	1
	Median	**0.005**	**0.0886**	**93.3**	**0.005**	**76**	**0.007**	**7.3**	**1.5**	**12.03**	**0.07**	**0.007**	**1.3**
Waiorau	19-Sep-05	0.005	0.057	97.2	0.005	30	0.011	6.6	3	4.49	0.08	0.007	1.2
Waiorau	25-Oct-05	0.005	0.0978	93.9	0.006	66	0.014	7.5	4	6.4	0.025	0.01	4.6
Waiorau	14-Nov-05	0.005	0.1046	89	0.0025	58	0.01	7.7	1.5	8.7	0.06	0.0025	0.36
Waiorau	19-Dec-05	0.005	0.0925	95.5	0.005	94	0.012	7.73	1.5	16.6	0.06	0.007	1.4
Waiorau	10-Jan-06	0.005	0.0895	96	0.0025	61	0.012	7.7	1.5	11.34	0.025	0.008	
Waiorau	08-Feb-06	0.005	0.0935	90.1	0.005	760	0.008	7.65	6	11.25	0.07	0.011	2.1
Waiorau	07-Mar-06	0.005	0.1092	95.2	0.005	68	0.009	7.7	1.5	11.1	0.08	0.007	1.1
	Median	**0.005**	**0.0935**	**95.2**	**0.005**	**66**	**0.011**	**7.7**	**1.5**	**11.1**	**0.06**	**0.007**	**1.3**
d/s Callaghan's Ck	19-Sep-05	0.005	0.059	97.5	0.006	2	0.0025	6.7	1.5	4.64	0.025	0.006	1.1
d/s Callaghan's Ck	25-Oct-05	0.005	0.1034	92.5	0.006	170	0.0025	7.7	1.5	5.7	0.025	0.013	1.5
d/s Callaghan's Ck	14-Nov-05	0.005	0.1089	88.6	0.0025	44	0.0025	7.7	1.5	8.4	0.025	0.0025	0.39
d/s Callaghan's Ck	19-Dec-05	0.005	0.0951	92.6	0.005	94	0.0025	7.95	1.5	18.04	0.025	0.006	1.4
d/s Callaghan's Ck	10-Jan-06	0.005	0.0934	97.8	0.005	52	0.005	7.9	1.5	12.11	0.025	0.006	
d/s Callaghan's Ck	08-Feb-06	0.005	0.095	89.6	0.005	320	0.0025	7.89	1.5	11.4	0.06	0.01	0.53
d/s Callaghan's Ck	07-Mar-06	0.005	0.1118	93.7	0.005	38	0.0025	7.9	1.5	11.4	0.05	0.005	0.6
	Median	**0.005**	**0.0951**	**92.6**	**0.005**	**52**	**0.0025**	**7.89**	**1.5**	**11.4**	**0.025**	**0.006**	**0.85**

Lindis

Site	Date	NH4	Cond	DO%	DRP	Ecoli	NNN	pH	SS	Temp	TN	TP	Turb
		mg/L	mS/cm	%sat	mg/L	cfu/100ml	mg/L	pH	mg/L	Deg C	mg/L	mg/L	NTU
S.H. 8	26-Oct-05	0.005	0.0731	97.2	0.007	60	0.019	7.3	3	11.2	0.025	0.007	2.4
S.H. 8	15-Nov-05	0.01	0.0813	96.1	0.005	32	0.026	7.5	1.5	15.7	0.22	0.009	0.56
	Median	**0.0075**	**0.0772**	**96.65**	**0.006**	**46**	**0.0225**	**7.4**	**2.25**	**13.45**	**0.1225**	**0.008**	**1.48**
hydro site	20-Sep-05	0.005	0.042	97	0.006	7	0.026	6.6	7	7.5	0.11	0.02	1.6
hydro site	25-Oct-05	0.01	0.0726	89.6	0.008	120	0.017	7.7	1.5	15.4	0.09	0.014	4.5
hydro site	15-Nov-05	0.01	0.0797	91.3	0.005	45	0.028	7.3	1.5	14.2	0.14	0.013	0.56
hydro site	20-Dec-05	0.01	0.0599	89.4	0.009	56	0.088	7.05	1.5	12.41	0.12	0.009	0.22
hydro site	09-Jan-06	0.01	0.0669	93.6	0.005	21	0.075	7.26	1.5	11.29	0.11	0.005	0.18
hydro site	07-Feb-06	0.01	0.0687	88.1	0.007	43	0.068	7.13	1.5	12.2	0.1	0.008	0.39
hydro site	08-Mar-06	0.01	0.0855	88.3	0.006	21	0.079	6.6	1.5	10.7	0.12	0.006	0.26
	Median	**0.01**	**0.0687**	**89.6**	**0.006**	**43**	**0.068**	**7.13**	**1.5**	**12.2**	**0.11**	**0.009**	**0.39**
Ardgour Bridge	20-Sep-05	0.01	0.04	100.5	0.006	27	0.015	6.9	12	6.86	0.08	0.014	3.2
Ardgour Bridge	25-Oct-05	0.01	0.0668	93.6	0.009	4	0.005	7.6	5	14.2	0.06	0.008	3.6
Ardgour Bridge	15-Nov-05	0.01	0.0754	93.2	0.005	39	0.0025	7.6	3	15	0.08	0.015	0.86
Ardgour Bridge	20-Dec-05	0.01	0.0699	99.4	0.006	180	0.02	7.16	1.5	17.76	0.09	0.014	0.45
Ardgour Bridge	09-Jan-06	0.01	0.0799	64.2	0.008	9	0.226	6.67	1.5	14.51	0.24	0.009	0.12
Ardgour Bridge	07-Feb-06	0.005	0.075	77.9	0.007	29	0.116	6.84	1.5	15.29	0.14	0.009	0.29
Ardgour Bridge	08-Mar-06	0.01	0.0855	79.9	0.007	26	0.052	6.6	1.5	12.4	0.12	0.008	0.61
	Median	**0.01**	**0.075**	**93.2**	**0.007**	**27**	**0.02**	**6.9**	**1.5**	**14.51**	**0.09**	**0.009**	**0.61**
Archie's Flat	20-Sep-05	0.005	0.037	97.4	0.008	7	0.019	6.6	9	4.84	0.09	0.013	1.8
Archie's Flat	25-Oct-05	0.005	0.0652	95.6	0.007	30	0.005	7.5	4	13.1	0.025	0.011	4.2
Archie's Flat	15-Nov-05	0.01	0.0738	93.8	0.005	65	0.007	7.2	4	12.6	0.09	0.013	0.7
Archie's Flat	20-Dec-05	0.01	0.0644	94.9	0.006	160	0.008	7.44	1.5	16.44	0.11	0.008	0.59
Archie's Flat	09-Jan-06	0.01	0.0641	92.1	0.006	26	0.0025	7.44	1.5	14.73	0.06	0.009	0.38
	Median	**0.01**	**0.0644**	**94.9**	**0.006**	**30**	**0.007**	**7.44**	**4**	**13.1**	**0.09**	**0.011**	**0.7**
u/s confluence	25-Oct-05	0.01	0.0738	86.4	0.009	30	0.0025	7	1.5	16.4	0.1	0.016	2
u/s confluence	15-Nov-05	0.01	0.0853	88.3	0.006	49	0.0025	6.9	1.5	11	0.13	0.012	0.33

Site	Date	NH4	Cond	DO%	DRP	Ecoli	NNN	pH	SS	Temp	TN	TP	Turb
		mg/L	mS/cm	%sat	mg/L	cfu/100ml	mg/L	pH	mg/L	Deg C	mg/L	mg/L	NTU
u/s confluence	20-Dec-05	0.01		0.09	0.007	110	0.0025	7.6	1.5		0.08	0.012	0.48
u/s confluence	09-Jan-06	0.01	0.0671	93.1	0.006	80	0.005	7.39	1.5	11.35	0.06	0.009	0.3
u/s confluence	07-Feb-06	0.005	0.0727	89.4	0.008	120	0.0025	7.35	1.5	13.51	0.025	0.01	0.4
u/s confluence	08-Mar-06	0.005	0.0777	89	0.007	150	0.0025	6.7	1.5	11.6	0.07	0.008	0.44
	Median	**0.01**	**0.0738**	**88.65**	**0.007**	**95**	**0.0025**	**7.175**	**1.5**	**11.6**	**0.075**	**0.011**	**0.42**
us Cluden Stm	20-Sep-05	0.005	0.036	96.5	0.006	6	0.022	6.5	21	4.5	0.08	0.01	2.9
us Cluden Stm	25-Oct-05	0.005	0.064	88.1	0.007	24	0.015	7.5	5	12.5	0.025	0.008	3
us Cluden Stm	15-Nov-05	0.01	0.0722	89.5	0.006	70	0.02	6.7	4	11.8	0.08	0.012	0.78
us Cluden Stm	20-Dec-05	0.01		0.08	0.006	130	0.03	7.3	1.5		0.09	0.011	0.46
us Cluden Stm	09-Jan-06	0.005	0.0618	96.1	0.008	18	0.029	7.12	1.5	14.68	0.08	0.006	0.3
us Cluden Stm	07-Feb-06	0.01	0.0636	91.1	0.007	58	0.041	7.13	1.5	13.15	0.09	0.01	0.43
us Cluden Stm	08-Mar-06	0.01	0.0922	88.3	0.007	35	0.045	6.6	1.5	11.6	0.12	0.008	0.47
	Median	**0.01**	**0.0638**	**89.5**	**0.007**	**35**	**0.029**	**7.12**	**1.5**	**12.15**	**0.08**	**0.01**	**0.47**
Lindis Peak	20-Sep-05	0.005	0.033	98.5	0.006	3	0.017	6.6	8	3.61	0.23	0.014	1.8
Lindis Peak	15-Nov-05	0.01	0.0688	88.7	0.005	120	0.006	6.9	1.5	9.6	0.07	0.009	0.67
Lindis Peak	20-Dec-05	0.005		0.08	0.005	110	0.006	8	1.5		0.17	0.008	1.2
Lindis Peak	09-Jan-06	0.01	0.0586	98	0.005	28	0.005	7.62	1.5	14.57	0.06	0.009	0.53
Lindis Peak	07-Feb-06	0.01	0.0599	94.3	0.007	80	0.013	7.51	1.5	14.12	0.07	0.009	0.52
Lindis Peak	08-Mar-06	0.01	0.0737	92.3	0.006	50	0.005	6.9	1.5	10.9	0.07	0.007	0.58
	Median	**0.01**	**0.0599**	**93.3**	**0.0055**	**65**	**0.006**	**7.205**	**1.5**	**10.9**	**0.07**	**0.009**	**0.625**
Black Bridge	20-Sep-05	0.005	0.031	95.9	0.007	3	0.024	6.5	7	3.66	0.06	0.013	1.7
Black Bridge	25-Oct-05	0.005	0.0581	90.3	0.008	38	0.013	7.5	3	15.3	0.025	0.007	3
Black Bridge	15-Nov-05	0.01			0.005	83	0.015	6.9	3		0.06	0.01	0.51
Black Bridge	20-Dec-05	0.01	0.0541	94.6	0.006	210	0.018	7.24	1.5	16.57	0.07	0.008	0.37
Black Bridge	09-Jan-06	0.01	0.0539	94.7	0.006	12	0.015	7.28	1.5	15.16	0.05	0.009	0.32
Black Bridge	07-Feb-06	0.005	0.0553	89.9	0.008	40	0.021	7.4	1.5	12.75	0.06	0.009	0.47
Black Bridge	08-Mar-06	0.01	0.683	9.39	0.007	110	0.011	6.4	1.5	9.5	0.07	0.008	0.74
	Median	**0.01**	**0.0547**	**92.45**	**0.007**	**40**	**0.015**	**7.24**	**1.5**	**13.955**	**0.06**	**0.009**	**0.51**

Site	Date	NH4	Cond	DO%	DRP	Ecoli	NNN	pH	SS	Temp	TN	TP	Turb
		mg/L	mS/cm	%sat	mg/L	cfu/100ml	mg/L	pH	mg/L	Deg C	mg/L	mg/L	NTU
Pass Burn	20-Sep-05	0.005	0.029	96.9	0.007	1	0.01	7	7	2.69	0.025	0.014	1.6
Pass Burn	25-Oct-05	0.005	0.0564	91.9	0.008	2	0.0025	7.3	4	15.8	0.025	0.017	4.9
Pass Burn	15-Nov-05	0.005	0.0631	93.2	0.006	18	0.0025	7	1.5	7.5	0.11	0.01	0.74
Pass Burn	20-Dec-05	0.01			0.007	3200	0.0025	8	45		0.22	0.072	1.3
Pass Burn	09-Jan-06	0.005	0.0531	99	0.006	8	0.0025	7.84	1.5	15.65	0.025	0.007	0.25
Pass Burn	07-Feb-06	0.005	0.0549	93.9	0.008	37	0.0025	7.44	1.5	11.78	0.025	0.009	0.36
Pass Burn	08-Mar-06	0.01	0.0668	93	0.007	69	0.0025	6.8	1.5	8.2	0.06	0.008	0.75
	Median	**0.005**	**0.05565**	**93.55**	**0.007**	**18**	**0.0025**	**7.3**	**1.5**	**9.99**	**0.025**	**0.01**	**0.75**