Otago Regional Council

Waiareka Creek and Island Stream Report

May 2005

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Executive Summary

Water quality monitoring in the Island Stream and Waiareka Creek has been undertaken as part of the state of environment monitoring programme since the mid nineties. Monthly monitoring was undertaken at two sites on Island Stream and four sites on Waiareka Creek from September 2004 to March 2005. Water was tested for a range of physico-chemical and microbiological parameters.

Monitoring results indicate that water quality in both catchments deteriorated as the summer progressed. For example there was a marked increase in both Escherichia coli and nutrients from the initial samples, with concentrations peaking at the end of summer, in February. The more agriculturally intensive upper Waiareka Creek catchment recorded extremely high E coli levels in February (6200 cfu/100ml) and in the same monitoring run Island Stream recorded 4500 cfu/100ml at Maheno.

Nutrient concentrations were also affected with increasing temperatures over the summer period, especially in Waiareka Creek where median phosphorus and nitrogen concentrations exceeded the ANZECC 2000 default trigger guidelines, suggesting that excessive weed growth or algal blooms are likely to occur.

The trend of decreasing water quality over the summer period is attributed to two main factors, the naturally low flows of both streams coupled with the intensive agricultural land use of the catchments.

The Downlands Irrigation scheme will alter flow regimes in Waiareka Creek. Water quality is likely to improve due to increased flow sourced from the Waitaki River, on the other hand, agriculture is likely to intensify which may continue to adversely affect water quality.

Future water quality monitoring will enable a comparison to be made between the effect the Downlands Irrigation scheme has on the water quality of Waiareka Creek, and the water quality of Island Stream, which is unaffected by the scheme.

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1. Introduction

This report presents the results and findings of a water quality monitoring programme undertaken in the Island Stream and Waiareka Creek catchments between September 2004 and March 2005.

1.1 Specific objectives 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 small coastal catchments in order to establish baseline water quality.
- To identify sites of poor water quality and attempt to identify the causes of water quality problems.
- To assess State of Environment water quality prior to the Downlands Irrigation Scheme.

2. Background Information

2.1 Catchment Description

The Kakanui River has a total catchment area of 894 km^2 and flows into the Pacific Ocean 10km south of Oamaru. The catchment is contained by the Kakanui Mountains and Pisgah Spur to the west and south and by hill country to the north dividing it from the Waitaki basin. The catchment consists of about 35% river valley and about 40% of rolling hills or downland of less than 600m elevation, the remaining 25% of the catchment is mountainous, reaching heights of 1,640m.

The Waiareka Creek drains the downlands in the north and east of the catchment. The distinctive downland topography is formed mainly on limestone and typically has few tributaries making up its drainage pattern. Waiareka Creek joins the Kakanui River in the estuary. Waiareka Creek has a catchment of 110 km^2

Island Stream drains the south-eastern portion of the catchment and joins the Kakanui River at Maheno. Island Stream has a catchment of 115 km^2.

Waiareka Creek and Island Stream seldom have any significant flows except during floods. In summer flows are low due to low catchment runoff, losses to groundwater recharge especially in the upper reaches of Waiareka Creek and abstractions for irrigation.

2.2 Land use in the Waiareka Creek and Island Stream Catchments

The catchments have undergone an enormous change in land use practice during the last ten to fifteen years, the major land use change to affect water quality and quantity is the increase in dairy conversions and cow numbers through conversions from sheep farming and expansion of existing dairying units. Figure 2.1 shows that high producing exotic grassland predominates in both catchments.

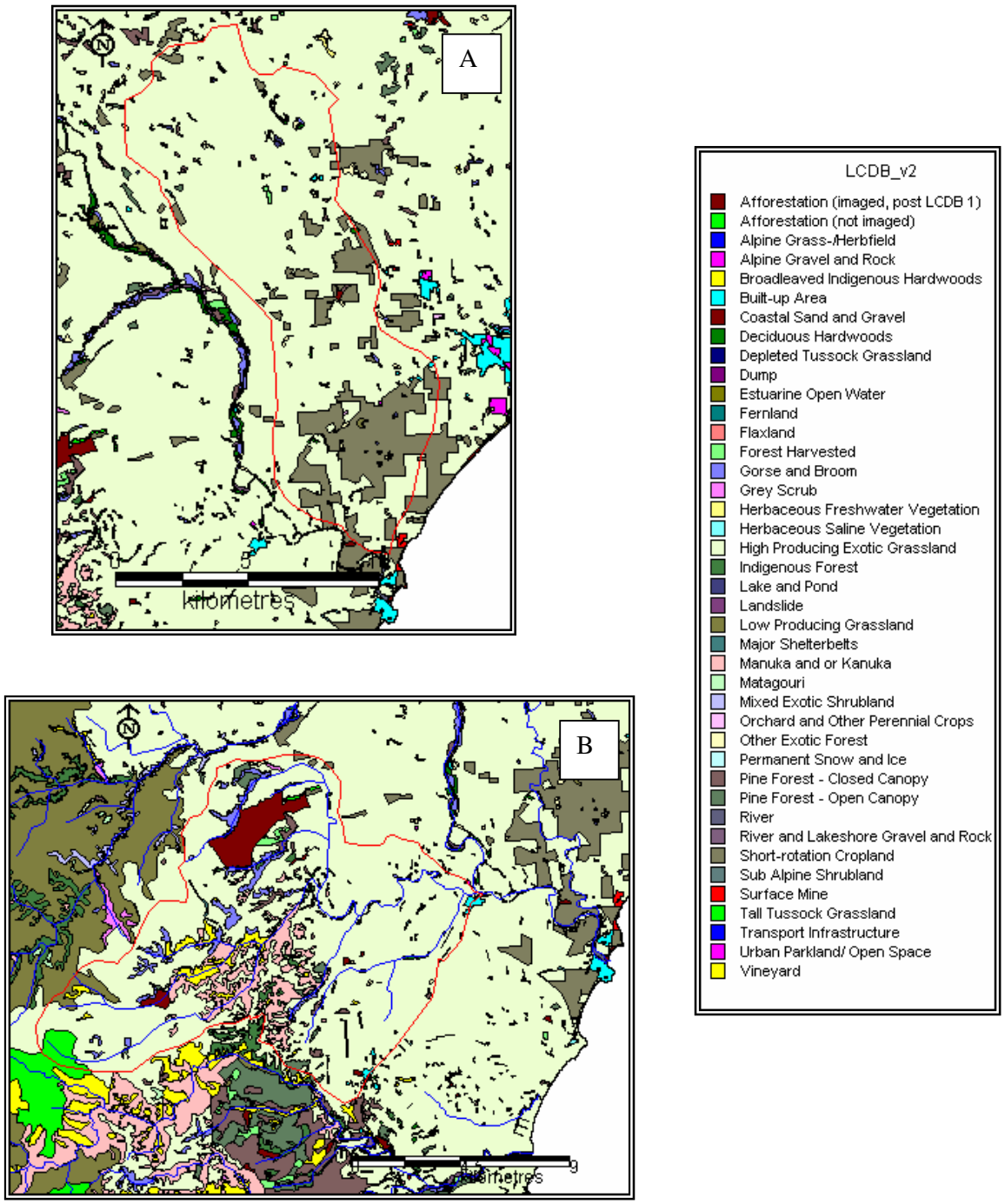

Figure 2.1 A; Waiareka Creek Catchment, B; Island Stream Catchments (LCDB_V2)

Waiareka Creek flows through an agricultural catchment which changes from exotic grassland to short rotation cropland with distance down the catchment. The Island Stream catchment has a variety of land uses in its upper catchment mainly involving different types of forestry and a substantial amount of manuka/kanuka.

Agribase 2000 gives a detailed breakdown of the type of farming activities in the catchment. Table 2.1 shows that Island Stream catchment has a greater percentage of dairying than Waiareka Creek, but it should be noted that these statistics are five years out of date and it is likely that the percentages have increased since 2000.

Table 2.1 Land use by catchment (hectares). Statistics for the Waiareka Creek and Island Stream (Agribase 2000)

	Waiareka Creek.	**Island Stream**
Total Catchment Area	10970	11560
Primarily Beef	2182	448
Dairying	160	667
Deer Farming	768	191
Dairy Dry Stock	54	499
Grazing Properties	0	39
Primarily Sheep	4500	3993
Mixed Sheep and Beef	2096	2235
Undefined	2895	1798
Total Dairying	214 (2%)	947 (8%)

2.3 Cultural Health Index

Schedule 1D of the Regional Plan: Water confirms the significance of the Kakanui to Ngai Tahu, in 2000 the Cultural Health Index (CHI) was used to monitor various sites on the Kakanui catchment for cultural health values.

The CHI for streams links scientific methods and cultural knowledge about stream health (MfE, 2003). The index has three distinct components, each of which is made up of multiple measures. The three components are; the status of the site, a mahinga kai measure and a runanga evaluation of cultural stream health. Results from monitoring the Island Stream at Maheno were poor, and the site was the worst of all 46 sites monitored in the Kakanui and Taieri catchments. One other site was monitored on Island Stream and the Waiareka Creek was monitored at three sites, but these data are not available.

2.4 Physico-chemical, Microbiological and Biological Monitoring

The Otago Regional Council has monitored Island Stream and Waiareka Creek for physico-chemical and microbiological water quality parameters in the State of Environment monitoring programme. Island Stream at Maheno was monitored between December 1991 and April 2002 and Waiareka Creek has been sampled at Teschmakers from August 1999 to date.

Between September 2004 and March 2005 spot sampling was conducted at sites shown in Figure 2.2. 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.

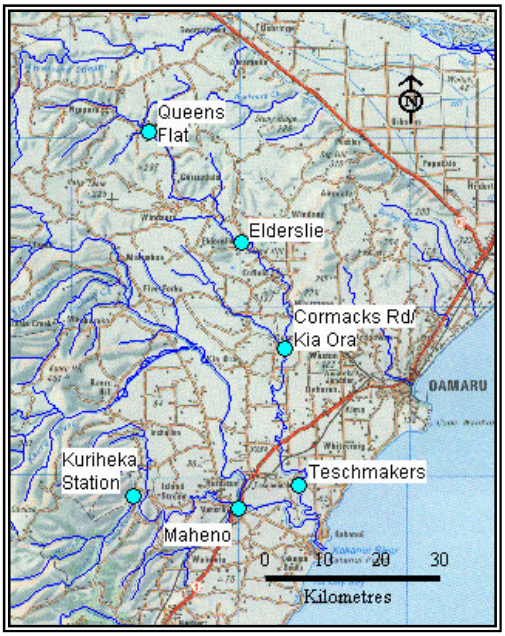

Figure 2.2 Location of water quality monitoring sites sampled between September 2004 and March 2005.

Water samples were tested for a range of physico-chemical and microbiological parameters. These included DO, temperature, conductivity, pH, suspended solids, turbidity, faecal coliforms (FC), *Escherichia coli (E. coli*), ammoniacal nitrogen (NH4), nitrite-nitrate nitrogen (NNN), total nitrogen (TN), dissolved reactive phosphorus (DRP) and total phosphorus (TP).

2.5 Rainfall

The amount of rainfall 24 hours and 7 days prior to each sampling period was determined at the Dasher raingauge on the Kauru and the Clifton Falls raingauge on the Kakanui. No rainfall was recorded at either raingauge on any sampling occasion for either time period.

3. Island Stream

Figure 3.1 Sampling sites on Island Stream: A; Kuriheka, B; Maheno

Routine water quality monitoring at Maheno began in December 1991. A summary of the water quality results for Island Stream are shown in Table 3.1. Full results are located in Appendix 1.

Table 3.1 Median water quality results for the Island Stream catchment, Sep 2004-March 2005 (*n*=7), with long term medians for the Maheno indicated in italics and exceedances of the ANZECC 2000 default trigger values for lowland rivers indicated in bold type.

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 *	5.6	550†	0.021	0.444	0.614	0.010	0.033
Island Stream							
Kuriheka	0.75	**520**	0.02	0.025	0.32	0.009	0.02
Maheno	2 *(1.9)*	**290** *(190)*	0.02 *(0.015)*	0.022 *(0.031)*	0.33 ***(0.45)***	0.008 ***(0.012)***	0.032 ***(0.45)***

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

*Default Trigger Value for Lowland Rivers

Table 3.1 shows that median levels for nutrients at all sites in the Island Stream are below the ANZECC default trigger guidelines for lowland rivers. However, at both Kuriheka and Maheno *E. coli* concentrations exceeded the surveillance/green mode of the MfE/MoH 2003 Recreational Water Quality Guideline (<260 *E.coli*/100ml). In February Maheno recorded a particularly elevated *E.coli* concentration of 4500 cfu/100ml and the sampler had noted *'stock access to water (cattle), stream water very discoloured'*.

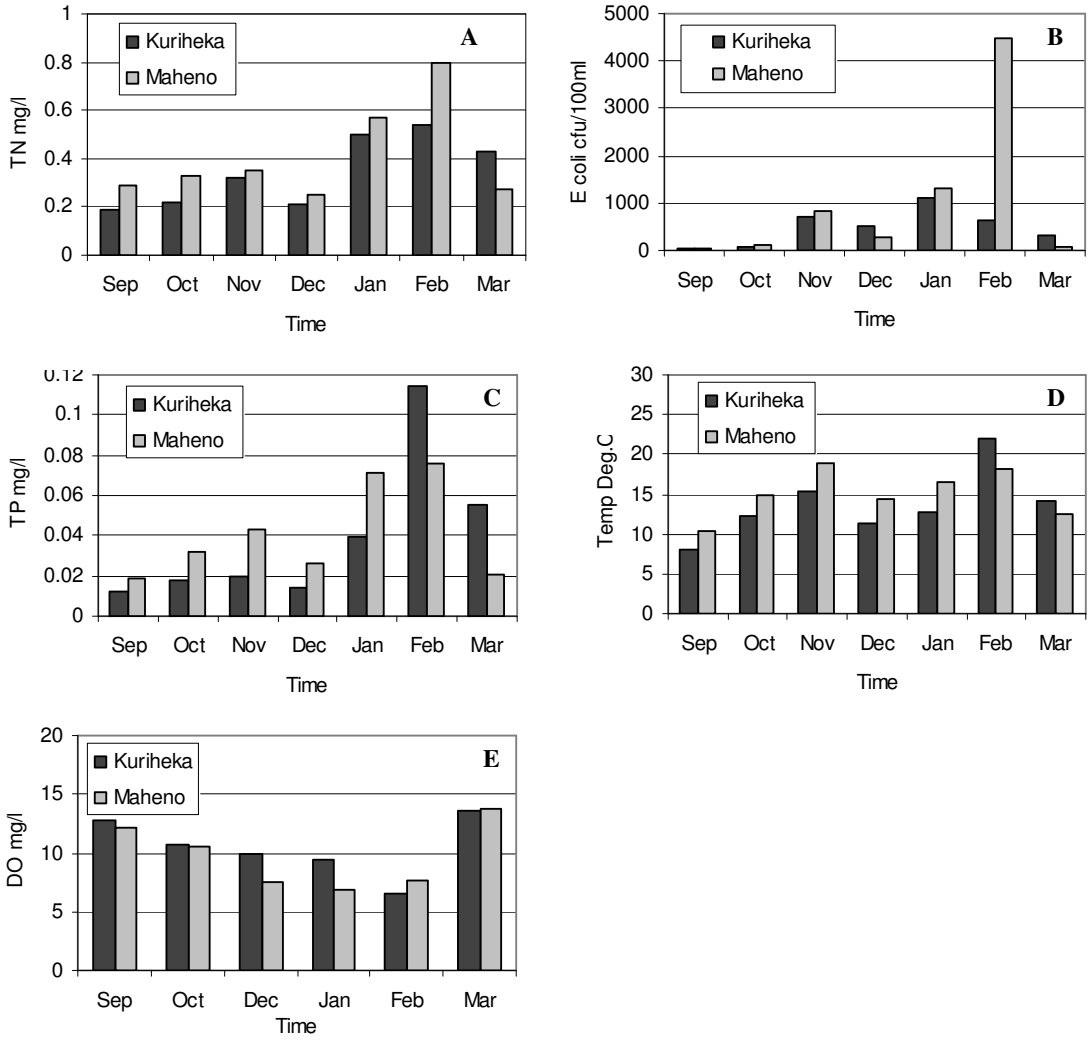

Figure 3.2 Island Stream water quality at Kuriheka and Maheno. Samples taken at monthly intervals between September 2004 and March 2005. A; Total phosphorus (TP), B; *Escherichia coli* (EC), C; Total nitrogen (TN), D; Temperature (Temp); E, Dissolved Oxygen (DO) - November result not available.

Figure 3.2 shows a deterioration of water quality over the summer period, this is particularly clear for total phosphorus (Figure 3.2C) whose concentrations increase at both Kuriheka and Maheno from September, before peaking in January. This pattern is repeated for total nitrogen and *E. coli*. The opposite pattern occurs with dissolved oxygen, DO levels are shown in Figure 3.2E, there is a decrease in DO levels from September to January, and then concentrations increase in March. However at no time did oxygen levels decrease to a level which would be of a concern to aquatic life.

The contaminant concentration is closely related to temperature, this can be seen in Figure 3.3, higher temperatures correspond with higher contaminant levels.

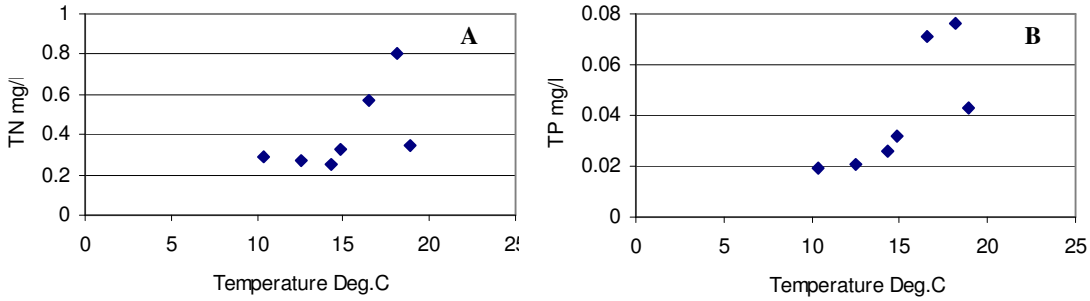

Figure 3.3 Island Stream at Maheno. Contaminant concentration and temperature. A; total nitrogen (TN) and B; total phosphorus (TP).

Island Stream has been monitored by the Otago Regional Council in the State of Environment monitoring programme at various times between December 1991 and April 2002. Regression analysis undertaken on all samples showed a statistically significant relationship between total phosphorus and temperature at the 99% confidence level, however there was not a statistically significant relationship between *E. coli* and temperature or total nitrogen and temperature.

4. Waiareka Creek

Figure 4.1 Sampling sites on Waiareka Creek: A; Queens Flat, B; Elderslie, C; Cormacks, Kia Ora Road, D; Teschmakers.

Table 4.1 Median water quality results for the Waiareka catchment, Sep 2004-March 2005 (*n*=7), with long term medians for Teschmakers indicated in italics and exceedances of the ANZECC 2000 default trigger values for lowland rivers indicated in bold type.

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	5.6	<260†	0.021	0.444	0.614	0.010	0.033
Waiareka Creek							
Queens Flat	1.3	10	0.02	0.0025	**1.03**	**0.051**	**0.144**
Elderslie	0.9	**300**	**0.05**	0.014	**0.94**	**0.123**	**0.181**
Cormacks Rd	0.625	84	0.02	0.006	**0.665**	**0.039**	**0.06**
Teschmakers	0.75 *(1.36)*	38 *(45)*	**0.03** *(0.04)*	0.013 *(0.049)*	**0.78** ***(0.89)***	**0.154** ***(0.077)***	**0.19** ***(0.135)***

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

* Default Trigger Value for Lowland Rivers

Routine water quality monitoring at Teschmakers began in August 1999 and a summary of the water quality is shown in Table 4.1. Full results are located in Appendix 1.

Table 4.1 shows that median levels for TN, DRP and TP at all sites in the Waiareka Creek exceed the ANZECC default trigger guidelines for lowland rivers, whilst Elderslie and Teschmakers exceed the ANZECC default trigger guideline for NH4. At Elderslie, *E. coli* concentrations exceeded the surveillance/green mode of the MfE/MoH 2003 Recreational Water Quality Guideline (<260 *E.coli*/100ml) and in February Elderslie recorded a particularly elevated E.coli concentration of 6200 cfu/100ml and the sampler had noted *'strong odour and grey algal deposit on creek bed'*

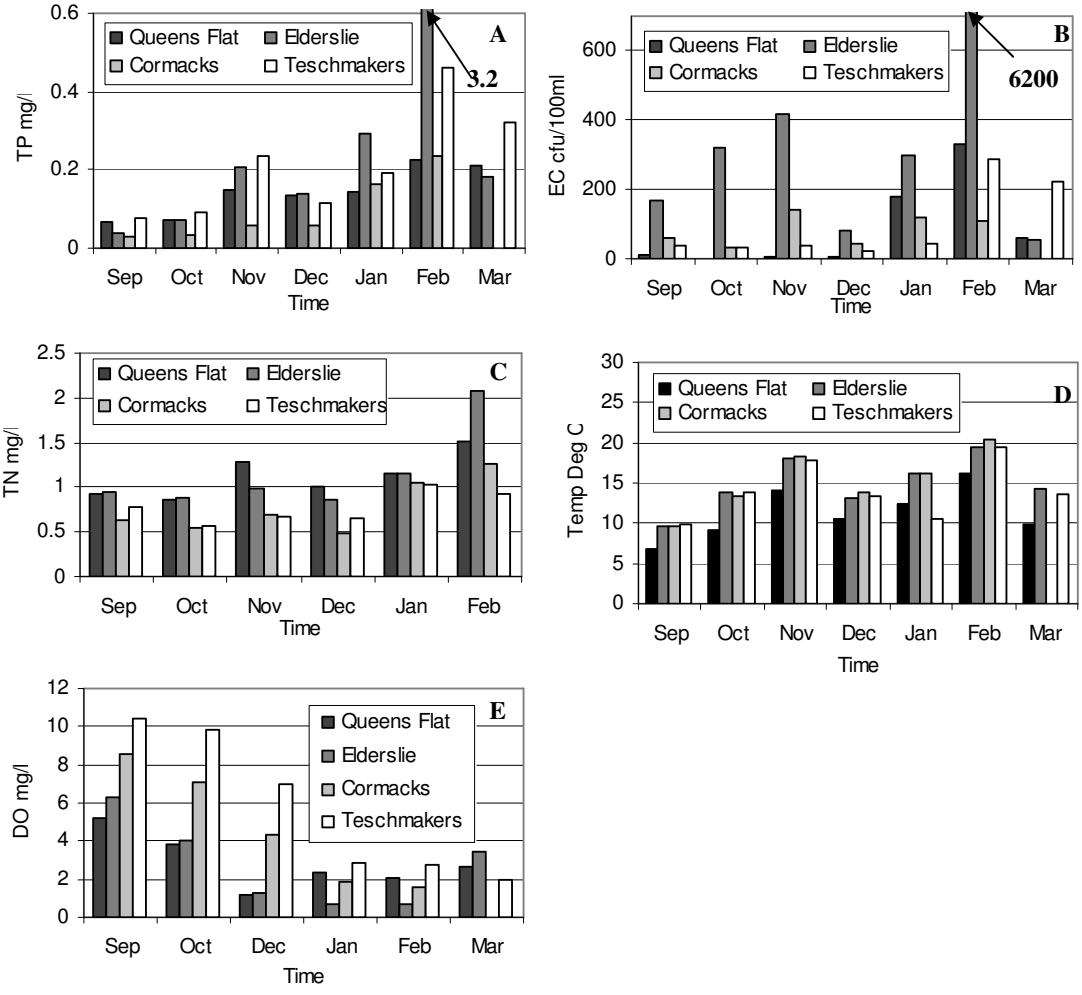

Figure 4.2 Waiareka Creek water quality at Queens Flat, Elderslie, Cormacks/Kia Ora Rd and Teschmakers. Samples taken at monthly intervals between September 2004 and March 2005. A; Total phosphorus (TP), B; *Escherichia coli* (EC), C; Total nitrogen (TN), D; Temperature (Temp), E; Dissolved Oxygen (DO), November result missing.

Figure 4.2 shows that the Waiareka Creek experiences the same deterioration of water quality over the irrigation period as Island Stream. This is most clearly seen in Figure 4.2A, where there is a clear increase in total phosphorus with time, particularly in January and February. The same increases in contaminant concentration are seen in *E. coli* and TN, Figure 4.2B and C.

Figure 4.2E shows that dissolved oxygen concentrations fall to extremely low levels, by January all sites recorded less than 3 mg/l, with Elderslie registering 0.68 mg/l. This is well below the level to protect aquatic life, particularly fish.

The drop in contaminant concentrations in December corresponds with a decrease in temperature Figure 4.2D. The contaminant concentration is closely related to temperature, this can be seen in Figure 4.3, higher temperatures correspond with higher contaminant levels.

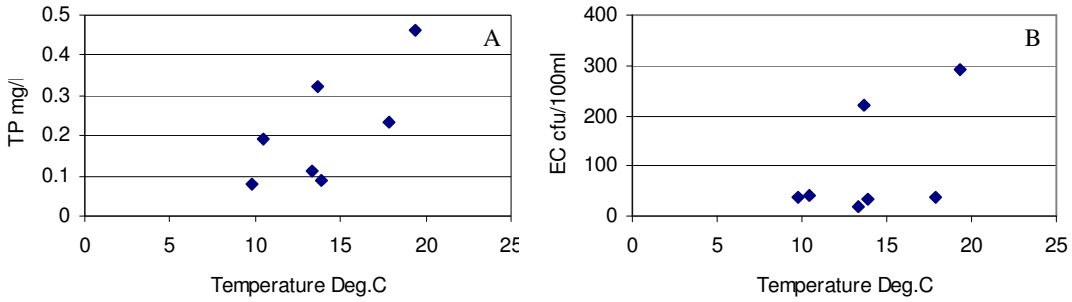

Figure 4.3 Waiareka Creek at Teschmakers. Contaminant concentration and temperature. A; total phosphorus (TP) and B; *E. coli* (EC).

Waiareka Creek has been monitored by the Otago Regional Council in the State of Environment monitoring programme at various times between August 1990 and August 2004. Regression analysis undertaken on all samples showed a statistically significant relationship between E. coli and temperature and E. coli and dissolved oxygen at the 99% confidence level, and between total phosphorus and temperature, and total nitrogen and temperature at the 90% confidence level.

5. Discussion

There is a general increase in contaminants over the summer period. This corresponds to lower flows in Waiareka creek as well as the irrigation period for the mainly agricultural catchments.

Water quality in Waiareka Creek is particularly poor, especially around Elderslie. The Otago Regional Council wells database lists two bores drilled at Elderslie specifically for dairy shed purposes in 1999/2000 which together yield 28.07 l/s. Only two other dairy shed bores are listed for the Waiareka catchment which indicates that dairying is particularly intensive around Elderslie. In the Island Stream catchment, two dairy shed bores are listed, one is located at Maheno with a yield of 1.5 l/s.

The impacts of land use on water quality are also influenced by stock access to streams, for example the February sampling field sheet for Kuriheka noted that stock had access to the water. Stock access not only pollutes the water directly, but leads to stream bank and channel erosion which in turn leads to higher turbidity and total phosphorus concentrations.

The proposed Downlands irrigation scheme will divert water from the Waitaki River to irrigate approximately 16,500 ha (stage one) and eventually 20500 ha of rolling downlands between the Waitaki and Kakanui valleys, which includes most of the Waiareka Catchment. At the moment the main impediment to intensive farming in this area is a severe lack of soil moisture, the irrigation scheme will ease this and it is expected that land use will intensify significantly.

An augmentation flow of up to 1 cumec would be discharged into sections of Waiareka Creek and farmers would abstract directly from the Creek. From a water quality perspective the scheme would:

- Dilute poor quality Waiareka water with Waitaki River water which is lower in nutrients and higher in dissolved oxygen.
- Improve instream conditions through higher flows.
- Improve instream habitat through higher flows.

However it should be noted that even though water quality is expected to improve due to higher flows, there is still the possibility that the corresponding intensification of agriculture will result in land runoff. This would adversely affect water quality in Waiareka Creek, even with the most efficient means of irrigation application (K-line, guns, centre pivots) available.

6. Conclusion

The results of the water quality monitoring programme indicate that water quality in both Island Stream and Waiareka Creek deteriorate over the summer period, with elevated nutrient and bacteria concentrations corresponding with higher temperatures.

Both tributaries are small in terms of flow, and this, coupled with a larger nutrient input onto the land, due to dairy farm conversions and more intensive methods of farming, mean that they are vulnerable to pollution.

The proposed Downlands irrigation scheme should ease the situation in Waiareka Creek due to higher flows, but as the scheme will encourage the intensification of agriculture it is likely that poor water quality will continue to remain an issue.

Once the irrigation scheme is established, it is proposed to monitor Waiareka Creek to assess the affects of land use change on the stream environment, especially to gauge if the additional flow continues to mitigate the intensification of land use. The effects of the scheme may also be picked up in monitoring Kakanui estuary, the estuary was monitored over one tidal cycle in February 2005 prior to the commencement of the scheme and any changes in water quality in future surveys may reflect changes in Waiareka Creek water quality.

7. References

Australian and New Zealand Environment and Conservation Council (ANZECC). 2000.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Ministry for the Environment, 2003. A Cultural Health Index For Streams And Waterways. MfE, Wellington.

Ministry for the Environment, Ministry of Health. 2002. Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Ministry for the Environment, Wellington.

Otago Regional Council, 2001. North and Coastal Otago Monitoring Report. Otago Regional Council, Dunedin.

Otago Regional Council. 2000. Regional Plan: Water for Otago. Otago Regional Council, Dunedin.

Appendix 1

SOURCE	SITE_NAME	DATE	TIME	COND	DO	PH	SS	TEMP	TURB
Island Stream	Kuriheka	13-Sep-04	12:05	0.054	12.78	7.82	0.5	8.02	0.45
Island Stream	Kuriheka	13-Oct-04	10:42	0.0509	10.69	7.31	1	12.37	0.7
Island Stream	Kuriheka	09-Nov-04	14:00	0.067	11.41	8.1	3	15.45	0.75
Island Stream	Kuriheka	13-Dec-04	08:40	0.0437	9.91	7.24	2	11.3	0.75
Island Stream	Kuriheka	18-Jan-05	10:55	0.0556	9.42	7.71	2	12.76	1.7
Island Stream	Kuriheka	09-Feb-05	11:36	0.1941	6.56	6.94	3	21.9	3.3
Island Stream	Kuriheka	09-Mar-05	12:15	0.286	13.6	7.32	1	14.1	2.8
			Median	**0.0556**	**10.69**	**7.32**	**2**	**12.76**	**0.75**
Island Stream	Maheno	13-Sep-04	12:30	0.149	12.16	7.58	0.5	10.37	1.4
Island Stream	Maheno	13-Oct-04	11:10	0.1451	10.54	7.17	3	14.82	1.5
Island Stream	Maheno	09-Nov-04	15:20	0.143		7.53	2	18.88	2.1
Island Stream	Maheno	13-Dec-04	09:05	0.1198	7.51	6.97	0.5	14.3	2
Island Stream	Maheno	18-Jan-05	11:20	0.1103	6.84	6.87	2	16.51	2
Island Stream	Maheno	09-Feb-05	11:15	0.0736	7.69	7.04	49	18.15	55
Island Stream	Maheno	09-Mar-05	11:50	0.1106	13.8	7.46	3	12.5	2.1
			Median	**0.1198**	**9.12**	**7.17**	**2**	**14.82**	**2**
Waiareka Ck	Queens Flat	13-Sep-04	10:00	1.591	5.17	7.09	3	6.7	0.5
Waiareka Ck	Queens Flat	13-Oct-04	08:45	1.739	3.81	7.08	3	9.04	0.5
Waiareka Ck	Queens Flat	09-Nov-04	09:15	1.799		7.13	11	13.96	1.5
Waiareka Ck	Queens Flat	13-Dec-04	09:40	1.623	1.18	7.25	5	10.5	1.3
Waiareka Ck	Queens Flat	18-Jan-05	08:45	1.152	2.36	7.14	3	12.51	1.3
Waiareka Ck	Queens Flat	09-Feb-05	09:15	1.403	2.05	7.27	11	16.19	2.1
Waiareka Ck	Queens Flat	09-Mar-05	09:00	2.06	2.7	7.44	4	9.9	2.8
			Median	**1.623**	**2.53**	**7.14**	**4**	**10.5**	**1.3**
Waiareka Ck	Elderslie	13-Sep-04	10:20	1.467	6.3	7.22	3	9.71	0.9
Waiareka Ck	Elderslie	13-Oct-04	09:10	1.403	4.01	7.15	2	13.79	1.1
Waiareka Ck	Elderslie	09-Nov-04	12:55	1.603		7.01	4	18.08	0.85
Waiareka Ck	Elderslie	13-Dec-04	10:10	1.453	1.23	7.19	3	13.1	0.9
Waiareka Ck	Elderslie	18-Jan-05	09:05	1.316	0.68	7.1	3	16.23	0.7
Waiareka Ck	Elderslie	09-Feb-05	09:35	1.442	0.66	7.03	10	19.48	30
Waiareka Ck	Elderslie	09-Mar-05	09:35	1.904	3.4	7.32	1	14.3	0.85
			Median	**1.453**	**2.32**	**7.15**	**3**	**14.3**	**0.9**
Waiareka Ck	Cormacks	13-Sep-04	10:45	1.42	8.59	7.38	2	9.55	0.65
Waiareka Ck	Cormacks	13-Oct-04	09:40	1.331	7.08	7.33	0.5	13.35	0.6
Waiareka Ck	Cormacks	09-Nov-04	13:15	1.482		7.21	2	18.18	0.7
Waiareka Ck	Cormacks	13-Dec-04	10:35	1.393	4.34	7.35	2	13.8	0.45
Waiareka Ck	Cormacks	18-Jan-05	09:30	1.356	1.91	7.23	3	16.27	0.5
Waiareka Ck	Cormacks	09-Feb-05	10:10	1.495	1.53	7.24	5	20.42	0.8
			Median	**1.4065**	**4.34**	**7.29**	**2**	**15.035**	**0.625**
Waiareka Ck	Teschmakers	13-Sep-04	11:15	1.341	10.46	7.52	4	9.76	0.8
Waiareka Ck	Teschmakers	13-Oct-04	10:05	1.402	9.86	7.61	1	13.84	0.55
Waiareka Ck	Teschmakers	09-Nov-04	14:43	1.446	11.7	7.43	4	17.88	0.75
Waiareka Ck	Teschmakers	13-Dec-04	11:47	1.467	6.95	7.58	5	13.3	0.75
Waiareka Ck	Teschmakers	18-Jan-05	10:00	1.27	2.82	7.3	3	10.48	0.75
Waiareka Ck	Teschmakers	09-Feb-05	10:30	1.373	2.79	7.22	6	19.34	0.65
Waiareka Ck	Teschmakers	09-Mar-05	10:30	1.884	2	7.45	3	13.7	0.6
			Median	**1.402**	**6.95**	**7.45**	**4**	**13.7**	**0.75**

SOURCE	NAME	DATE	TIME	DRP	EC	FCC	NH4	NNN	TN	TP
Island S	Kuriheka	13-Sep-04	12:05	0.009	24	62	0.02	0.025	0.19	0.012
Island S	Kuriheka	13-Oct-04	10:42	0.007	74	120	0.02	0.018	0.22	0.018
Island S	Kuriheka	09-Nov-04	14:00	0.009	730	850	0.02	0.027	0.32	0.02
Island S	Kuriheka	13-Dec-04	08:40	0.007	520	1400	0.02	0.01	0.21	0.014
Island S	Kuriheka	18-Jan-05	10:55	0.014	1100	1000	0.02	0.052	0.5	0.039
Island S	Kuriheka	09-Feb-05	11:36	0.012	640	850	0.02	0.037	0.54	0.114
Island S	Kuriheka	09-Mar-05	12:15	0.012	310	380	0.02	0.012	0.43	0.055
			Median	**0.009**	**520**	**850**	**0.02**	**0.025**	**0.32**	**0.02**
Island S	Maheno	13-Sep-04	12:30	0.0025	58	97	0.02	0.016	0.29	0.019
Island S	Maheno	13-Oct-04	11:10	0.0025	100	86	0.01	0.0025	0.33	0.032
Island S	Maheno	09-Nov-04	15:20	0.009	820	870	0.03	0.022	0.35	0.043
Island S	Maheno	13-Dec-04	09:05	0.007	290	310	0.005	0.006	0.25	0.026
Island S	Maheno	18-Jan-05	11:20	0.017	1300	1600	0.04	0.071	0.57	0.071
Island S	Maheno	09-Feb-05	11:15	0.008	4500	3500	0.03	0.179	0.8	0.076
Island S	Maheno	09-Mar-05	11:50	0.009	97	260	0.02	0.035	0.27	0.021
			Median	**0.008**	**290**	**310**	**0.02**	**0.022**	**0.33**	**0.032**
Waiareka	Queens	13-Sep-04	10:00	0.035	10	10	0.02	0.0025	0.92	0.067
Waiareka	Queens	13-Oct-04	08:45	0.046	0.5	0.5	0.01	0.0025	0.87	0.071
Waiareka	Queens	09-Nov-04	09:15	0.051	8	8	0.02	0.0025	1.28	0.148
Waiareka	Queens	13-Dec-04	09:40	0.058	4	8	0.02	0.0025	1	0.134
Waiareka	Queens	18-Jan-05	08:45	0.138	180	300	0.02	0.005	1.16	0.144
Waiareka	Queens	09-Feb-05	09:15	0.044	330	980	0.07	0.02	1.52	0.227
Waiareka	Queens	09-Mar-05	09:00	0.078	62	44	0.02	0.005	1.03	0.213
			Median	**0.051**	**10**	**10**	**0.02**	**0.0025**	**1.03**	**0.144**
Waiareka	Elderslie	13-Sep-04	10:20	0.008	170	150	0.04	0.046	0.94	0.038
Waiareka	Elderslie	13-Oct-04	09:10	0.031	320	220	0.02	0.084	0.88	0.07
Waiareka	Elderslie	09-Nov-04	12:55	0.128	420	620	0.05	0.014	0.99	0.206
Waiareka	Elderslie	13-Dec-04	10:10	0.085	84	110	0.07	0.008	0.87	0.14
Waiareka	Elderslie	18-Jan-05	09:05	0.229	300	330	0.05	0.006	1.15	0.291
Waiareka	Elderslie	09-Feb-05	09:35	2.17	6200	5200	0.26	0.01	2.07	3.2
Waiareka	Elderslie	09-Mar-05	09:35	0.123	52	36	0.06	0.024	0.91	0.181
			Median	**0.123**	**300**	**220**	**0.05**	**0.014**	**0.94**	**0.181**
Waiareka	Cormacks	13-Sep-04	10:45	0.011	58	70	0.05	0.008	0.64	0.028
Waiareka	Cormacks	13-Oct-04	09:40	0.015	31	34	0.02	0.0025	0.54	0.035
Waiareka	Cormacks	09-Nov-04	13:15	0.032	140	150	0.01	0.006	0.69	0.06
Waiareka	Cormacks	13-Dec-04	10:35	0.047	46	56	0.02	0.0025	0.48	0.06
Waiareka	Cormacks	18-Jan-05	09:30	0.136	120	96	0.02	0.007	1.06	0.163
Waiareka	Cormacks	09-Feb-05	10:10	0.182	110	100	0.05	0.006	1.27	0.236
			Median	**0.0395**	**84**	**83**	**0.02**	**0.006**	**0.665**	**0.06**
Waiareka	Tesch.	13-Sep-04	11:15	0.037	38	48	0.06	0.019	0.78	0.079
Waiareka	Tesch.	13-Oct-04	10:05	0.065	35	30	0.02	0.005	0.57	0.089
Waiareka	Tesch.	09-Nov-04	14:43	0.154	37	48	0.04	0.013	0.68	0.234
Waiareka	Tesch.	13-Dec-04	11:47	0.091	20	24	0.005	0.0025	0.66	0.113
Waiareka	Tesch.	18-Jan-05	10:00	0.155	41	44	0.02	0.021	1.03	0.19
Waiareka	Tesch.	09-Feb-05	10:30	0.404	290	410	0.03	0.0025	0.93	0.461
Waiareka	Tesch.	09-Mar-05	10:30	0.241	220	350	0.06	0.027	0.84	0.323
			Median	**0.154**	**38**	**48**	**0.03**	**0.013**	**0.78**	**0.19**