environment SOUTHLAND

Te Taiao Tonga

Water Quality in the Waihopai Catchment

2005 – 2006

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Executive Summary

This report summarises the results of water quality monitoring at 12 sites in the Waihopai catchment from December 2005-December 2006. The report is based on monthly physico-chemical and microbiological water quality records collected for a surface water quality investigation in the Waihopai catchment, completing Phase One of Environment Southland's "Living Streams" programme. The objectives of Phase One were to determine the state of water quality in the Waihopai catchment and identify links between land use, non-point source pollution, and water quality.

The water quality in the Waihopai catchment is indicative of a highly modified lowland catchment with intensive agriculture in the headwaters, with lifestyle, community inputs at various points, and urban pressures in the lower reaches. Consequently, identifying patterns in water quality was complicated due to the diversity of land use within the catchment, along with a lack of investigation into drain and stormwater inputs. The broad scale of the monitoring programme (12 sites spread throughout a large catchment) also provided limited spatial resolution in the sampling results. However, even given the difficulty in isolating sources of poor water quality within the catchment, patterns have been identified with respect to faecal contamination, nutrients and sediment that deserve more detailed assessment.

Faecal Contamination

Faecal contamination is a significant factor influencing water quality in the catchment. Median *E. coli* levels exceed ANZECC (2000) guidelines at all but one site in the catchment and a median of 800 *E. coli*/100 ml has been identified at the Spurhead Creek site in the headwaters of the Waihopai River. It appears the main cause of faecal contamination in the Waihopai River is effluent run-off and tile discharge from agriculture in the mid to upper catchment, and possibly poorly functioning septic tank systems from lifestyle blocks in the mid to lower portion of the catchment. Further study is required to identify specific sources of faecal contamination.

Nutrients

Monitoring indicates that nutrient input occurs throughout the Waihopai catchment, with particular "hot-spots" in the upper reaches. In particular, the Waihopai River tributary at Waituna-Morton Mains (maximum nitrate 5.0 g/m^3, maximum total phosphorus 0.41 g/m^3), and in the Waihopai south branch at Waituna-Morton Mains, where ammonia nitrogen has peaked at 0.36 g/m^3.

Median concentrations of all nutrients throughout the catchment exceed ANZECC (2000) guidelines over the December 2005-December 2006 period (with the exception of ammonia nitrogen at Spurhead Creek), indicating intensive agricultural land use and a need for the wholesale adoption of Best Management Practices (BMPs) within the catchment. Through the adoption of BMPs, (including the construction of riparian margins and wetlands in boggy areas, nutrient management plans, and the exclusion of stock from waterways),

nutrient and sediment runoff, and faecal contamination will be minimised within the catchment.

Sediment

Visual clarity and turbidity are poor during rainfall events and associated high river flows as a result of sediment runoff and re-suspension. These peaks in sediment input to the Waihopai River during rainfall events, indicates a need for more widely adopted BMPs within the catchment, including riparian margins to trap sediment runoff and increase bank stability, and the exclusion of stock from waterways as advised in the Proposed Regional Fresh Water Plan (Environment Southland, 2000).

Recommendations

1. Actively encourage and facilitate BMPs in the form of farm plans and the construction of riparian margins and wetlands in the mid to upper reaches of the Waihopai catchment, in particular Spurhead Creek, the Waihopai River tributary at Waituna-Morton Mains, and the south branch of the Waihopai River, to reduce sediment and nutrient runoff, decrease faecal contamination, increase bank stability, and enhance stream habitats via shading in headwater sub-catchments.

2. Focused targeting on the exclusion of stock from waterways, as advised in Variation 5 (Stock Access) of the Proposed Regional Fresh Water Plan (2000), to minimise effluent and sediment runoff, and faecal contamination throughout the Waihopai catchment.

3. Increase community awareness and ownership of the water quality issues in the Waihopai catchment through primary school education, landowner field days, and community outreach activities. This initiative is currently being formulated into a strategy to be delivered as Phase Three of the Living Streams project.

4. Initiate a Stormwater Focus Study to identify and characterise all stormwater inputs to the Waihopai River and the role they play in the future contamination of the lower catchment.

5. Expand an existing monitoring programme (components of which are currently underway as Phase Two of the Living Streams programme) to identify and characterise septic tank discharge within the catchment, to minimise human faecal contamination in the Waihopai River.

6. Investigate temporal sediment trends in the Waihopai catchment by tracking sediment yields and source inputs to the New River Estuary. This project has been initiated as a component of Environment Southland's Estuary Monitoring programme and is linked to sedimentation monitoring which has been established at sites in the New River Estuary.

7. Further work investigating water quality at a sub-catchment scale, so that trends can be tightly linked to specific land use activities within the catchment, and the performance of BMPs measured in relation to the "10% improvement target" and Variation 4 Water Quality objectives (bacterial, nitrogen, phosphorus and clarity) as specified in the Proposed Regional Fresh Water Plan (Environment Southland, 2000).

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1.0 Introduction

1.1 Living Streams

The "Living Streams" programme was initiated within Council in 2005 with the aim of providing the community with information about water quality within their catchment, and empowering them to take action. This report summarises the results of Phase One of the Living Streams programme in the Waihopai catchment; a one year Surface Water Quality Investigation.

Phase Two of the programme is a Catchment Pollution Source Study and involves the identification of pollution sources within the Waihopai catchment, aiding in targeting regions of specific concern, where the nature and source of contaminants are able to be determined.

Phase Three of the programme, the Waterways Action project, involves working in partnership with the community to ensure healthy waterways, increase community awareness and ownership, and empowering communities to take positive environmental action.

Another target of significance is set out in the following goal, which was adopted by Council in June 2005:

> *"Southland will have beaten the non-point source pollution problem by 2015."*

This goal is commonly known as the "BHAG", which stands for Big, Hairy, Audacious Goal. Council endeavours to make non-point source pollution (in particular nutrient management and faecal contamination) the priority for action in all our planning and delivery.

As the goal is "big" and Southland covers an extensive area, the goal will be attempted on a catchment basis, with the first priority catchment being the Waihopai, incorporating mechanisms like the Living Streams programme.

1.2 Catchment Description

The Waihopai River comprises a large catchment of 18,328 ha and is approximately 34 km in length. It rises in the uplands west of Edendale and flows west into the New River Estuary on the western boundary on Invercargill, where the river discharges on average approximately 2800 l/sec. The catchment consists of 94.1% extensively drained "high producing exotic grassland", either in pasture or crops, and just 1% indigenous and exotic forest (Figure 1.1, Table 1.1). Dairy farms are now common in the catchment, particularly in the upper reaches and comprise 28 % (5,202 ha) of the total catchment area (18,328 ha) (Figure 1.1).

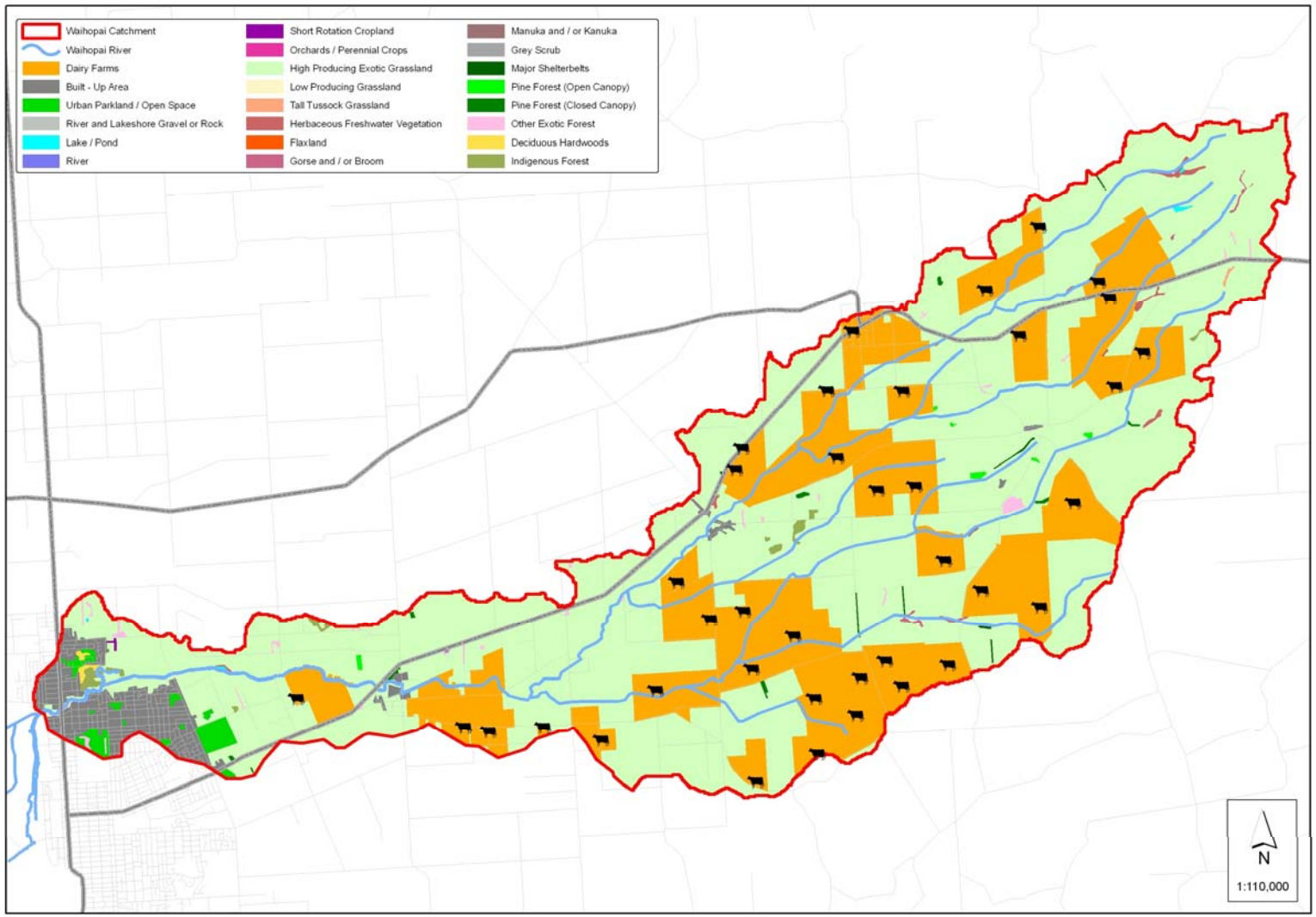

Figure 1.1: Waihopai Catchment Land Cover and Dairy Land Use

Table 1.1: Land Cover in the Waihopai Catchment

Land cover Type	Area (ha)	% Land cover
Built-up Area	614.9	3.4
Deciduous Hardwoods	11.8	0.1
Gorse and Broom	25.5	0.1
Herbaceous Freshwater Vegetation	42.0	0.2
High Producing Exotic Grassland	17246.7	94.1
Indigenous Forest	58.7	0.3
Major Shelterbelts	44.2	0.2
Other Exotic Forest	83.7	0.5
Pine Forest - Closed Canopy	22.3	0.1
Pine Forest - Open Canopy	15.6	0.1
Urban Parkland/ Open Space	135.5	0.7
Total	**18328.3**	**100.0**

The lower Waihopai River has been physically modified, characterised by straightened watercourses with no riparian vegetation, and stormwater outfalls in the lower reaches. Channelisation is most apparent below the retention dam (Figure 1.2), approximately 7.5 km upstream from the mouth of the Waihopai River. In this section, aquatic plant growth is prevalent.

Figure 1.2: The Waihopai Dam, view downstream

Major point source discharges to the Waihopai River include urban stormwater from Invercargill City. Other more minor discharges enter the river from Mossburn Enterprises (Fish Merchants in Kennington), the Woodlands Tavern (consented treated sewage

discharge) and Transpower NZ Limited. In addition, 39 dairy shed effluent discharges to land are consented (current and under variation) in the Waihopai catchment.

1.3 Objectives

The overall objectives of Phase 1 – Surface Water Quality Investigation are to:

- determine the state of water quality in the Waihopai catchment;
- identify links between land use, non-point source pollution, and water quality in the Waihopai Catchment.

2.0 Sampling Methodology

2.1 Background

As Phase One of the Living Streams programme, water quality was monitored within the Waihopai catchment during 2005/06, this report summarises the results of the monitoring programme and is described further in 2.2. In addition to this programme, one site within the catchment has been monitored consistently on a long-term basis; Waihopai River upstream of Queen's Drive (Table 2.1 and Figures 2.1, 2.2). Monitoring was initiated at this site in July 1995 and is sampled monthly. Eight other sites along the Waihopai River and its tributaries have also been sampled sporadically, particularly in a focus study during 1988/89.

Phase Two of the Living Streams programme, the Catchment Pollution Source Study, involved the initiation of longitudinal sampling within the catchment. This project was implemented to target "hot-spots" in the catchment and identify specific inputs to the Waihopai River. This project was co-ordinated by the Compliance Division in the south branch of the Waihopai River, where water quality data was collected within an intensive area and faecal sterol analysis carried out to determine the source of faecal contamination to waterways within this subsection of the catchment.

Phase Three of the Living Streams programme includes gaining community involvement and ownership of water quality issues in the Waihopai, by focusing on the south branch of the Waihopai River where water quality is degraded.

A long term goal of the Council is to beat non-point source pollution in Southland by 2015 (BHAG). Water quality knowledge gained from the Living Streams programme will aid in the success of the Council's BHAG, by targeting areas within specific catchments where improvements in water quality and community ownership can be made.

2.2 Current Monitoring

A total of 12 sites were monitored monthly in the Waihopai catchment as Phase 1 of the Living Streams programme. Monitoring began in December 2005 and concluded in December 2006. Sampling sites are described in Table 2.1 and illustrated in Figure 2.2.

The water quality monitoring sites are distributed throughout the length of the catchment, generally located at bridges for ease of access (Figure 2.2). The sites were chosen to cover all the main tributaries to the Waihopai River, and are at regular intervals along the River itself.

Table 2.1: Location of water quality sites in the Waihopai Catchment

Site Number	Site Name	Map Reference
1	Waihopai River at Victoria Avenue	E46: 516 140
2	Waihopai River u/s Queen's Drive	E46: 533 147
3	Waihopai River at Waihopai Dam	E46: 557 152
4	Waihopai River at Kennington SH1	E46: 596 146
5	Waihopai North Branch at Longbush Road	E46: 642 142
6	Waihopai River at Woodlands Bridge	E46: 676 186
7	Waihopai River at Dacre SH1	F46: 732 230
8	Spurhead Creek at Dacre-Morton Mains Road	F46: 744 216
9	Waihopai South Branch at Longbush Road	E46: 642 151
10	Waihopai South Branch at Woodlands South	E46: 678 148
11	Waihopai South Branch at Waituna-Morton Mains	F46: 746 187
12	Waihopai River Tributary at Waituna-Morton Mains	F46: 736 162

Figure 2.1: Waihopai River, downstream of Queen's Drive Bridge

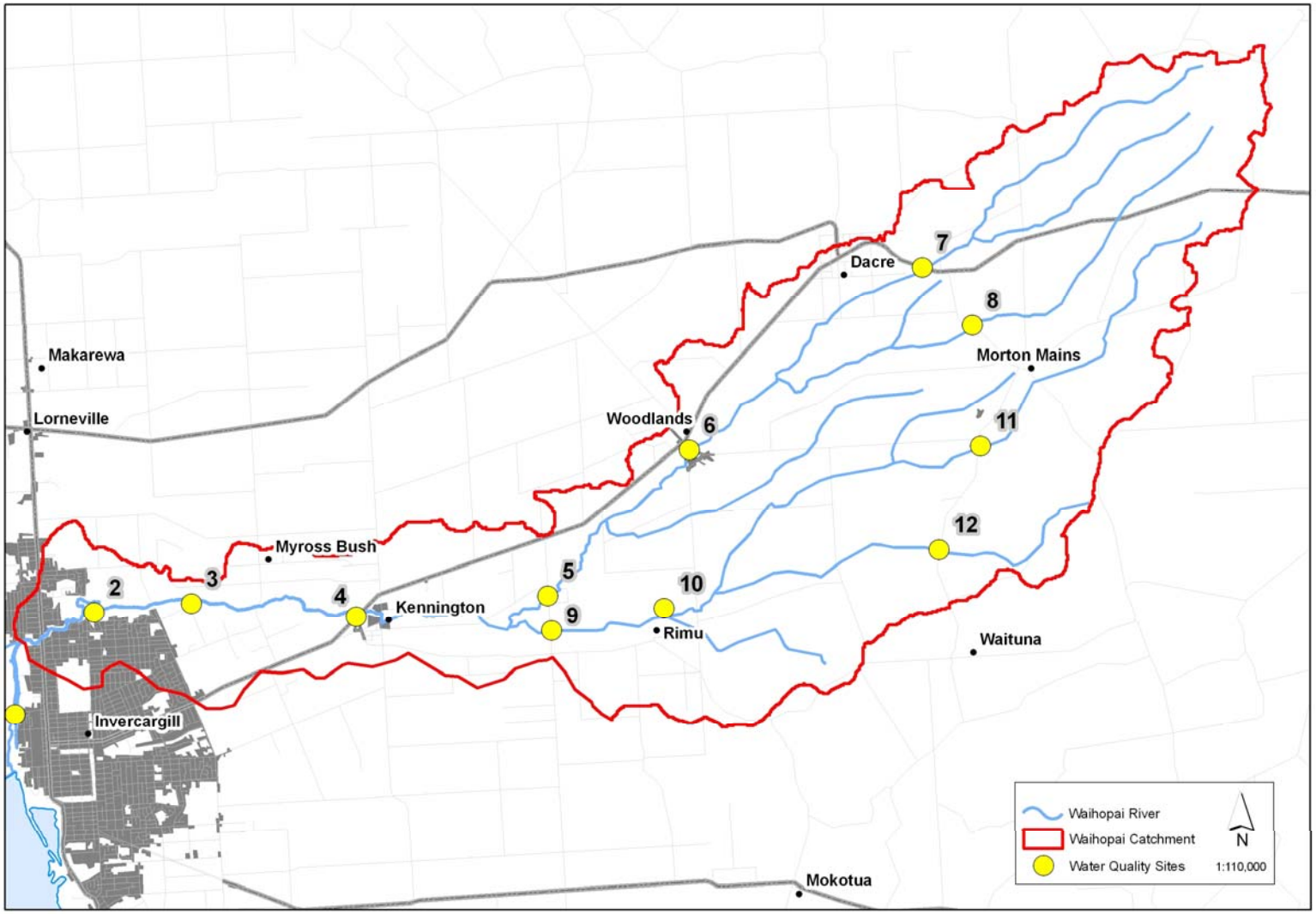

Figure 2.2: Location of Water Quality Sites in the Waihopai Catchment

3.0 Results

The results of the Waihopai catchment water quality monitoring programme are discussed below. Monitoring data is summarised in Table 3.1, Figures 3.2-3.14 and complete results can be found in Appendix 1.

Water Quality results in this report are summarised using Box-Plots, which illustrate the median and spread of the data (Figure 3.1):

- the vertical line inside the box represents the median value;
- the left and right boundaries of the box represent the lower (25%) and upper (75%) quartiles of the data, respectively;
- 50% of the data falls within the box;
- the "whiskers" extending from the box represent the 5th and 95th percentile values;
- the black dots represent outliers.

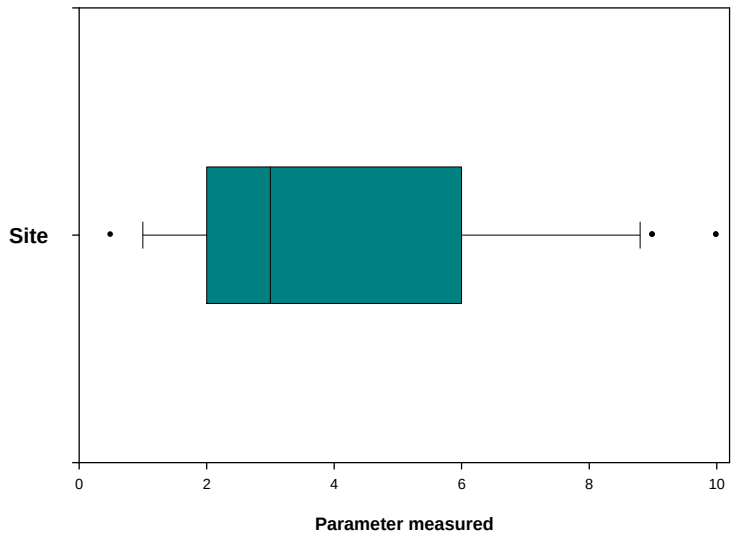

Figure 3.1: Example Box-Plot

3.1 Temperature, pH and Dissolved Oxygen

Temperature, pH and dissolved oxygen fluctuate on a daily basis. These diurnal fluctuations must be recognised when comparing sites that are sampled at different times of day. Radiant energy from the sun warms the streams during the day and plant photosynthesis increases both pH and dissolved oxygen in streams. The metabolic rate of stream organisms doubles for every 10ºC increase in stream temperature.

Table 3.1: Summary of Physico-Chemical and Microbiological Water Quality Data in the Waihopai Catchment over December 2005–December 2006. Median and Range (Min to Max)

	Flow	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC
	l/s	CFU/ 100mL	CFU/ 100mL	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	°C	pH	NTU	m	µS/cm
Waihopai River at Victoria Avenue	2775 (450 - 15026)	770 (132 - 30000)	530 (130 - 29000)	1.7 (0.2 - 9.4)	2.3 (1.4 - 5.7)	0.080 (0.029 - 0.500)	0.012 (0.003 - 0.031)	0.052 (0.005 - 0.300)	8.7 (5.4 - 12.2)	12.4 (6.3 - 22.0)	6.9 (6.4 - 7.3)	11.0 (5.0 - 75.0)	0.50 (0.10 - 1.27)	206 (148 - 795)
Waihopai River u/s Queens Drive	2309 (400 - 9545)	530 (183 - 12000)	400 (80 - 12000)	1.8 (0.7 - 2.9)	2.4 (1.3 - 4.4)	0.035 (0.021 - 0.290)	0.010 (0.003 - 0.034)	0.024 (0.005 - 0.280)	9.8 (5.8 - 15.1)	12.3 (6.4 - 21.7)	7.0 (6.4 - 7.4)	4.4 (1.6 - 40.0)	1.12 (0.20 - 1.78)	197 (140 - 210)
Waihopai River at Waihopai Dam	2167 (373 - 8909)	520 (120 - 14000)	410 (100 - 13000)	1.9 (0.7 - 2.9)	2.4 (1.4 - 4.3)	0.035 (0.025 - 0.200)	0.010 (0.003 - 0.035)	0.039 (0.005 - 0.270)	9.4 (5.3 - 12.6)	11.8 (6.3 - 21.5)	6.8 (6.4 - 7.3)	4.2 (2.4 - 40.0)	1.06 (0.20 - 1.98)	195 (138 - 207)
Waihopai River at Kennington SH1	2174 (373 - 8883)	550 (150 - 12000)	330 (120 - 9400)	1.8 (1.0 - 2.9)	2.7 (1.8 - 9.4)	0.041 (0.020 - 0.290)	0.011 (0.007 - 0.035)	0.058 (0.040 - 0.270)	9.5 (5.2 - 10.6)	11.7 (6.3 - 21.1)	6.9 (6.3 - 7.1)	4.4 (3.3 - 36.0)	1.00 (0.22 - 1.70)	194 (136 - 208)
Waihopai North Branch at Longbush Road	2075 (350 - 8269)	900 (75 - 25000)	370 (75 - 21000)	1.9 (1.2 - 2.3)	2.5 (1.9 - 4.1)	0.033 (0.017 - 0.260)	0.010 (0.005 - 0.042)	0.032 (0.005 - 0.210)	10.2 (5.5 - 14.7)	11.4 (6.4 - 19.3)	6.9 (6.4 - 7.3)	3.8 (2.2 - 55.0)	0.74 (0.23 - 1.50)	182 (129 - 224)
Waihopai River at Woodlands Bridge	774 (132 - 3109)	960 (200 - 20000)	570 (190 - 15000)	1.9 (1.1 - 2.3)	2.6 (1.9 - 4.1)	0.036 (0.022 - 0.230)	0.013 (0.003 - 0.046)	0.050 (0.020 - 0.190)	10.0 (5.6 - 11.9)	10.3 (6.2 - 17.8)	6.7 (6.4 - 7.1)	5.1 (2.6 - 55.0)	0.87 (0.21 - 1.46)	176 (118 - 192)
Waihopai River at Dacre SH1	262 (45 - 1019)	680 (130 - 18000)	520 (130 - 16000)	1.1 (0.2 - 2.3)	2.0 (1.0 - 5.3)	0.034 (0.023 - 0.360)	0.013 (0.003 - 0.064)	0.050 (0.014 - 0.270)	9.6 (5.2 - 12.0)	10.7 (5.9 - 16.9	6.9 (6.4 - 7.1)	3.8 (2.0 - 70.0)	1.25 (0.12 - 1.75)	170 (114 - 180)
Spurhead Creek at Dacre Morton Mains Road	689 (155 - 15026)	900 (130 - 32000)	800 (100 - 27000)	1.1 (0.2 - 2.0)	1.8 (1.1 - 3.6)	0.056 (0.018 - 0.220)	0.010 (0.003 - 0.052)	0.016 (0.010 - 0.170)	9.2 (4.4 - 12.1)	10.8 (5.6 - 17.9)	6.8 (6.3 - 7.1)	4.4 (3.0 - 45.0)	0.83 (0.13 - 1.31)	180 (119 - 197)
Waihopai South Branch at Longbush Road	1052 (178 - 4212)	1000 (100 - 21000)	540 (100 - 20000)	1.8 (0.7 - 3.0)	2.5 (1.3 - 5.0)	0.050 (0.025 - 0.180)	0.011 (0.003 - 0.096)	0.042 (0.005 - 0.240)	10.4 (5.6 - 13.0)	11.6 (6.6 - 19.8)	6.7 (6.2 - 7.3)	5.4 (3.5 - 40.0)	0.80 (0.19 - 1.27)	200 (138 - 214)
Waihopai South Branch at Woodlands South	785 (133 - 3109)	800 (380 - 23000)	630 (320 - 21000)	1.8 (0.4 - 3.3)	2.8 (1.0 - 5.2)	0.054 (0.027 - 0.140)	0.011 (0.003 - 0.024)	0.056 (0.019 - 0.230)	10.0 (5.5 - 11.4)	10.9 (6.5 - 18.5)	6.7 (6.1 - 7.4)	7.0 (3.8 - 38.0)	0.83 (0.24 - 1.50)	199 (131 - 210)
Waihopai South Branch at Waituna Morton	272 (51 - 1048)	830 (33 - 29000)	750 (33 - 27000)	1.8 (0.8 - 2.5)	2.6 (1.5 - 4.0)	0.043 (0.019 - 0.370)	0.010 (0.003 - 0.019)	0.055 (0.017 - 0.360)	9.4 (4.4 - 12.1)	10.3 (6.1 - 15.8)	6.6 (6.1 - 6.9)	4.8 (3.0 - 50.0)	1.19 (0.23 - 1.39)	181 (118 - 221)
Waihopai River Tributary at Waituna Morton Mains	131 (22 - 517)	230 (40 - 6200)	190 (33 - 4800)	2.1 (0.5 - 5.0)	3.2 (1.5 - 5.9)	0.037 (0.010 - 0.410)	0.008 (0.003 - 0.100)	0.040 (0.021 - 0.300)	8.6 (4.7 - 10.9)	10.3 (6.8 - 17.2)	6.4 (6.0 - 7.0)	5.3 (2.1 - 18.0)	1.04 (0.41 - 1.45)	204 (133 - 217)

Notes: FC = Faecal Coliforms; NNN = Nitrate Nitrite Nitrogen; TN = Total Nitrogen; TP = Total Phosphorus; DRP = Dissolved Reactive Phosphorus; NH4 = Total Ammoniacal Nitrogen; DO = Dissolved Oxygen; Temp = Temperature; Turb = Turbidity; EC = Electrical Conductivity.

3.1.1 Temperature

Results show a general trend of increasing water temperature from upstream to downstream. Downstream sites experienced a larger range of temperatures throughout the year compared to upstream sites. However, this downstream trend is an artifact of the sampling regime, since upstream sites were generally sampled earlier in the morning. The lowest recorded temperature was 5.6ºC at the Spurhead Creek site and the highest temperature of 21.7ºC was found in the Waihopai River upstream of Queen's Drive (Table 3.1, Figure 3.2).

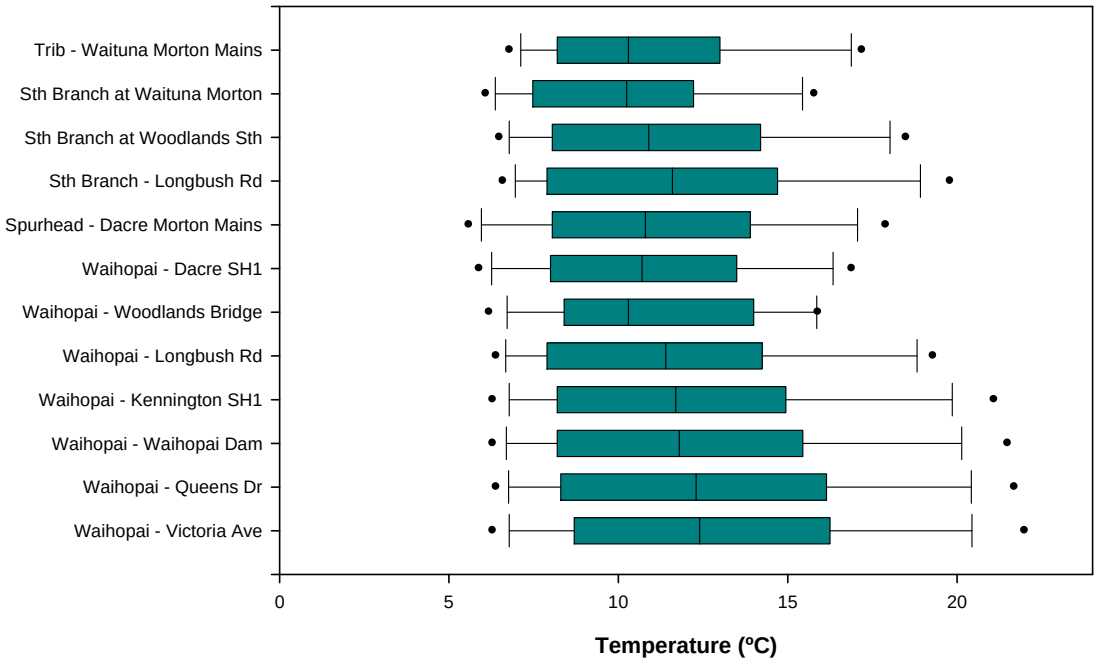

Figure 3.2: Temperature in the Waihopai Catchment (December 2005–December 2006)

3.1.2 pH

The sites sampled throughout the catchment showed moderately acidic pH, when compared with the ANZECC guideline (pH 7.2–7.8) for low risk of adverse biological effects in lowland rivers (ANZECC, 2000). The maximum pH was 7.4 (Waihopai River upstream of Queen's Drive and Waihopai south branch at Woodlands South) and a minimum pH of 6.0 was recorded in a tributary of the Waihopai River at Waituna-Morton Mains (Table 3.1, Figure 3.3). The pH range over the sampling period was low, with a maximum fluctuation of 1.3 units in the Waihopai south branch at the Woodlands South site.

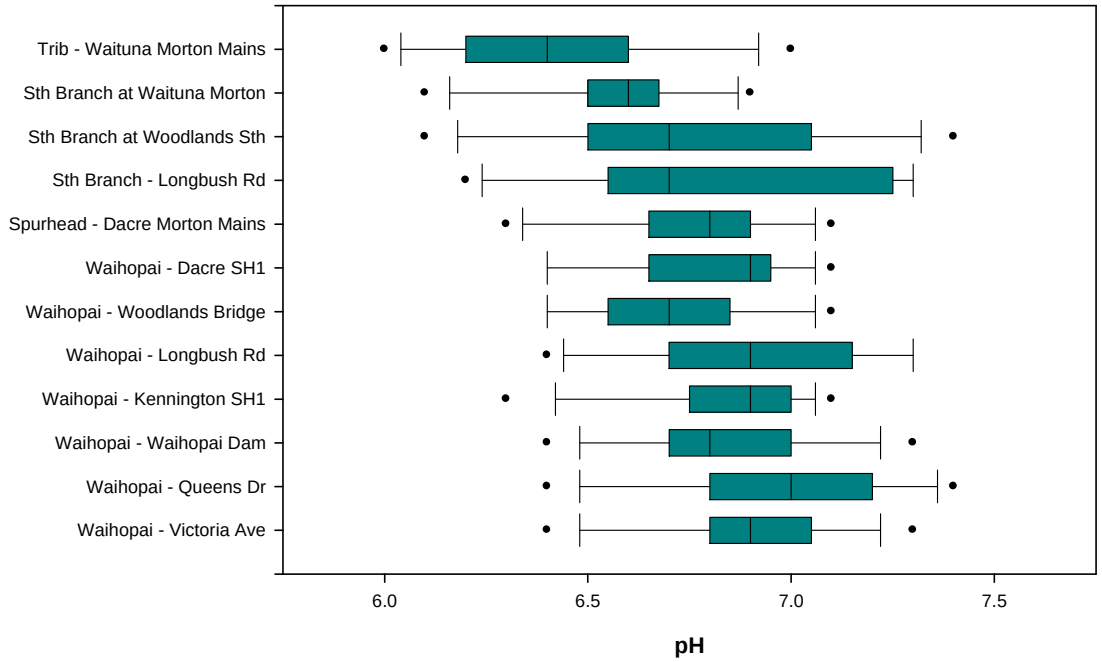

Figure 3.3: pH in the Waihopai Catchment (December 2005–December 2006)

3.1.3 Dissolved Oxygen

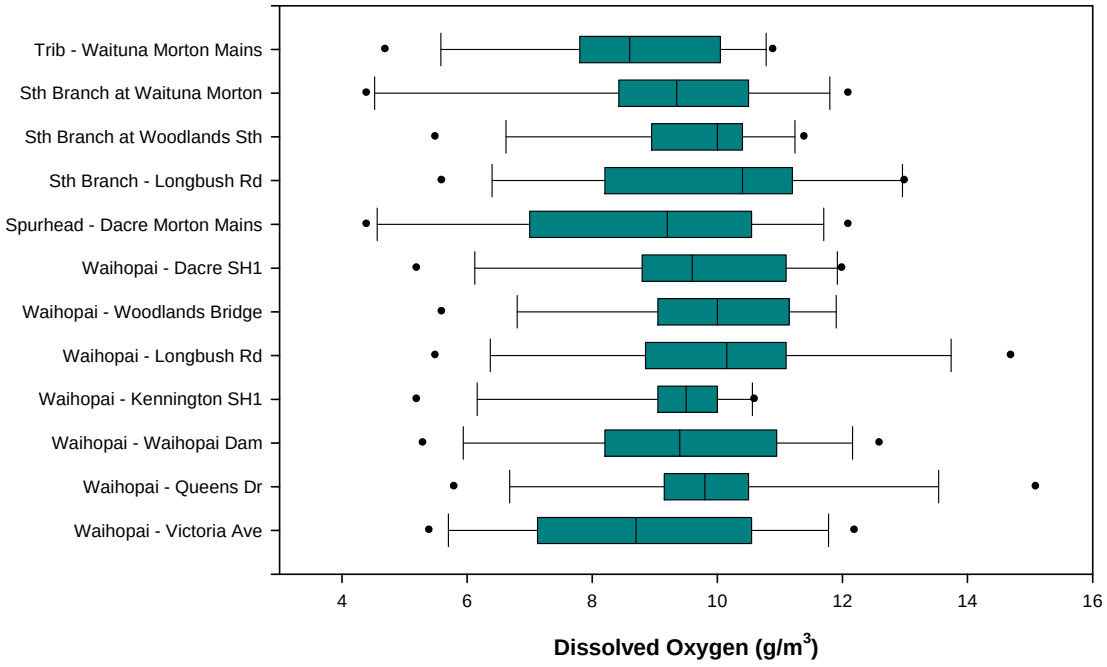

Figure 3.4: Dissolved Oxygen in the Waihopai Catchment (December 2005–December 2006)

Dissolved oxygen (DO) levels were variable throughout the catchment with the greatest range in DO found in the Waihopai River upstream of Queen's Drive (range of 9.3 g/m^3), however this may be due to diurnal fluctuations related to the time at which water samples

were taken. Minimum DO levels of 4.4 g/m^3 were recorded at both the Waihopai south branch at Waituna-Morton Mains and Spurhead Creek at Dacre-Morton Mains Road sites over the sampling period (Table 3.1, Figure 3.4). The Waihopai River upstream of Queen's Drive experienced the highest maximum DO concentration of 15.1 g/m^3, however, it is likely that this is an artifact of sampling being carried out within close proximity to the dam.

3.2 Visual Clarity, Turbidity and Conductivity

3.2.1 Visual Clarity (Black Disc)

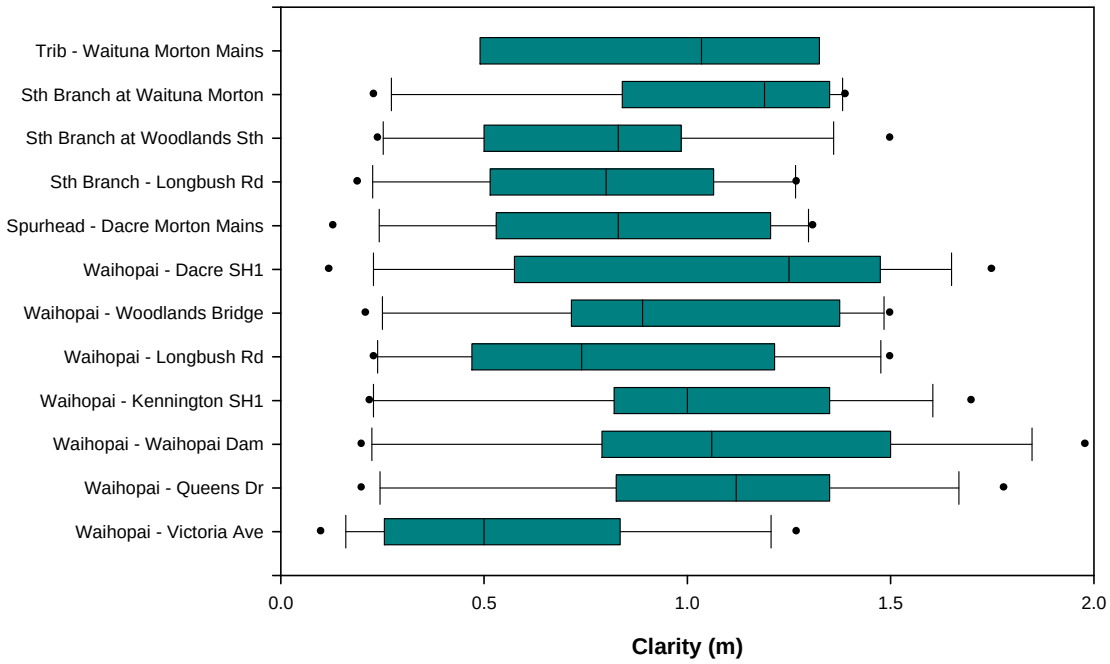

Figure 3.5: Visual Clarity in the Waihopai Catchment (December 2005–December 2006)

Visual clarity varied between sites and no upstream to downstream trends were identified. The minimum visual clarity recorded was 0.10 m in the Waihopai River at Victoria Avenue, however, this is attributable to the saltwater intrusion which occurs at this site which decreases visual clarity. A maximum visual clarity of 1.98 m was recorded at the Waihopai Dam site (Table 3.1, Figure 3.5). Median visual clarity at all sites (excluding Victoria Avenue) was above the ANZECC guideline of 0.80 m for low risk of adverse biological effects (ANZECC, 2000).

3.2.2 Turbidity

Turbidity was highest in the Waihopai River at Victoria Avenue due to the salt water intrusion at this site, and back wash of estuary sediments (maximum turbidity 75 NTU). Turbidity was lowest in the Waihopai River upstream of Queen's Drive (minimum turbidity 1.6 NTU) (Table 3.1, Figure 3.6). The overall median turbidity was 4.6 NTU for all sites, below the ANZECC (2000) guideline of 5.6 NTU for low risk of adverse biological effects

in lowland rivers. On some months, sampling coincided with rainfall events, which increased turbidity and introduced bias to the monitoring results. Under these circumstances the use of the ANZECC (2000) guideline (5.6 NTU) is not appropriate.

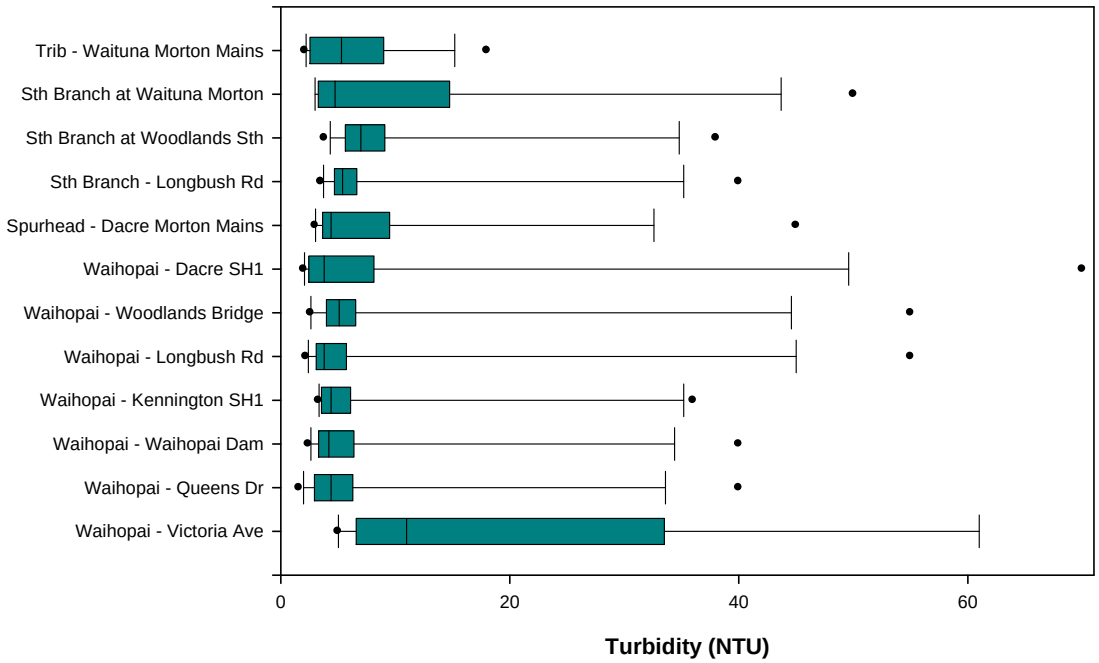

Figure 3.6: Turbidity in the Waihopai Catchment (December 2005–December 2006)

3.2.3 Conductivity

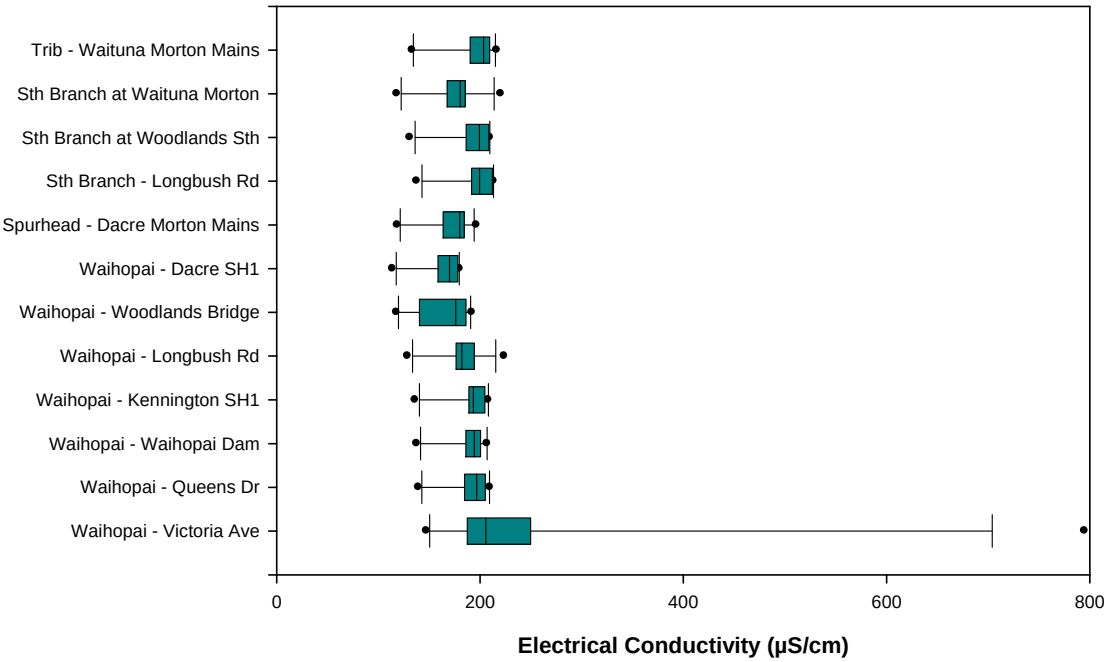

Figure 3.7: Conductivity in the Waihopai Catchment (December 2005–December 2006)

Electrical Conductivity (EC) at all sites ranged between 114 and 795 µS/cm over the sampling period, with the greatest range (647 µS/cm, and maximum value of 795 µS/cm) recorded in the Waihopai River at Victoria Avenue, representing the tidal influence at this site (Figure Table 3.1, 3.7).

3.3 Nutrients

3.3.1 Nitrogen

Total Nitrogen (TN) was highest in the Waihopai River at Kennington SHI (TN maximum 9.4 g/m^3) with the lowest median in the Spurhead Creek at Dacre-Morton Mains (TN minimum 1.8 g/m^3) (Table 3.1, Figure 3.8). Nitrate Nitrite Nitrogen (NNN) peaked in the Waihopai River at the Victoria Avenue site (NNN maximum 9.4 g/m^3), with the lowest median NNN value recorded in the Spurhead Creek at Dacre-Morton Mains and the Waihopai River at Dacre SH1 (NNN medians 1.1 g/m^3) (Table 3.1, Figure 3.9). Median TN and NNN values for all sites are above the ANZECC (2000) guidelines of 0.614 g/m^3 and 0.444 g/m^3, respectively, for low risk of adverse biological effects.

Total Ammonia Nitrogen (NH_4N) was high at a number of sites, particularly in the Waihopai south branch at Waituna-Morton Mains (NH_4N maximum 0.36 g/m^3). Other sites with high ammonia nitrogen levels were the Waihopai River at Victoria Avenue and the Waihopai River Tributary at Waituna-Morton Mains (NH_4N maximums of 0.3 g/m^3) (Table 3.1, Figure 3.10).

Total Ammonia Nitrogen was lowest (NH_4N median 0.016 g/m^3) in the Spurhead Creek at Dacre-Morton Mains, possibly as a result of nutrient uptake by in-stream plants, which can be abundant at this site (Table 3.1, Figure 3.10). Median values for NH_4N at all sites (except Spurhead Creek) exceeded the ANZECC (2000) guideline of 0.021 g/m^3 for low risk of adverse biological effects in lowland rivers.

3.3.2 Phosphorus

Total Phosphorus (TP) levels in the Waihopai catchment were highest in the Waihopai River at Victoria Avenue site, where a maximum of 0.5 g/m^3 TP was recorded due to the salt water intrusion at this site (Table 3.1, Figure 3.11).

Median Dissolved Reactive Phosphorus (DRP) levels were consistent throughout the catchment, however the Waihopai River Tributary site at Waituna-Morton Mains reached a maximum DRP concentration of 0.1 g/m^3 (Table 3.1, Figure 3.12).

Median TP and DRP values at all sites exceeded the ANZECC (2000) guidelines (0.033 and 0.01 g/m^3, respectively) for low risk of adverse biological effects.

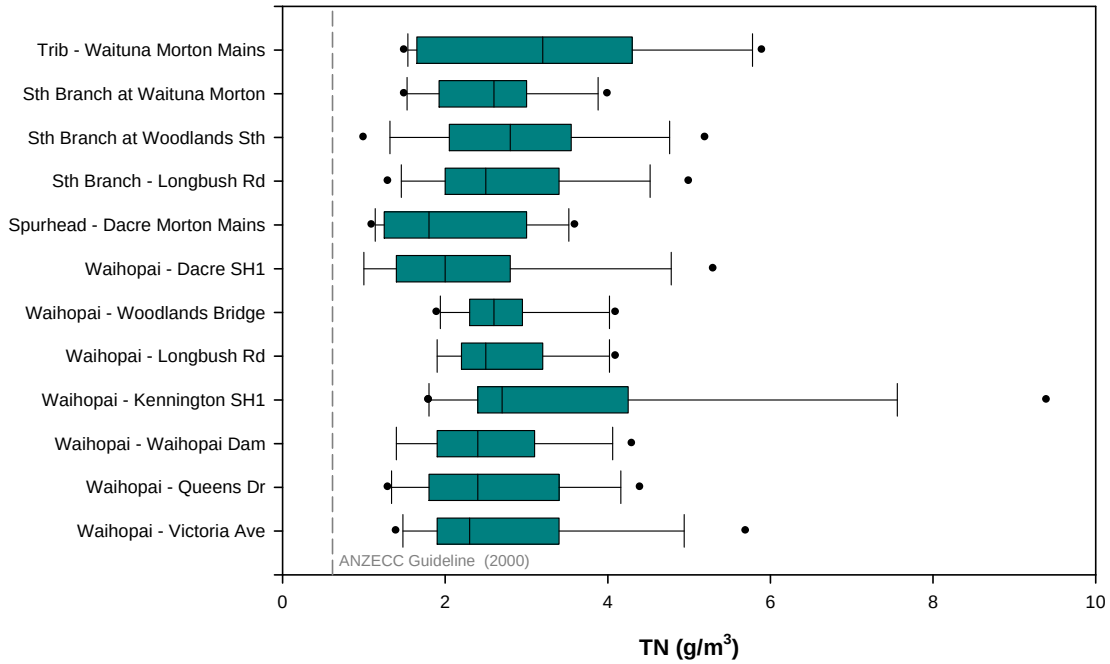

Figure 3.8: Total Nitrogen in the Waihopai Catchment (December 2005–December 2006)

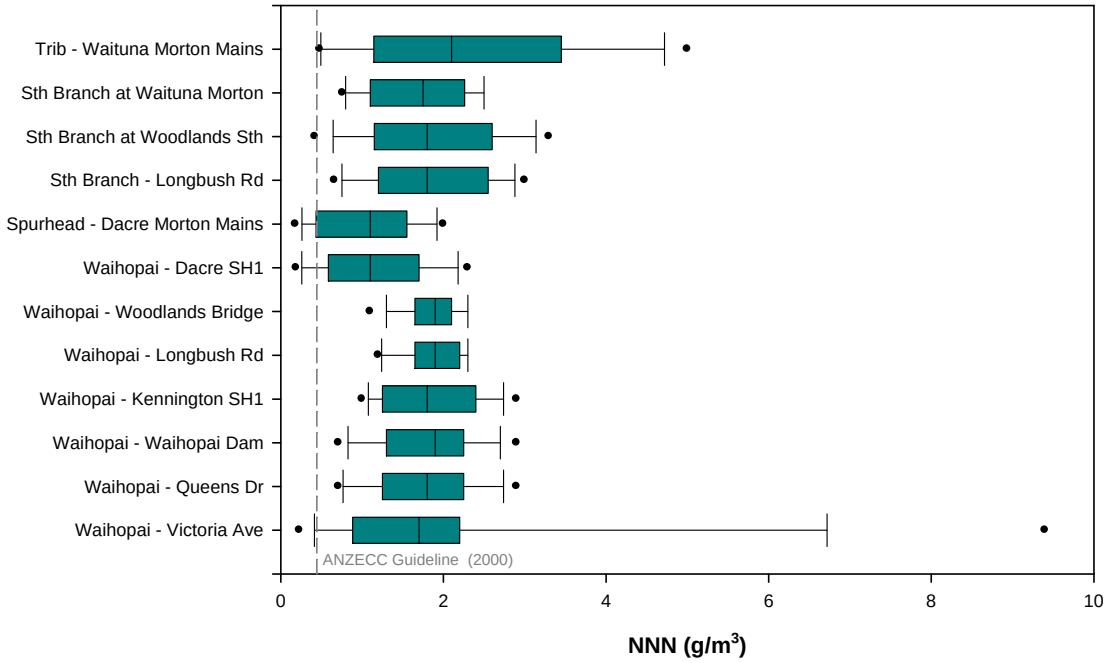

Figure 3.9: Nitrate, Nitrogen in the Waihopai Catchment (December 2005-December 2006)

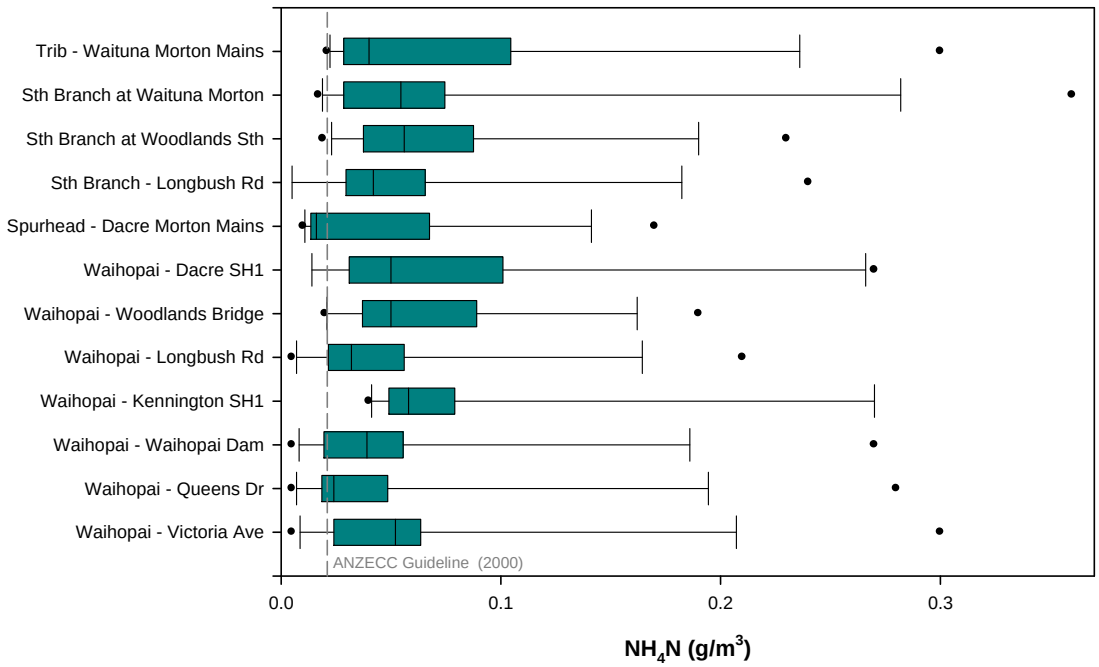

Figure 3.10: Ammonia, Nitrogen in the Waihopai Catchment (December 2005–December 2006)

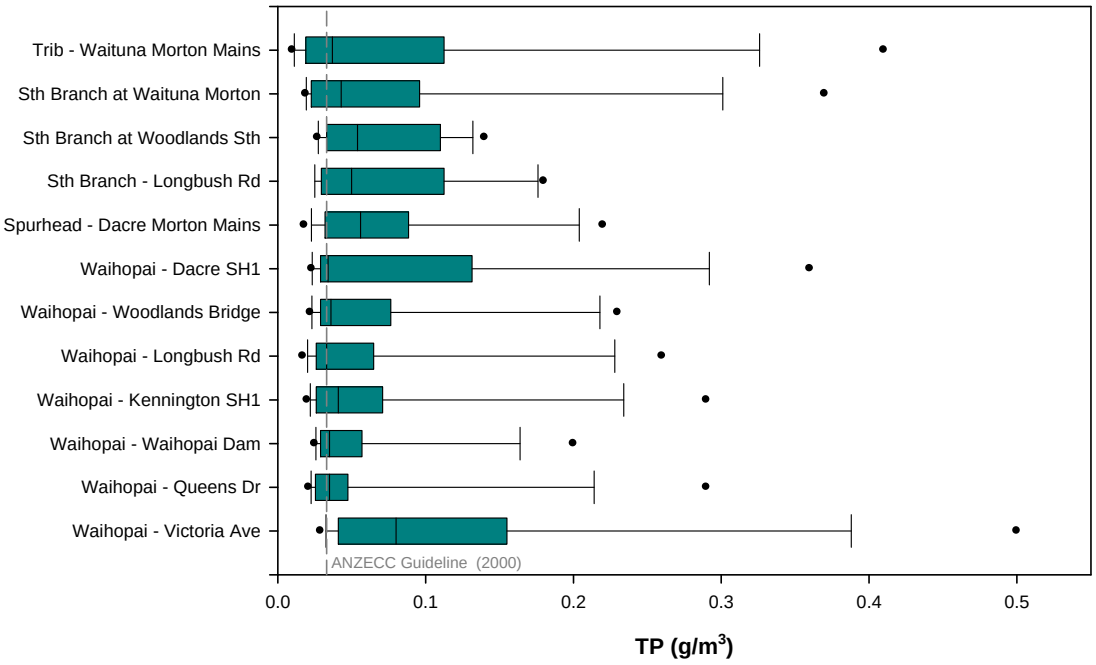

Figure 3.11: Total Phosphorus in the Waihopai Catchment (December 2005–December 2006)

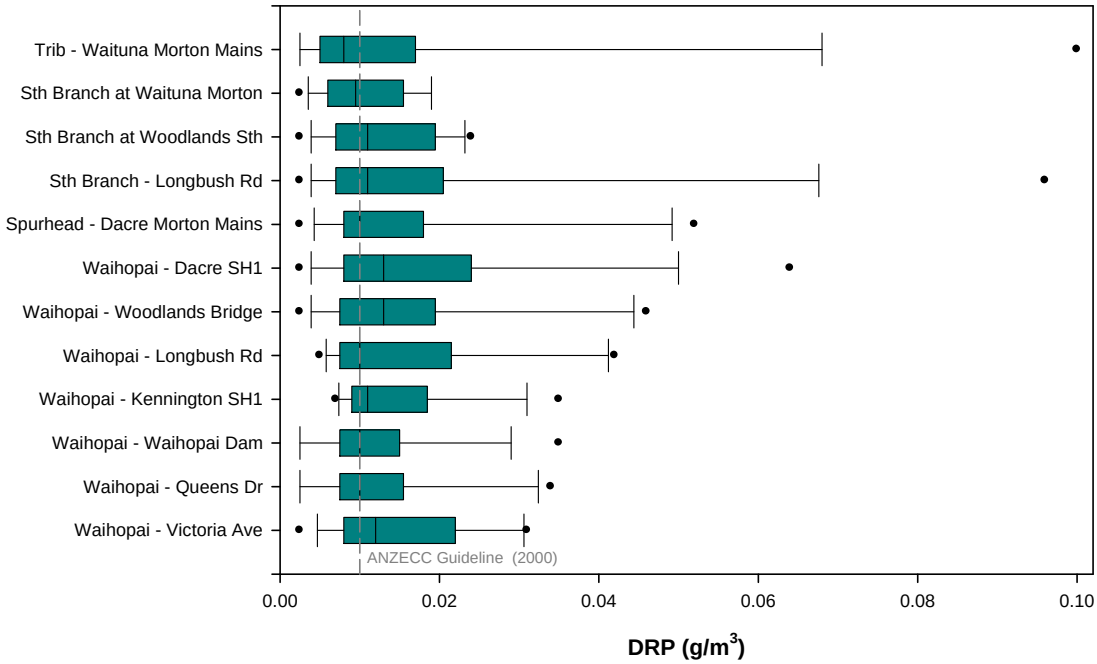

Figure 3.12: Dissolved Reactive Phosphorus in the Waihopai Catchment (December 2005-December 2006

3.4 Faecal Coliforms and *E. coli*

Faecal Coliform (FC) and *E. coli* levels within the catchment were highly variable and influenced by rainfall events, increasing land runoff and suspension of sediment. However, consistently lower bacterial levels were recorded in the Waihopai River Tributary at Waituna-Morton Mains (median 190 *E. coli*/100 ml). The Waihopai River at Victoria Avenue recorded the highest peak of Faecal Coliforms (30,000 CFU/100 ml), comprised predominately of the harmful bacteria *E. coli* (29,000 *E. coli*/100 ml) (Table 3.1, Figures 3.13 and 3.14).

Median Faecal Coliform values at all sites exceed the ANZECC (2000) stock water trigger value of 100 CFU/100ml. The median Faecal Coliform value for the Waihopai south branch at Longbush Road site equaled the ANZECC (1992) stock water and secondary contact recreation guideline of 1,000 CFU/100 ml, with all other site medians falling below this guideline.

Levels of *E. coli* have exceeded the Ministry for the Environment (2003) freshwater bathing "action" guideline of 550 *E. coli*/100 ml at all sites on greater than one occasion over the sampling period, and median levels of *E. coli* were above this guideline at four sites within the catchment over the sampling period (Table 3.1).

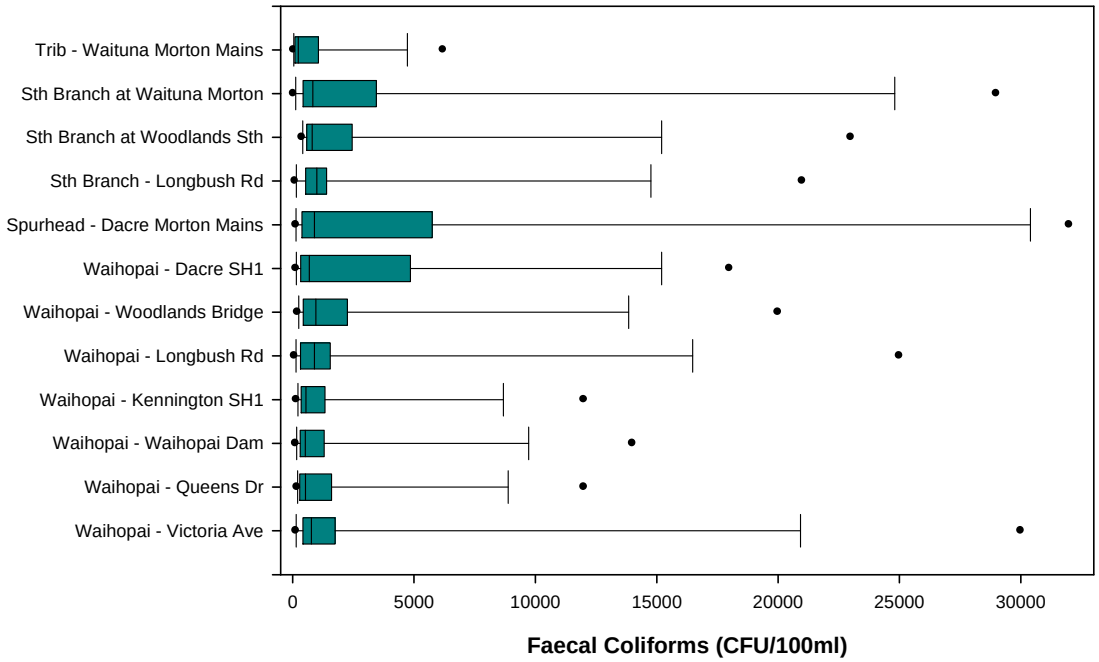

Figure 3.13: Faecal Coliforms in the Waihopai Catchment (December 2005–December 2006)

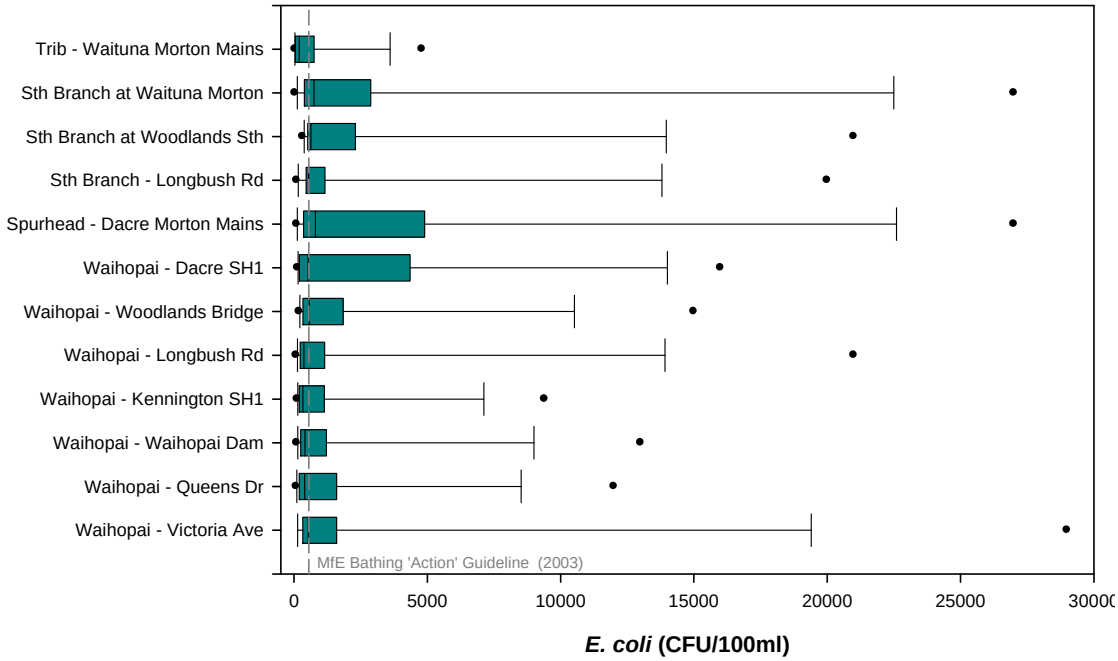

Figure 3.14: *E. coli* in the Waihopai Catchment (December 2005–December 2006)

4.0 Conclusions and Recommendations

4.1 Characteristics of the Waihopai Catchment

Table 4.1: Waihopai Site Characteristics and Observations

Site Name	Site Characteristics	Observations
Waihopai River at Victoria Avenue	Tidal influence, mud substrate.	High N and P, low clarity.
Waihopai River u/s Queen's Drive	Stormwater input at bridge, gravel bed.	High DO peak.
Waihopai River at Waihopai Dam	Gravel bed, site u/s of dam.	Highest recorded clarity.
Waihopai River at Kennington SH1	Site d/s of sawmill.	-
Waihopai North Branch at Longbush Road	Fenced waterway.	Low median clarity.
Waihopai River at Woodlands Bridge	Treated effluent discharge at site.	-
Waihopai River at Dacre SH1	-	High turbidity peak, lowest conductivity.
Spurhead Creek at Dacre-Morton Mains Road	Grassy channel.	High *E. coli* and faecal coliforms, lower N.
Waihopai South Branch at Longbush Road	Fenced waterway.	High DRP peak.
Waihopai South Branch at Woodlands South	Site d/s of meat processing plant.	Highest minimum recorded *E. coli*.
Waihopai South Branch at Waituna-Morton Mains	Low flow.	Highest ammonia nitrogen peak, high *E. coli* and faecal coliforms.
Waihopai River Tributary at Waituna-Morton Mains	Lowest flow.	High N and P, lower pH.

4.2 Water Quality Issues in the Waihopai Catchment

The water quality in the Waihopai catchment is indicative of a highly modified lowland catchment with intensive agriculture in the headwaters, with lifestyle, community inputs at various points, and urban pressures in the lower reaches (Figure 4.1). Consequently, identifying patterns in water quality was complicated due to the diversity of land use within the catchment, along with a lack of investigation into drain and stormwater inputs. The broad scale of the monitoring programme (12 sites spread throughout a large catchment) also provided limited spatial resolution in the sampling results. However, even given the difficulty in isolating sources of poor water quality within the catchment, patterns have been identified with respect to faecal contamination, nutrients and sediment that deserve more detailed assessment.

4.2.1 Faecal Contamination

Faecal contamination was found to be a significant factor influencing water quality throughout the catchment. Median *E. coli* levels exceeded ANZECC (2000) guidelines at all but one site in the catchment, and a median of 800 *E. coli*/100 ml was identified at the Spurhead Creek site in the headwaters of the Waihopai River (Table 4.1).

It appears the main cause of faecal contamination in the Waihopai River is effluent run-off and tile discharge from agriculture in the mid to upper catchment, and possibly poorly functioning septic tank systems from lifestyle blocks in the mid to lower portion of the catchment. Further study is required to identify specific sources of faecal contamination.

4.2.2 Nutrients

Monitoring has indicated that nutrient input occurs throughout the Waihopai catchment, with particular "hot-spots" in the upper reaches. In particular, the Waihopai River tributary at Waituna-Morton Mains, where the median nitrate concentration was 2.1 g/m^3, peaking at a maximum of 5.0 g/m^3 during the 2005/06 period. In addition, total phosphorus peaked on one occasion in December 2005 at 0.41 g/m^3, indicating possible fertiliser runoff at this site. Another "hot-spot" in the upper catchment was the Waihopai south branch at Waituna-Morton Mains, where ammonia nitrogen peaked at 0.36 g/m^3 in December 2005 (Table 3.1).

Median concentrations of all nutrients throughout the catchment exceeded ANZECC (2000) guidelines over the December 2005–December 2006 period (with the exception of ammonia nitrogen at Spurhead Creek). These results indicate intensive agricultural land use and a need for the wholesale adoption of Best Management Practices (BMPs) within the catchment. Through the adoption of BMPs, (including the construction of riparian margins and wetlands in boggy areas, nutrient management plans, and the exclusion of stock from waterways), nutrient and sediment runoff, and faecal contamination will be minimised within the catchment.

4.2.3 Sediment

Visual clarity and turbidity were poor during rainfall events and associated high river flows as a result of sediment runoff and re-suspension. These peaks in sediment input to the Waihopai River during rainfall events, indicate a need for more widely adopted Best Management Practices (BMPs) within the catchment, including riparian margins to trap sediment runoff and increase bank stability, and the exclusion of stock from waterways as advised in the Proposed Regional Fresh Water Plan (Environment Southland, 2000).

4.3 The Cumulative Effect

Nutrient concentrations, faecal contamination, and sediment loading are generally elevated in the lower reaches of the catchment, in particular the Waihopai River at Victoria Avenue site, where the total inputs of contaminants from the catchment accumulate. This sediment and

contaminants then enter the New River estuary, where sedimentation is measured as part of a long term Environment Southland estuary sedimentation study.

4.4 Recommendations

1. Actively encourage and facilitate BMPs in the form of farm plans and the construction of riparian margins and wetlands in the mid to upper reaches of the Waihopai catchment, in particular Spurhead Creek, the Waihopai River tributary at Waituna-Morton Mains, and the south branch of the Waihopai River, to reduce sediment and nutrient runoff, decrease faecal contamination, increase bank stability, and enhance stream habitats via shading in headwater sub-catchments.

2. Focused targeting on the exclusion of stock from waterways, as advised in Variation 5 (Stock Access) of the Proposed Regional Fresh Water Plan (2000), to minimise effluent and sediment runoff, and faecal contamination throughout the Waihopai catchment.

3. Increase community awareness and ownership of the water quality issues in the Waihopai catchment through primary school education, landowner field days, and community outreach activities. This initiative is currently being formulated into a strategy to be delivered as Phase Three of the Living Streams programme.

4. Initiate a Stormwater Focus Study to identify and characterise all stormwater inputs to the Waihopai River and the role they play in the future contamination of the lower catchment.

5. Expand an existing monitoring programme (components of which are currently underway as Phase Two of the Living Streams programme) to identify and characterise septic tank discharge within the catchment, to minimise human faecal contamination in the Waihopai River.

6. Investigate temporal sediment trends in the Waihopai catchment by tracking sediment yields and source inputs to the New River Estuary. This project has been initiated as a component of Environment Southland's Estuary Monitoring programme and is linked to sedimentation monitoring which has been established at sites in the New River Estuary.

7. Further work investigating water quality at a sub-catchment scale, so that trends can be tightly linked to specific land use activities within the catchment, and the performance of BMPs measured in relation to the "10% improvement target" and Variation 4 Water Quality objectives (bacterial, nitrogen, phosphorus and clarity) as specified in the Proposed Regional Fresh Water Plan (Environment Southland, 2000).

5.0 Control of Records

Water Quality in the Waihopai Catchment Report
S:\Environmental_Info\KirstenM\ REPORTING\Waihopai\Waihopai WQ Report.

Raw data: December 2005 to December 2006
S:\Environmental_Info\KirstenM\ MONITORING\Rivers\Waihopai\Waihopai Data 05-06.

6.0 References

ANZECC, 1992. *Australian water quality guidelines for fresh and marine waters.* National Water Quality Management Strategy Paper No. 4, Australian and New Zealand Environment and Conservation Council, Canberra.

ANZECC, 2000. *Australia and NewZealand guidelines for fresh and marine water quality, Volume 1, The Guidelines.* Australia and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Environment Southland, 2000. *Proposed Regional Fresh Water Plan.* Environment Southland, Publication No. 2000-20.

Ministry for the Environment, 2003. *Microbial Water Quality Guidelines for Marine and Freshwater Recreational Areas.* Ministry for the Environment, Wellington.

Appendix 1: Monitoring Data (December 2005 – December 2006)

Table 1: Waihopai River at Victoria Avenue

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 11:28	1100	630	0.7	1.4	0.080	0.011	0.068	6.4	22	7.1	11.0	0.55	795	450
23/01/2006 12:15	1700	530	1.8	2.5	0.043	0.031	0.054	9.3	18	6.6	5.8	0.80	212	3724
20/02/2006 13:38	7300	5000	0.8	1.6	0.180	0.013	0.061	7.4	18.1	6.8	40.0	0.25	340	629
20/03/2006 12:15	600	350	1.7	2.2	0.058	0.012	0.028	9.9	14.5	7.1	5.1	0.86	-	2344
19/04/2006 12:20	370	300	1.1	2.1	0.220	0.016	0.052	-	13.5	7.0	30.0	0.31	-	749
12/05/2006 08:50	30000	29000	2.7	5.7	0.500	0.028	0.300	8.1	9.9	6.4	75.0	0.10	215	13549
16/06/2006 11:43	1500	1500	2.5	3.8	0.120	0.015	0.054	10.4	7.5	6.8	31.0	0.26	200	15026
14/07/2006 11:30	160	130	1.9	3.1	0.042	0.008	0.050	10.8	6.3	6.8	7.4	1.11	199	3481
18/08/2006 12:54	670	530	0.2	3.7	0.029	0.008	0.046	10.6	7.6	6.9	8.1	0.81	206	3679
15/09/2006 14:40	770	470	9.4	2.3	0.130	0.008	0.014	12.2	9.8	7.3	30.0	0.50	188	2406
13/10/2006 11:35	470	400	1.8	2.5	0.038	0.009	0.005	5.4	12.4	7.0	9.2	0.30	148	3263
17/11/2006 07:50	1800	1700	1.0	1.8	0.100	0.003	0.066	7.1	11.4	6.8	36.0	0.25	250	2775
15/12/2006 07:30	132	130	1.5	2.0	0.040	0.030	0.020	7.2	13.4	7.0	5.0	1.27	162	1123
Mean	**3582**	**3128**	**2.1**	**2.7**	**0.122**	**0.015**	**0.063**	**8.7**	**12.6**	**6.9**	**22.6**	**0.57**	**265**	**4092**
Median	**770**	**530**	**1.7**	**2.3**	**0.080**	**0.012**	**0.052**	**8.7**	**12.4**	**6.9**	**11.0**	**0.50**	**206**	**2775**
Min	**132**	**130**	**0.2**	**1.4**	**0.029**	**0.003**	**0.005**	**5.4**	**6.3**	**6.4**	**5.0**	**0.10**	**148**	**450**
Max	**30000**	**29000**	**9.4**	**5.7**	**0.500**	**0.031**	**0.300**	**12.2**	**22.0**	**7.3**	**75.0**	**1.27**	**795**	**15026**
Std Dev	**8154**	**7882**	**2.3**	**1.2**	**0.128**	**0.009**	**0.074**	**2.1**	**4.7**	**0.2**	**20.5**	**0.37**	**183**	**4684**

Note: half the detection limit. FC = faecal coliforms; NNN = nitrate nitrite nitrogen; TN = total nitrogen; TP = total phosphorus; DRP = dissolved reactive phosphorus; NH4 = total ammoniacal nitrogen; DO = dissolved oxygen; Temp = temperature; Turb = turbidity; EC = electrical conductivity.

Table 2: Waihopai River upstream Queen's Drive

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 12:20	230	80	0.7	1.4	0.047	0.007	0.022	10.2	21.7	7.3	1.6	1.32	201	443
23/01/2006 12:00	390	310	1.6	2.6	0.038	0.010	0.066	9.1	17.9	6.6	5.9	0.83	210	2379
20/02/2006 13:09	740	600	0.9	1.3	0.030	0.003	0.023	11.2	18.5	7.3	2.9	1.38	194	400
20/03/2006 11:48	350	280	1.8	2.1	0.048	0.012	0.029	10.3	14.4	7.0	4.7	1.28	-	1491
19/04/2006 12:34	4200	3300	1.4	1.8	0.035	0.013	0.019	15.1	12.4	7.4	2.6	1.78	199	476
12/05/2006 09:15	12000	12000	2.9	4.4	0.290	0.034	0.280	8.0	9.2	6.4	40.0	0.20	208	8485
16/06/2006 11:25	900	900	2.5	3.8	0.100	0.018	0.051	9.8	7.3	6.8	24.0	0.31	195	9545
14/07/2006 09:24	250	150	2.1	3.1	0.026	0.008	0.046	10.6	6.4	6.8	4.4	1.04	207	2915
18/08/2006 12:31	330	200	2.4	3.7	0.021	0.008	0.045	9.5	7.7	6.8	5.7	1.06	201	3050
15/09/2006 08:30	600	600	1.8	2.5	0.025	0.013	0.018	10.4	8.9	7.1	3.3	1.12	188	2025
13/10/2006 11:10	530	400	1.9	2.4	0.032	0.009	0.005	5.8	12.3	7.0	3.1	1.26	140	2709
17/11/2006 08:15	2300	2300	1.1	1.9	0.025	0.003	0.024	9.2	10.9	6.8	6.7	0.82	184	2309
15/12/2006 07:45	183	180	1.5	1.8	0.040	0.030	0.010	9.6	12.9	7.0	3.0	1.50	150	927
Mean	**1769**	**1638**	**1.7**	**2.5**	**0.058**	**0.013**	**0.049**	**9.9**	**12.3**	**6.9**	**8.3**	**1.07**	**190**	**2858**
Median	**530**	**400**	**1.8**	**2.4**	**0.035**	**0.010**	**0.024**	**9.8**	**12.3**	**7.0**	**4.4**	**1.12**	**197**	**2309**
Min	**183**	**80**	**0.7**	**1.3**	**0.021**	**0.003**	**0.005**	**5.8**	**6.4**	**6.4**	**1.6**	**0.20**	**140**	**400**
Max	**12000**	**12000**	**2.9**	**4.4**	**0.290**	**0.034**	**0.280**	**15.1**	**21.7**	**7.4**	**40.0**	**1.78**	**210**	**9545**
Std Dev	**3276**	**3256**	**0.6**	**1.0**	**0.073**	**0.010**	**0.072**	**2.1**	**4.7**	**0.3**	**11.1**	**0.45**	**22**	**2899**

Note: half the detection limit. Greater than 1.50 m.

Table 3: Waihopai River at Waihopai Dam

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 12:00	800	630	0.7	1.4	0.062	0.011	0.021	11.5	21.5	7.3	3.3	1.06	196	413
23/01/2006 11:45	520	250	1.9	2.6	0.042	0.008	0.053	8.4	17.1	6.6	5.4	0.85	196	2224
20/02/2006 12:50	290	250	1.0	1.4	0.033	0.003	0.021	6.9	18.1	7.0	2.4	1.31	191	373
20/03/2006 11:26	390	320	1.9	2.2	0.047	0.011	0.039	8.8	13.8	6.8	4.2	1.27	-	1397
19/04/2006 12:53	330	290	1.5	1.9	0.035	0.011	0.013	12.6	11.9	7.0	3.3	1.65	198	444
12/05/2006 09:30	14000	13000	2.9	4.3	0.200	0.035	0.270	8.0	9.2	6.4	40.0	0.20	207	7853
16/06/2006 11:10	1600	1600	2.4	3.3	0.110	0.019	0.055	9.6	7.3	6.7	26.0	0.26	193	8909
14/07/2006 09:40	120	100	2.1	2.9	0.028	0.007	0.049	10.6	6.3	6.7	4.5	1.06	207	2709
18/08/2006 12:17	630	470	2.4	3.7	0.025	0.009	0.060	9.6	7.6	6.8	6.2	1.04	201	2854
15/09/2006 08:51	1000	830	1.9	2.5	0.027	0.010	0.021	11.3	8.8	7.0	3.8	1.50	188	1890
13/10/2006 10:45	240	200	1.9	2.4	0.032	0.009	0.018	5.3	11.8	6.9	3.0	1.50	138	2532
17/11/2006 08:30	3300	3000	1.1	2.2	0.052	0.003	0.056	9.4	10.9	6.8	6.6	0.73	186	2167
15/12/2006 07:55	410	410	1.5	1.9	0.030	0.020	0.005	9.4	13.0	7.1	3.3	1.98	150	865
Mean	**1818**	**1642**	**1.8**	**2.5**	**0.056**	**0.012**	**0.052**	**9.3**	**12.1**	**6.9**	**8.6**	**1.11**	**188**	**2664**
Median	**520**	**410**	**1.9**	**2.4**	**0.035**	**0.010**	**0.039**	**9.4**	**11.8**	**6.8**	**4.2**	**1.06**	**195**	**2167**
Min	**120**	**100**	**0.7**	**1.4**	**0.025**	**0.003**	**0.005**	**5.3**	**6.3**	**6.4**	**2.4**	**0.20**	**138**	**373**
Max	**14000**	**13000**	**2.9**	**4.3**	**0.200**	**0.035**	**0.270**	**12.6**	**21.5**	**7.3**	**40.0**	**1.98**	**207**	**8909**
Std Dev	**3757**	**3504**	**0.6**	**0.9**	**0.049**	**0.009**	**0.068**	**2.0**	**4.6**	**0.2**	**11.3**	**0.52**	**22**	**2694**

Note: half the detection limit. Greater than 1.50 m.

Table 4: Waihopai River at Kennington SH1

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 11:03	830	600	1.0	1.8	0.077	0.017	0.045	10.5	21.1	7.0	3.3	1.23	196	416
23/01/2006 11:20	490	370	1.7	2.8	0.041	0.011	0.064	9.3	16.6	6.6	5.5	0.74	208	2228
20/02/2006 12:04	640	210	1.3	1.8	0.053	0.010	0.082	9.0	18.0	7.0	3.6	0.90	191	373
20/03/2006 10:58	550	330	1.8	2.5	0.051	0.011	0.058	9.5	13.3	6.9	4.4	0.93	-	1397
19/04/2006 13:08	150	120	1.6	2.3	0.065	0.016	0.062	9.7	11.7	7.0	4.0	1.40	198	444
12/05/2006 09:48	12000	9400	2.9	4.8	0.290	0.035	0.270	7.6	9.3	6.3	34.0	0.22	208	7789
16/06/2006 10:55	3700	3700	2.5	4.7	0.150	0.025	0.076	9.9	7.8	6.9	36.0	0.24	190	8883
14/07/2006 09:57	550	180	2.3	2.7	0.027	0.008	0.057	10.6	6.3	6.7	4.9	1.11	207	2704
18/08/2006 11:44	370	170	2.5	3.8	0.025	0.009	0.058	9.7	7.5	6.8	6.7	1.00	200	2873
15/09/2006 09:08	970	670	1.9	2.7	0.037	0.011	0.053	10.1	8.6	6.9	4.0	1.30	189	1890
13/10/2006 10:22	330	230	1.9	2.8	0.035	0.009	0.043	5.2	11.7	6.8	3.4	1.46	136	2543
17/11/2006 08:50	1700	1600	1.2	2.5	0.025	0.007	0.270	9.4	10.9	6.8	5.0	0.94	191	2174
15/12/2006 08:35	313	310	1.2	9.4	0.020	0.020	0.040	9.1	12.9	7.1	3.5	1.70	150	859
Mean	**1738**	**1376**	**1.8**	**3.4**	**0.069**	**0.015**	**0.091**	**9.2**	**12.0**	**6.8**	**9.1**	**1.01**	**189**	**2659**
Median	**550**	**330**	**1.8**	**2.7**	**0.041**	**0.011**	**0.058**	**9.5**	**11.7**	**6.9**	**4.4**	**1.00**	**194**	**2174**
Min	**150**	**120**	**1.0**	**1.8**	**0.020**	**0.007**	**0.040**	**5.2**	**6.3**	**6.3**	**3.3**	**0.22**	**136**	**373**
Max	**12000**	**9400**	**2.9**	**9.4**	**0.290**	**0.035**	**0.270**	**10.6**	**21.1**	**7.1**	**36.0**	**1.70**	**208**	**8883**
Std Dev	**3222**	**2603**	**0.6**	**2.0**	**0.075**	**0.008**	**0.080**	**1.4**	**4.4**	**0.2**	**11.5**	**0.44**	**23**	**2679**

Table 5: Waihopai River at Longbush Road

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 10:26	1200	370	1.3	1.9	0.063	0.021	0.018	9.6	19.3	7.1	2.2	1.44	183	390
23/01/2006 11:00	1500	1100	1.9	3.2	0.017	0.007	0.032	9.8	15.8	6.5	5.5	0.69	224	2105
20/02/2006 11:15	400	220	1.5	2.2	0.039	0.011	0.025	10.2	18.1	7.3	3.2	0.25	179	350
20/03/2006 10:20	930	770	1.8	2.4	0.043	0.010	0.026	10.7	12.7	6.9	3.9	1.16	-	1316
19/04/2006 13:21	900	900	1.9	2.5	0.067	0.022	0.062	14.7	11.5	7.3	3.6	0.74	186	416
12/05/2006 10:14	25000	21000	2.2	4.1	0.260	0.040	0.210	8.4	9.1	6.4	30.0	0.25	196	7213
16/06/2006 10:30	3700	3300	2.3	3.9	0.180	0.042	0.096	8.6	7.1	6.6	55.0	0.23	181	8269
14/07/2006 11:45	75	75	2.2	3.2	0.025	0.007	0.034	11.5	6.4	7.0	3.5	0.72	196	2513
18/08/2006 11:15	270	200	2.3	3.1	0.033	0.008	0.036	10.1	7.5	6.8	6.0	0.73	190	2706
15/09/2006 09:20	370	370	1.8	2.5	0.027	0.008	0.025	10.8	8.3	6.8	3.8	1.10	179	1772
13/10/2006 09:46	400	330	1.9	2.7	0.029	0.009	0.005	5.5	11.4	6.8	2.7	1.26	129	2404
17/11/2006 10:55	1600	1200	1.2	1.9	0.025	0.005	0.050	11.2	11.1	7.0	4.1	1.17	176	2075
15/12/2006 10:50	243	240	1.8	2.2	0.030	0.020	0.010	-	12.7	7.2	3.0	1.50	145	806
Mean	**2814**	**2313**	**1.9**	**2.8**	**0.064**	**0.016**	**0.048**	**10.1**	**11.6**	**6.9**	**9.7**	**0.86**	**180**	**2487**
Median	**900**	**370**	**1.9**	**2.5**	**0.033**	**0.010**	**0.032**	**10.2**	**11.4**	**6.9**	**3.8**	**0.74**	**182**	**2075**
Min	**75**	**75**	**1.2**	**1.9**	**0.017**	**0.005**	**0.005**	**5.5**	**6.4**	**6.4**	**2.2**	**0.23**	**129**	**350**
Max	**25000**	**21000**	**2.3**	**4.1**	**0.260**	**0.042**	**0.210**	**14.7**	**19.3**	**7.3**	**55.0**	**1.50**	**224**	**8269**
Std Dev	**6734**	**5678**	**0.4**	**0.7**	**0.072**	**0.012**	**0.054**	**2.2**	**4.1**	**0.3**	**15.4**	**0.44**	**24**	**2485**

Note: half the detection limit. Greater than 1.50 m.

Table 6: Waihopai River at Woodlands Bridge

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 10:09	1400	730	1.6	2.4	0.048	0.013	0.076	9.0	15.8	6.9	2.7	1.41	178	148
23/01/2006 10:30	1600	400	1.6	2.6	0.030	0.006	0.042	9.5	15.9	6.4	5.9	0.71	188	798
20/02/2006 10:48	310	250	1.9	1.9	0.022	0.007	0.055	11.1	15.3	7.0	2.6	1.34	175	132
20/03/2006 10:01	960	780	2.0	2.8	0.088	0.015	0.078	8.6	12.7	6.7	6.3	0.72	-	497
19/04/2006 10:06	450	370	2.0	2.7	0.045	0.017	0.050	11.2	9.5	6.7	4.1	0.96	118	158
12/05/2006 10:58	20000	15000	2.2	4.1	0.200	0.042	0.190	9.4	9.2	6.4	29.0	0.31	192	2667
16/06/2006 10:17	4600	3800	2.3	3.9	0.230	0.046	0.100	9.1	7.5	6.5	55.0	0.21	178	3109
14/07/2006 10:12	200	190	2.0	2.9	0.028	0.008	0.033	10.9	6.2	6.7	4.3	0.84	188	957
18/08/2006 11:00	450	300	2.3	3.0	0.036	0.008	0.041	10.9	7.8	6.7	5.3	0.89	182	1026
15/09/2006 10:53	1100	730	1.7	2.6	0.065	0.019	0.120	11.9	9.0	6.8	5.1	0.80	171	663
13/10/2006 09:34	770	570	1.8	2.5	0.032	0.008	0.022	5.6	11.2	6.6	3.9	1.46	124	911
17/11/2006 09:15	2900	2900	1.1	2.0	0.025	0.003	0.046	10.0	10.3	6.8	5.1	1.00	169	774
15/12/2006 10:05	420	420	1.8	2.2	0.030	0.020	0.020	11.9	12.0	7.1	6.8	1.50	131	304
Mean	**2705**	**2034**	**1.9**	**2.7**	**0.068**	**0.016**	**0.067**	**9.9**	**11.0**	**6.7**	**10.5**	**0.93**	**166**	**934**
Median	**960**	**570**	**1.9**	**2.6**	**0.036**	**0.013**	**0.050**	**10.0**	**10.3**	**6.7**	**5.1**	**0.89**	**176**	**774**
Min	**200**	**190**	**1.1**	**1.9**	**0.022**	**0.003**	**0.020**	**5.6**	**6.2**	**6.4**	**2.6**	**0.21**	**118**	**132**
Max	**20000**	**15000**	**2.3**	**4.1**	**0.230**	**0.046**	**0.190**	**11.9**	**15.9**	**7.1**	**55.0**	**1.50**	**192**	**3109**
Std Dev	**5342**	**4049**	**0.3**	**0.6**	**0.068**	**0.013**	**0.047**	**1.7**	**3.2**	**0.2**	**15.0**	**0.41**	**26**	**927**

Note: half the detection limit. Greater than 1.50 m.

Table 7: Waihopai River at Dacre SH1

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 08:20	2700	2200	0.4	1.0	0.059	0.012	0.054	7.5	16.9	7.0	2.6	1.1	178	51
23/01/2006 08:30	370	200	1.3	1.7	0.024	0.006	0.022	9.1	14.8	6.6	2.2	1.3	178	275
20/02/2006 08:23	500	300	0.5	1.0	0.034	0.008	0.050	9.6	15.5	6.9	2.3	1.8	157	45
20/03/2006 08:07	680	520	1.1	2.0	0.180	0.028	0.270	8.8	11.9	6.9	4.4	0.8	-	170
19/04/2006 10:23	180	180	0.9	1.3	0.030	0.013	0.014	12.0	9.8	6.9	2.0	1.4	169	53
12/05/2006 11:18	11000	11000	2.0	4.0	0.190	0.029	0.120	9.4	9.3	6.4	19.0	0.4	180	891
16/06/2006 09:10	7000	6500	2.3	5.3	0.360	0.064	0.260	8.8	6.8	6.4	70.0	0.1	172	1019
14/07/2006 10:26	280	200	1.8	2.4	0.023	0.010	0.040	10.8	5.9	6.8	3.8	1.5	179	323
18/08/2006 09:28	590	390	0.2	3.2	0.028	0.013	0.082	10.2	7.1	6.8	6.7	0.6	171	351
15/09/2006 10:30	130	130	1.4	2.0	0.051	0.017	0.041	11.8	8.9	7.0	4.0	1.3	168	224
13/10/2006 08:06	700	700	1.6	2.0	0.032	0.008	0.014	5.2	10.9	6.7	3.5	1.5	114	314
17/11/2006 09:20	18000	16000	0.6	1.7	0.083	0.003	0.060	10.6	10.7	6.9	9.6	0.5	163	262
15/12/2006 08:50	1100	1100	0.9	1.5	0.030	0.020	0.050	11.4	12.2	7.1	3.6	1.5	126	103
Mean	**3325**	**3032**	**1.2**	**2.2**	**0.086**	**0.018**	**0.083**	**9.6**	**10.8**	**6.8**	**10.3**	**1.1**	**163**	**314**
Median	**680**	**520**	**1.1**	**2.0**	**0.034**	**0.013**	**0.050**	**9.6**	**10.7**	**6.9**	**3.8**	**1.3**	**170**	**262**
Min	**130**	**130**	**0.2**	**1.0**	**0.023**	**0.003**	**0.014**	**5.2**	**5.9**	**6.4**	**2.0**	**0.1**	**114**	**45**
Max	**18000**	**16000**	**2.3**	**5.3**	**0.360**	**0.064**	**0.270**	**12.0**	**16.9**	**7.1**	**70.0**	**1.8**	**180**	**1019**
Std Dev	**5481**	**5057**	**0.7**	**1.2**	**0.100**	**0.016**	**0.086**	**1.9**	**3.4**	**0.2**	**18.5**	**0.5**	**21**	**305**

Note: half the detection limit. Greater than 1.50 m.

Table 8: Spurhead Creek at Dacre-Morton Mains Road

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 08:30	2700	1800	0.4	1.3	0.100	0.016	0.090	4.4	17.9	6.9	4.1	0.56	197	450
23/01/2006 08:50	28000	16000	1.3	2.0	0.052	0.010	0.029	8.7	15.1	6.6	6.0	0.61	185	3724
20/02/2006 08:49	900	530	0.5	1.1	0.072	0.016	0.045	6.1	15.8	6.9	4.4	1.00	184	629
20/03/2006 08:35	800	710	1.1	1.8	0.056	0.010	0.013	7.9	12.7	6.8	4.4	0.83	-	2344
19/04/2006 10:33	260	250	0.9	1.3	0.065	0.014	0.016	9.7	9.4	6.8	3.1	0.81	182	749
12/05/2006 11:33	32000	27000	1.8	3.4	0.180	0.045	0.170	9.2	9.1	6.3	14.0	0.41	189	13549
16/06/2006 09:20	7700	6500	2.0	3.6	0.220	0.052	0.098	8.5	6.5	6.4	45.0	0.13	168	15026
14/07/2006 10:37	150	150	1.7	2.7	0.030	0.008	0.014	11.0	5.6	6.8	3.6	1.20	182	3481
18/08/2006 09:37	130	100	0.2	3.3	0.018	0.008	0.016	9.8	7.1	6.9	3.7	1.21	178	242
15/09/2006 10:20	500	470	1.2	1.9	0.034	0.007	0.015	12.1	9.0	7.0	5.0	1.03	168	155
13/10/2006 08:21	800	800	1.4	1.2	0.037	0.008	0.012	4.8	11.0	6.7	4.6	1.28	119	216
17/11/2006 09:30	3800	3300	0.4	1.3	0.077	0.003	0.038	10.1	10.8	6.9	13.0	0.50	162	181
15/12/2006 09:05	910	909	0.7	1.2	0.030	0.020	0.010	11.1	12.2	7.1	3.0	1.31	128	71
Mean	**6050**	**4501**	**1.0**	**2.0**	**0.075**	**0.017**	**0.044**	**8.7**	**10.9**	**6.8**	**8.8**	**0.84**	**170**	**3395**
Median	**900**	**800**	**1.1**	**1.8**	**0.056**	**0.010**	**0.016**	**9.2**	**10.8**	**6.8**	**4.4**	**0.83**	**180**	**689**
Min	**130**	**100**	**0.2**	**1.1**	**0.018**	**0.003**	**0.010**	**4.4**	**5.6**	**6.3**	**3.0**	**0.13**	**119**	**155**
Max	**32000**	**27000**	**2.0**	**3.6**	**0.220**	**0.052**	**0.170**	**12.1**	**17.9**	**7.1**	**45.0**	**1.31**	**197**	**15026**
Std Dev	**10865**	**8065**	**0.6**	**0.9**	**0.061**	**0.015**	**0.048**	**2.4**	**3.7**	**0.2**	**11.5**	**0.37**	**24**	**5255**

Note: half the detection limit.

Table 9: Waihopai South Branch at Longbush Road

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 10:40	1200	770	0.9	1.7	0.085	0.014	0.030	7.6	19.8	7.3	4.5	1.10	213	198
23/01/2006 10:50	1000	530	1.8	2.6	0.029	0.010	0.029	9.9	15.8	6.5	5.4	0.69	196	1071
20/02/2006 11:44	680	540	0.7	1.3	0.077	0.011	0.035	10.6	17.6	7.3	5.7	1.03	203	178
20/03/2006 10:37	1400	930	1.9	2.3	0.170	0.096	0.048	10.1	13.6	6.8	4.1	1.00	-	667
19/04/2006 13:31	240	240	1.2	1.9	0.071	0.021	0.035	13.0	11.9	7.2	7.3	0.35	214	212
12/05/2006 10:25	21000	20000	3.0	5.0	0.180	0.025	0.240	8.2	9.7	6.2	28.0	0.28	213	3650
16/06/2006 10:35	5400	4500	2.7	3.8	0.140	0.019	0.083	8.2	7.5	6.3	40.0	0.19	194	4212
14/07/2006 11:38	100	100	2.4	3.2	0.025	0.006	0.042	10.8	6.6	6.6	4.9	0.68	211	1278
18/08/2006 11:26	900	530	2.7	3.6	0.031	0.007	0.045	10.4	7.5	6.7	6.0	0.79	205	1373
15/09/2006 09:25	1100	830	2.1	2.9	0.031	0.007	0.096	11.0	8.3	6.8	5.5	0.80	191	900
13/10/2006 09:56	630	470	1.8	2.5	0.030	0.007	0.005	5.6	11.6	6.7	5.0	1.26	138	1219
17/11/2006 10:20	1400	1400	1.2	2.1	0.025	0.003	0.044	11.4	11.3	6.6	5.2	0.95	194	1052
15/12/2006 10:40	440	437	1.4	2.1	0.050	0.020	0.005	12.9	13.0	7.3	3.5	1.27	155	410
Mean	**2730**	**2406**	**1.8**	**2.7**	**0.073**	**0.019**	**0.057**	**10.0**	**11.9**	**6.8**	**9.6**	**0.80**	**194**	**1263**
Median	**1000**	**540**	**1.8**	**2.5**	**0.050**	**0.011**	**0.042**	**10.4**	**11.6**	**6.7**	**5.4**	**0.80**	**200**	**1052**
Min	**100**	**100**	**0.7**	**1.3**	**0.025**	**0.003**	**0.005**	**5.6**	**6.6**	**6.2**	**3.5**	**0.19**	**138**	**178**
Max	**21000**	**20000**	**3.0**	**5.0**	**0.180**	**0.096**	**0.240**	**13.0**	**19.8**	**7.3**	**40.0**	**1.27**	**214**	**4212**
Std Dev	**5648**	**5404**	**0.7**	**1.0**	**0.056**	**0.024**	**0.061**	**2.1**	**4.1**	**0.4**	**11.1**	**0.35**	**24**	**1262**

Note: half the detection limit.

Table 10: Waihopai South Branch at Woodlands South

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 09:53	730	630	1.0	1.8	0.120	0.019	0.054	9.5	18.5	6.8	7.0	0.83	209	149
23/01/2006 10:10	640	490	2.2	3.2	0.028	0.007	0.045	9.4	15.5	6.4	7.9	0.62	209	805
20/02/2006 10:29	1000	770	0.4	1.0	0.076	0.015	0.029	10.0	17.3	7.4	9.1	0.71	200	133
20/03/2006 09:41	2400	2100	1.8	2.6	0.056	0.011	0.060	10.2	12.9	6.9	5.7	0.91	-	502
19/04/2006 11:43	710	620	1.2	2.0	0.100	0.022	0.130	9.2	10.3	7.2	9.1	0.38	208	158
12/05/2006 11:53	23000	21000	3.3	5.2	0.120	0.024	0.230	8.3	9.7	6.1	30.0	0.27	210	2707
16/06/2006 09:36	3500	3400	2.9	4.1	0.140	0.018	0.079	8.7	7.5	6.3	38.0	0.24	194	3109
14/07/2006 10:49	380	320	2.4	3.3	0.027	0.006	0.051	11.0	6.5	6.6	6.7	0.70	203	955
18/08/2006 10:13	800	530	2.8	3.8	0.034	0.007	0.056	10.2	7.2	6.6	7.2	0.87	199	1037
15/09/2006 09:40	1100	1100	2.1	2.9	0.036	0.007	0.094	10.4	8.6	6.8	6.2	0.89	187	670
13/10/2006 09:15	530	530	1.8	2.8	0.032	0.008	0.019	5.5	11.1	6.6	5.1	1.15	131	920
17/11/2006 10:10	2500	2500	1.1	2.1	0.054	0.003	0.081	10.4	10.9	6.7	5.6	1.06	187	785
15/12/2006 10:24	474	470	1.6	2.2	0.050	0.020	0.030	11.4	12.7	7.2	3.8	1.50	148	306
Mean	**2905**	**2651**	**1.9**	**2.8**	**0.067**	**0.013**	**0.074**	**9.6**	**11.4**	**6.7**	**10.9**	**0.78**	**190**	**941**
Median	**800**	**630**	**1.8**	**2.8**	**0.054**	**0.011**	**0.056**	**10.0**	**10.9**	**6.7**	**7.0**	**0.83**	**199**	**785**
Min	**380**	**320**	**0.4**	**1.0**	**0.027**	**0.003**	**0.019**	**5.5**	**6.5**	**6.1**	**3.8**	**0.24**	**131**	**133**
Max	**23000**	**21000**	**3.3**	**5.2**	**0.140**	**0.024**	**0.230**	**11.4**	**18.5**	**7.4**	**38.0**	**1.50**	**210**	**3109**
Std Dev	**6114**	**5595**	**0.8**	**1.1**	**0.040**	**0.007**	**0.056**	**1.5**	**3.8**	**0.4**	**10.5**	**0.36**	**25**	**932**

Note: half the detection limit. Greater than 1.50 m.

Table 11: Waihopai South Branch at Waituna-Morton Mains

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 09:29	29000	27000	0.9	2.6	0.370	0.014	0.360	4.4	15.8	6.8	50.0	-	221	51
23/01/2006 09:15	680	530	1.5	2.2	0.022	0.006	0.028	8.5	14.6	6.3	3.8	0.84	186	277
20/03/2006 08:56	370	340	1.4	1.9	0.052	0.012	0.031	9.9	12.3	6.7	3.0	1.16	-	172
19/04/2006 10:50	350	320	1.0	1.5	0.054	0.019	0.030	12.1	10.2	6.9	4.3	1.20	188	54
12/05/2006 11:53	15000	12000	2.5	3.6	0.110	0.016	0.100	8.4	9.7	6.1	15.0	0.44	185	888
16/06/2006 09:36	3700	3000	2.5	4.0	0.140	0.019	0.063	8.6	7.0	6.5	29.0	0.23	177	1048
14/07/2006 10:49	33	33	2.0	2.6	0.020	0.007	0.049	10.7	6.1	6.6	3.2	1.35	185	327
18/08/2006 09:52	730	670	2.0	3.1	0.036	0.009	0.076	9.9	7.1	6.6	5.6	0.88	181	354
15/09/2006 10:10	1200	1200	1.8	2.6	0.019	0.006	0.023	11.1	8.6	6.6	3.5	1.35	168	227
13/10/2006 08:40	930	830	1.7	2.0	0.028	0.006	0.017	4.8	10.8	6.5	3.0	1.28	118	316
17/11/2006 09:40	2700	2500	0.8	1.6	0.025	0.003	0.070	9.3	10.3	6.6	5.2	1.19	168	266
15/12/2006 09:27	602	600	2.4	2.7	0.050	0.010	0.060	9.4	12.0	6.6	14.0	1.39	139	104
Mean	**4608**	**4085**	**1.7**	**2.5**	**0.077**	**0.011**	**0.076**	**8.9**	**10.4**	**6.6**	**11.6**	**1.03**	**174**	**340**
Median	**830**	**750**	**1.8**	**2.6**	**0.043**	**0.010**	**0.055**	**9.4**	**10.3**	**6.6**	**4.8**	**1.19**	**181**	**272**
Min	**33**	**33**	**0.8**	**1.5**	**0.019**	**0.003**	**0.017**	**4.4**	**6.1**	**6.1**	**3.0**	**0.23**	**118**	**51**
Max	**29000**	**27000**	**2.5**	**4.0**	**0.370**	**0.019**	**0.360**	**12.1**	**15.8**	**6.9**	**50.0**	**1.39**	**221**	**1048**
Std Dev	**8718**	**7928**	**0.6**	**0.8**	**0.100**	**0.005**	**0.093**	**2.3**	**3.0**	**0.2**	**14.4**	**0.39**	**27**	**312**

Note: half the detection limit.

Table 12: Waihopai River Tributary at Waituna-Morton Mains

Time	FC	E-coli	NNN	TN	TP	DRP	NH4	DO	Temp	pH	Turb	Clarity	EC	Flow
	CFU/100ml	CFU/100ml	g/m3	g/m3	g/m3	g/m3	g/m3	mg/l	ºC		NTU	m	µS/cm	l/s
19/12/2005 08:44	6200	4800	0.5	1.5	0.140	0.100	0.140	6.9	16.4	7.0	8.4	0.55	204	25
23/01/2006 09:40	200	100	2.9	3.8	0.010	0.005	0.033	10.3	13.9	6.1	2.4	-	217	136
20/02/2006 10:10	40	40	0.5	1.7	0.200	0.019	0.300	7.5	17.2	6.8	18.0	-	212	22
20/03/2006 09:16	230	190	2.1	3.2	0.037	0.008	0.042	8.1	12.1	6.3	2.5	1.06	-	84
19/04/2006 11:26	80	50	1.2	1.6	0.044	0.015	0.099	8.1	10.5	6.4	11.0	0.41	208	27
12/05/2006 12:02	1800	1200	5.0	5.9	0.085	0.013	0.096	9.2	10.2	6.0	9.6	-	210	435
16/06/2006 09:45	230	190	4.3	5.6	0.410	0.011	0.028	8.9	7.8	6.1	8.1	0.47	202	517
14/07/2006 11:00	100	33	3.2	4.0	0.014	0.003	0.029	10.6	6.8	6.4	3.1	1.01	204	161
18/08/2006 10:42	270	130	3.7	4.6	0.029	0.005	0.035	9.8	7.6	6.3	5.3	-	197	173
15/09/2006 10:00	50	50	3.0	3.6	0.013	0.005	0.024	10.9	8.6	6.4	2.1	1.25	188	112
13/10/2006 08:52	200	200	1.5	3.2	0.024	0.006	0.021	4.7	10.3	6.3	2.6	1.45	133	155
17/11/2006 09:50	2500	1800	1.9	3.0	0.025	0.003	0.110	8.4	10.1	6.4	3.7	1.35	203	131
15/12/2006 09:50	313	310	1.1	1.6	0.040	0.020	0.040	8.6	11.0	6.8	5.6	-	137	51
Mean	**939**	**699**	**2.4**	**3.3**	**0.082**	**0.016**	**0.077**	**8.6**	**11.0**	**6.4**	**6.3**	**0.94**	**193**	**156**
Median	**230**	**190**	**2.1**	**3.2**	**0.037**	**0.008**	**0.040**	**8.6**	**10.3**	**6.4**	**5.3**	**1.04**	**204**	**131**
Min	**40**	**33**	**0.5**	**1.5**	**0.010**	**0.003**	**0.021**	**4.7**	**6.8**	**6.0**	**2.1**	**0.41**	**133**	**22**
Max	**6200**	**4800**	**5.0**	**5.9**	**0.410**	**0.100**	**0.300**	**10.9**	**17.2**	**7.0**	**18.0**	**1.45**	**217**	**517**
Std Dev	**1752**	**1342**	**1.4**	**1.5**	**0.113**	**0.026**	**0.078**	**1.7**	**3.2**	**0.3**	**4.6**	**0.41**	**28**	**153**

Note: half the detection limit.