Patterns of Water Quality in the Pomahaka Catchment

Otago Regional Council 2010

Otago Regional Council

Executive summary

Water quality in the lower Pomahaka catchment has been decreasing for a number of years, while land use has rapidly intensified. The catchment has poor draining pallic soils, which has resulted in tile-and-mole drainage being installed to improve grazing land-use. The deterioration in water quality has been largely caused by the management practices employed on this tile-and-mole drainage network.

The Otago Regional Council (ORC) conducted a 12-month water quality sampling programme, with the aim of getting a better understanding of the effects of land use on water quality in the Pomahaka catchment. Specifically, the purpose of the investigation was to:

1. Determine the spatial and seasonal patterns of water quality within the catchment.
2. Monitor the effects tile drains have on water quality in both dairy and mixed sheep and beef land use units within the catchment.
3. Determine the effects that degrading water quality has on ecological values.
4. To provide information that will aid policy decisions to halt this decline and ultimately improve water quality in the catchment.

This study was based on water quality, habitat condition and ecological values. It did not include views from iwi, local community or other stakeholders, such as recreational values or socio-economic benefits. However, the results will become part of the future debate of acceptable land use practices in the catchment.

The Pomahaka catchment is located in south-west Otago, the upper half being steep and dominated by tussock, while the lower areas are primarily pastoral rolling hill country. The most significant recreational pursuits in the area are angling and game bird hunting. The Otago Regional Plan: Water lists many natural values for the Pomahaka River, including high fish and macroinvertebrate diversity and a regionally significant brown trout fishery.

Land use is approximately 50% sheep and beef grazing, with dairy, deer and forestry being less common forms of agriculture. However, between 1999 and 2008 the number of dairy farms increased from 34 to 105, with the average size of the dairy farm also increasing from 179 to 197 ha.

Table E-1 shows the different types of land use for each sub-catchment area.

Table E-1 land use for each sub-catchment area

Site	Catchment area (km^2)	% Catchment Dairy	% Catchment Sheep and Beef	% Catchment Forest/Native cover
Washpool	35	79	21	0
Wairuna	39	51	49	0
Waipahi Upper	15	0	100	0
Waipahi Lower	299	1	96	3
Leithen Burn	72	0	60	40
Heriot Burn Upper	25	12	64	24
Heriot Burn Lower	142	15	73	12
Waikoikoi	116	20	80	0
Pomahaka Upper	714	0	94	6
Pomahaka Lower	1881	7	80	13
Spylaw Burn	167	1	99	0
Flodden Creek	43	26	30	44
Black Gully Upper	6	0	0	100
Black Gully Lower	25	36	40	24
Crookston Burn	32	44	31	25

Methodology

Chemical, physical and biological monitoring was undertaken at sites throughout the catchment (Figure E-1). Between November 2008 and November 2009, 15 streams (three headwater sites and 12 lowland sites) were sampled every two weeks. In addition to stream sampling, 21 tile drains were sampled monthly. Representative tile drains were selected from paddocks draining dairy (12 tile drains) and sheep paddocks (9 tile drains). At each site water samples were collected and analysed for: Total Phosphorus (TP); Total Nitrogen (TN); Nitrite-Nitrate-Nitrogen (NNN), Ammoniacal Nitrogen (NH4); Dissolved Reactive Phosphorus (DRP); Escherichia coli (*E. coli*); and Suspended Solids (SS).

Macroinvertebrate and fishery values were assessed at all 15 sites by physical habitat monitoring (sedimentation and habitat availability); and biological monitoring (macroinvertebrate and fish sampling).

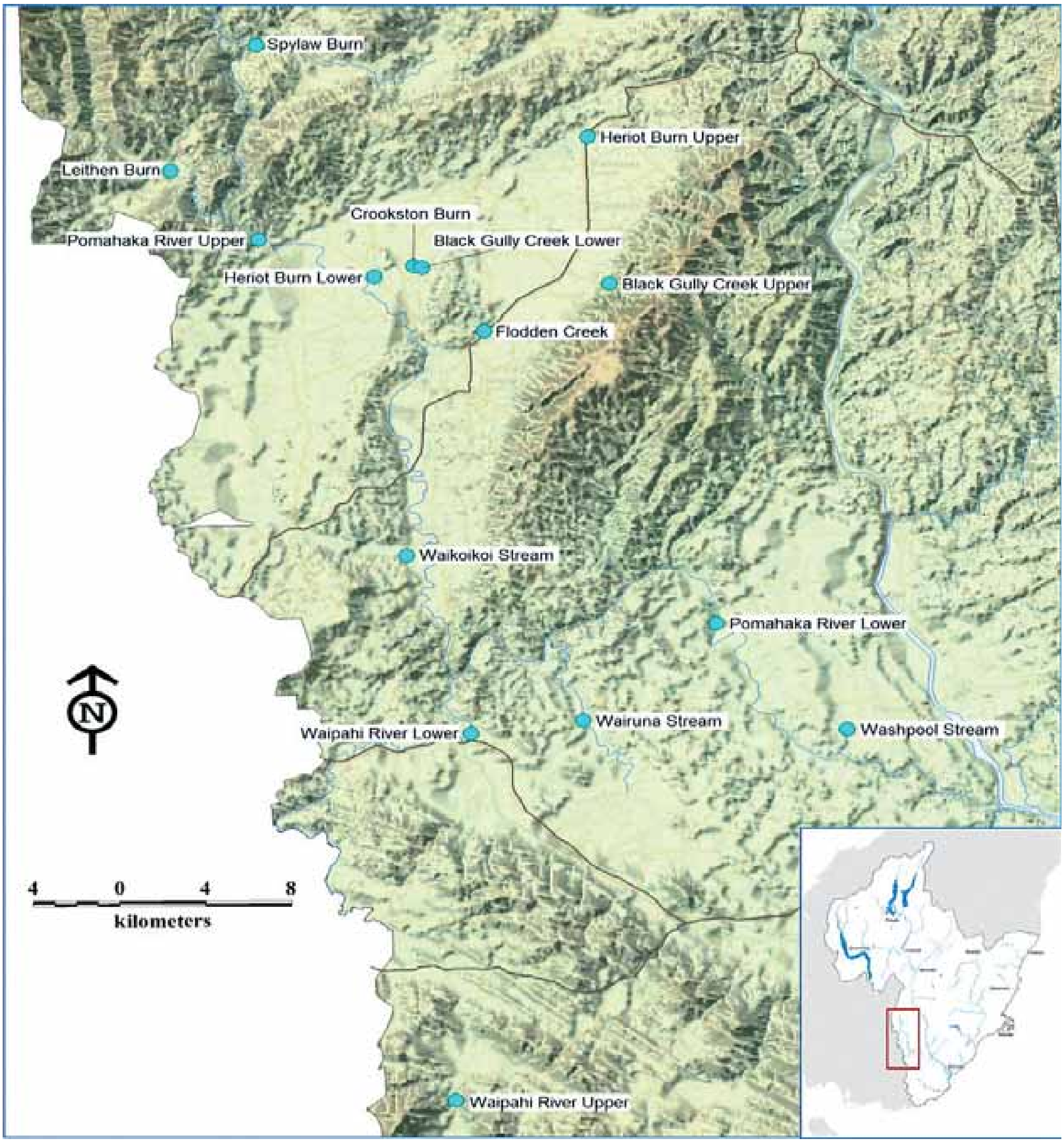

Fig E-1 Stream sampling sites in the Pomahaka catchment

The guideline values used were chosen to reflect the nature of the Pomahaka catchment, and in particular the recognition that the Pomahaka River is a regionally-significant trout fishery. Where possible, guideline standards reflecting discernable effects on ecology, angling and contact recreation have been used (Table E-2)

Table E-2: Physico-chemical and microbiological analytes and guideline values.

Analyte	Guideline Value	Ecological Effect
NH4	<0.9*	High levels of ammonia are toxic to aquatic life, especially fish. The level of total ammonia in water should be less than 0.88 grams per cubic metre to be safe for fish. Ammonia in waterways comes from either waste waters or animal wastes (dung and urine).
NNN	<0.295**	The biologically available component of TN, an excess of this nutrient may cause nuisance algal growths.
TN	<0.614*	Encourages the growth of nuisance aquatic plants. These plants can choke up waterways and out-compete native species. High levels can be a result of runoff and leaching from agricultural land.
DRP	<0.026**	The biologically available component of TP, an excess of this nutrient may cause nuisance algal growths
TP	<0.033*	Encourages the growth of nuisance aquatic plants which can choke up waterways and out-compete native species. High levels can be a result of either wastewater or, more often, runoff from agricultural land.
E. coli	<126*** (^1) <260 (^2) 260-550 (^3) <550	*E. coli* bacteria are used as an indicator of the human health risk from harmful micro-organisms present in water, for example from human or animal faeces.
SS	<7.2^^	Suspended solids smother larger substrate reducing available habitat for macroinvertebrates and fish. Nutrients may attach to sediments. High levels may clarity and affect photosynthesis, high levels would also makes it difficult for fish and other animals to see their prey.
*ANZECC & ARMCANZ (2000), **Biggs (2000), ***ANZECC (1992), ^MfE/MoH (2003) - ^1 = acceptable level, ^2 = alert level, ^3 = action level, ^^Cawthron (1999)/ ORC 2010: This value is based on taking the 5 NTU (turbidity) guideline recommended by Cawthron (1999) as the value that compromises trout growth potential and then applying the NTU value to a regression equation that was based on long turbidity and SS data from our sampling site at Pomahaka at Burkes Ford (Lower).		

Tile drain water quality

The tile drains flowed on average 55% of the time, with little difference between the differing land uses (dairy 57% and sheep 52%). Four of the tiles flowed on at least 11 out of 12 sampling occasions. There was a general seasonal pattern to the flow, with the late autumn through to early spring period showing saturated soils and high flow rates. Early spring, in particular, would be a high-risk time from agricultural pollution, when dairy herds return from wintering locations.

The sampling showed that concentrations of NNN, DRP, TP, TN and SS are much higher in tile drains draining dairy pasture than sheep pasture. NNN and TN are likely linked to animal stocking rate, effluent application, as well as urine patches in dairy pasture.

There was no major difference between *E. coli* concentrations in tile drains draining dairy or sheep farms. The key exception to this is that during dry periods *E. coli* levels were found in samples from tiles which had recently had effluent applied to a paddock.

Stream water quality

The key indicators for water quality are nutrients (N and P) and *E. coli*. Prolific algal growths depend on the availability of N and P and have negative impacts on streams by smothering habitat, and stripping waterways of oxygen at night. This can lead to fish kills and the displacement of macroinvertebrates. *E. coli* is the indicator for faecal contamination which has entered the waterway through runoff from pastoral land, tile drainage or wildlife.

Generally, the upstream control sites had the best water quality. The land use for these sites was dominated by sheep and beef, with also at least 10% forest cover. The worst streams for water quality (Washpool and Wairuna) had the highest proportions of dairy farming (79% and 51% respectively).

Physical habitat condition

The results of the habitat surveys showed there is degradation in habitat condition in many of the tributaries to the Pomahaka River. There was generally a notable increase in finer sediment as the streams flowed through productive land. The sources of the fine sediment were unvegetated banks that showed active erosion, and which had signs of stock access (Figure E1). This was observed particularly in the Wairuna and Washpool streams, and the Heriot and Crookston burns. The Washpool stream was the most heavily sedimented stream with an estimated 100% sediment cover.

Figure E-1: Stock access and bank slumping/collapse.

Land use effects on ecological instream values

It was necessary to look at multiple stressors (chemical, physical and community structure) together to gain a better understanding of ecological effects. Each site was graded either Excellent, Good, Fair or Poor for chemical, physical habitat, macroinvertebrate and trout fishery values (Table E-3).

Table E-3 shows degraded water quality was not necessarily related to degraded ecological values; as indicated by Crookston Burn at Walker Road which had poor water quality, but good fishery values. This was because poor water quality does not generally have toxicological effects. A degraded ecological value is often correlated with other factors such as sedimentation, changes in ecosystem function and structure, and the loss of riparian vegetation.

The control sites had excellent or good water quality, excellent physical habitat structure, good or excellent macroinvertebrate communities, and excellent or good fishery values. This was in contrast to the Washpool and Wairuna Streams, which had poor water quality, physical habitat, macroinvertebrates (except at the Washpool) and poor fishery values. These results of severely-degraded trout fishery values are most likely the result of significant habitat degradation through sedimentation.

Table E3: Summary of categories for Chemical, Physical Habitat, MCI and Trout condition related density for each stream.

Site	% catchment dairy farm	Chemical and Bacteria	Physical Habitat	MCI	Trout density/ condition
Leithen Burn	0	Excellent	Excellent	Excellent	Excellent
Pomahaka @ Glenken (Upper)	0	Good	Excellent	Excellent	n/a*
Black Gully (Upper)	0	Good	Excellent	Excellent	Good
Spylaw Burn	1	Fair	Good	Fair	Excellent
Pomahaka @ Burkes Ford (Lower)	7	Fair	Good	Good	n/a*
Flodden @ SH90	26	Good	Good	Good	Good
Crookston Burn @ Walker	44	Poor	Good	Good	Good
Heriot Burn (Upper)	12	Fair	Poor	Good	Good
Waikoikoi	20	Fair	Good	Fair	Fair
Waipahi @ Waipahi (Lower)	1	Fair	Good	Fair	n/a*
Heriot Burn (Lower)	15	Fair	Good	Fair	Fair
Waipahi @ Cairns Peak (Upper)	0	Poor	Poor	Good	Fair
Black Gully (Lower)	36	Poor	Poor	Good	Fair
Washpool @ Kilhastie	79	Poor	Poor	Fair	Poor
Wairuna @ Clydevale Rd	51	Poor	Poor	Poor	Poor

*n/a means density data could not be collected as the river was too wide to effectively net.

Conclusions

The main conclusions from the study were:

1. Water quality data from surface water and tile drains have been collected and analysed. The sites were representative of different land uses; specifically sheep and beef; and dairy.
2. Degraded water quality, physical habitat and ecological values can be attributed in many cases to poor land management practices.
3. Upstream control sites generally had excellent water quality. Catchments with a high proportion of land under sheep and beef farming had good water quality, while catchments with an increasing proportion of dairy farms had increasingly poorer water quality. The exceptions to this were the Flodden Creek catchment (26% dairy) which maintains good water quality; and Waipahi River Upper (0% dairy) which has poor water quality. *E. coli* levels were generally above guideline levels throughout the catchment, but were higher in dairying areas during low to median flows.
4. All catchments with more than 30% of the catchment under dairy farming had poor water quality.
5. Tiles draining dairy farms had more DRP, SS, TN and NNN than those draining sheep farms.
6. *E. coli* levels were high from both dairy and sheep tile drained land after rainfall (the highest two values recorded were from sheep farm drains). High *E. coli* values were also recorded from dairy farm tile drains during dry weather. However, in six of the 11 samples, both the sheep and dairy drained farms recorded *E. coli* concentration below the 260 cfu/mL guideline.
7. In-stream effects-based guidelines and an ecological value classification have been used to understand the effects of water quality degradation and habitat health. These have shown that the main issues of concern to the health of the river system are sediment, *E. coli* and DRP. Each of these are linked to poor land management practices.
8. NNN concentrations are only an ecological issue during summer low flows as NNN is rapidly flushed from the system during high flows.
9. Results from this study indicate sediment is an issue all year round, at all flow levels. Sediment control is critical as it can smother habitat, harbour bacteria, and bind P. P previously bound to sediment can be released back into the system during the low flow periods potentially increasing algal growth. *E. coli* that has been harboured in sediment can be released by sediment disturbance at times of low flow when contact recreational activities are most likely to occur.
10. Water quality values from both the stream and tile sites provide the basis for calculating in-stream standards and tile discharge standards. These could form the basis of community discussion prior to any future policy changes aimed at maintaining or improving ecological values.

Pomahaka River at Glenken.

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