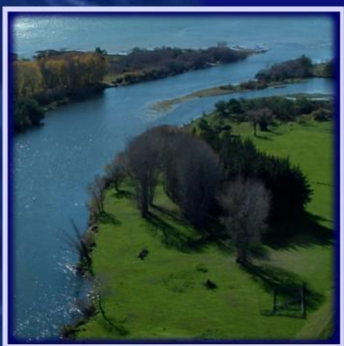
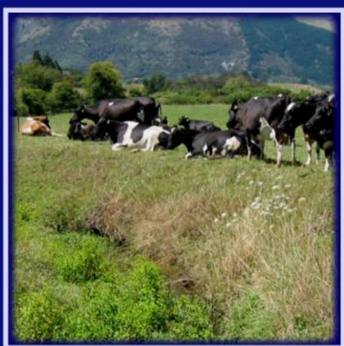
tasman district council

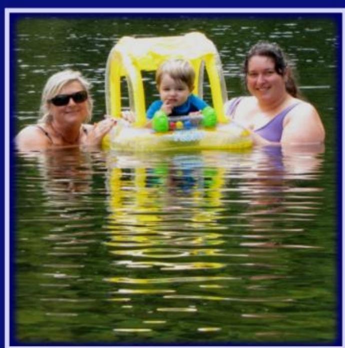
State of the Environment Report

River Water Quality in Tasman District

2015







State of the Environment Report

River Water Quality in Tasman District 2015

Document Status: Final

A technical report presenting results of the Tasman District Council's 'State of the Environment' River Water Quality Monitoring Programme and additional data from the National River Water Quality Network. Indicators measured include: physical, chemical, and bacteriological characteristics of the water, macroinvertebrate indices and periphyton cover. The report highlights water quality condition and trends, from the Waimea, Motueka, Takaka, Aorere and Buller water management areas.

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Tasman District Council Ref: 15001
File Ref: G:\Environmental\Trevor_James\Surface_Water_Quality\Reports\SER_2015\

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Recommended citation:
James, T and McCallum, J 2015. State of the Environment Report: River Water Quality in Tasman District 2015. Prepared for Tasman District Council.

Cover photos:

1. Claire Webster at the Aorere River
2. Koura from Dall Ck, Golden Bay
3. Jimmy Lee Ck, Washbourne Gardens
4. Mouth of the Motueka River
5. McConnon Ck, Golden Bay
6. Bathers at the Lee River Reserve

Photos taken by Trevor James and Jonathan McCallum.

1	2	3
4	5	6

Contents

Buller Water Management Area

This area includes the whole of the Buller catchment that is within the Tasman District boundary (Figure 1). This includes from Nelson Lakes, Owen, Matiri, Mangles, Matakitaki, Maruia Valley up to Boundary Rd, and Buller main stem about half way to Lyell from Maruia confluence. As of 2015, a 'Freshwater Management Unit' (FMU) under the 'National Policy Statement for Freshwater Management' has not yet been formally set up for this area. Like the Takaka and Waimea FMU's that have been operating from 2014, there will be a collaborative governance group from the community tasked with making recommendations for limits on water quality and quantity.

Between 2010 and 2014, there were five River Water Quality sites monitored in the Buller Water Management Area. There were no reference sites in this Water Management Area.

The Buller catchment contains the majority (about 35 km) of braided river in the district, a habitat that is used by the following threatened birds: Black-billed gull, Banded dotterel, Oystercatchers, and Black-fronted tern. The main braided sections exist in the Buller from Teetotal Flat to Kawatiri Junction, lower Howard River, and Matakitaki River from Nardoo Creek to Mammoth Flat.

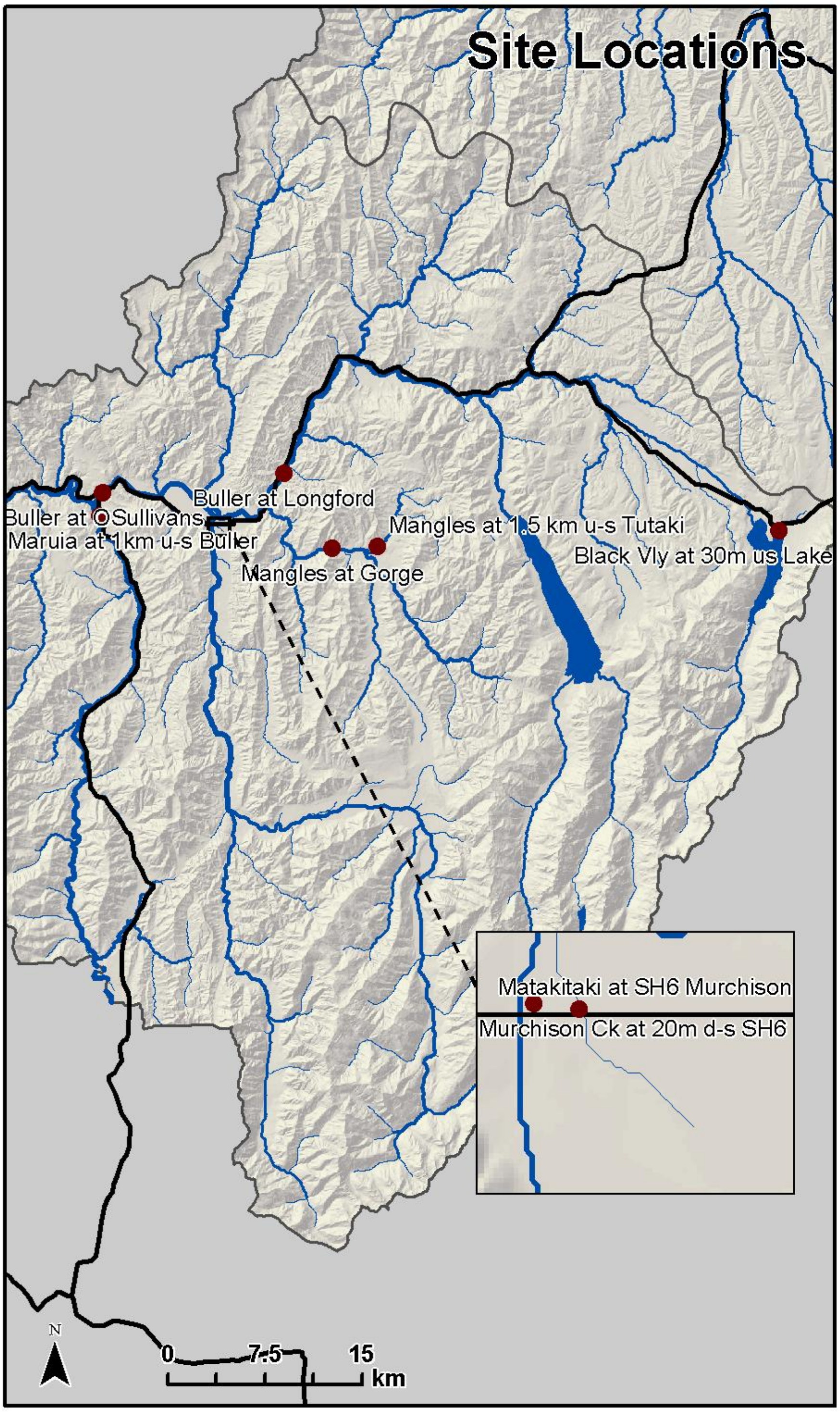


Figure 1. River Water Quality sites in the Buller Water Management Area. Note the Buller at Longford site is sampled at over the full range of river flows whereas the other sites are not.

Discussion of Specific Catchments/Areas

This section describes the more **notable aspects of water quality in a given catchment, actions taking place, and recommendations** for further action.

The key to the colour-coding for each water quality attribute state (A to D) is shown to the right. The cut-offs used for each attribute are shown in Table 1.

The dataset used to determine the attribute states was collected at base-flow over the period from 2010-2014 unless a comment is made otherwise. White (no colouring) indicates there are no data available to determine the attribute state.

Attribute State
A (Excellent)
B
C
D (Poor)

Trends in water quality attributes are reported if they are statistically significant (p-value<0.05) and ecologically meaningful (RSKSE>1%). An increasing trend can have a positive or negative effect on the stream ecosystem, depending on the attribute. To indicate the ecosystem effect of the trend, we have used a smile symbol (☺) for improving trends and a frown symbol (☹) for degrading trends.

Table 1. Numerical attribute states for each water quality attribute for the protection of river ecosystem health, aesthetics, and human health. Attributes highlighted in blue are included in the National Policy Statement for Freshwater Management (NPSFM 2014).

Attribute	Statistic	Units	Attribute State				Source
			A	B	C	D	
Water clarity	Single measurement	m	≥5	3 - 5	1.6 - 3	<1.6	-
Turbidity	Single measurement	NTU	≤5.6	>5.6	N/A	N/A	ANZECC & ARMCANZ (2000)
Resuspendable solids	Shuffle score (1 to 5)	N/A	1	2	3	≥4	-
Dissolved oxygen concentration	7-day mean minimum	g/m^3	≥8	7 - 8	5 - 7	<5	NPSFM (2014)
	Lowest 1-day minimum	g/m^3	≥7.5	5 - 7.5	4 - 5	<4	
Water Temperature	Midpoint of daily mean and daily maximum	^{o}C	≤18	18 - 20	20 - 24	>24	Davies-Colley et al. (2013)
pH	Single measurement	N/A	6.5 - 8.5	5 - 6.5, 8.5 - 9	>5 or >9	N/A	-
Ammonia-N	Annual median	g/m^3	≤0.03	0.03 – 0.24	0.24 - 1.3	>1.3	NPSFM (2014)
	Annual maximum	g/m^3	≤0.05	0.05 - 0.4	0.4 - 2.2	>2.2	
Nitrate-N	Annual median	g/m^3	≤1.0	1.0 - 2.4	2.4 – 6.9	>6.9	NPSFM (2014)
	Annual 95^{th} percentile	g/m^3	≤1.5	1.5 - 3.5	3.5 - 9.8	>9.8	
Dissolved reactive phosphorus	Single measurement	g/m^3	<0.01	≥0.01	N/A	N/A	ANZECC & ARMCANZ (2000)
E. coli	Annual median	CFU/100 ml	≤260	260 - 540	540 - 1000	>1000	NPSFM (2014)
	95^{th} percentile	CFU/100 ml	≤260	260 - 540	540 - 1000	>1000	
Macroinvertebrates	MCI	N/A	≥120	100 - 120	80 - 100	<80	Stark & Maxted (2007)
	SQMCI	N/A	≥6	5 - 6	4 - 5	<4	
Phormidium	Percentage cover	%	<20	≥20	N/A	N/A	MfE (2009)
Filamentous green algae	Percentage cover	%	<10	10-19	20-29	>30	Biggs and Kilroy (2000)
Periphyton	Periphyton score (1 to 10)	N/A	≥8	6 - 8	5 - 6	< 5	-

How to read a site summary

The site summaries in this report are based on data collected quarterly (monthly for selected sites) from 2010-14, with two exceptions: (1) macroinvertebrate community index values were from 2011-2015 and (2) dissolved oxygen measurements were taken over several days in a summer period from 2005-2015.

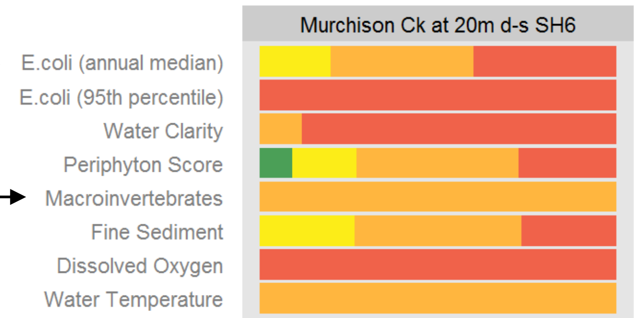
The rows of a site summary represent water quality attributes. The colours indicate attribute states **A** (very good), **B** (good), **C** (fair) **D** (poor).

Proportion of periphyton scores in each attribute state.

Proportion of water clarity measurements (m) in each attribute state.

Attribute state for the 95th percentile *E. coli* concentration. Minimum 10 samples.

Attribute states for the annual median *E. coli* concentration. No minimum sample size.



Proportion of macroinvertebrate community index (MCI) values in each attribute state.

Attribute state for the highest midpoint of daily mean and daily maximum temperature from a continuous record.

Attribute state for the mean minimum dissolved oxygen concentration over 3 or more days during summer. For sites with fewer than 3 days of continuous measurements, the 1-day minimum value was used.

Proportion of resuspendable solids (fine sediment) scores in each attribute state.

Water Clarity

Water clarity in the main stem and major tributaries of the Buller catchment is good or excellent (Band A >5 m or B > 3 m) for the majority of the record (Figure 2). The lower Matakitaki site at SH6 has some lowered water clarity at times, most likely due to on-going slips in the upper Glenroy catchment. Water clarity in the upper Matakitaki (upstream of Glenroy River) is exceptionally high (maximum recorded 24.5 m upstream of Nardoo Creek). Slips in the upper Howard River (within Nelson Lakes National Park) appear to have affected the Longford water clarity results and slips in indigenous forest in the upper Mangles catchment have affected the Mangles water clarity results. Unlike the Matakitaki, these slips appear to have stabilised and water clarity is improving again. The Buller at Longford site is sampled over the full range of river flows, wheras the other sites are not.

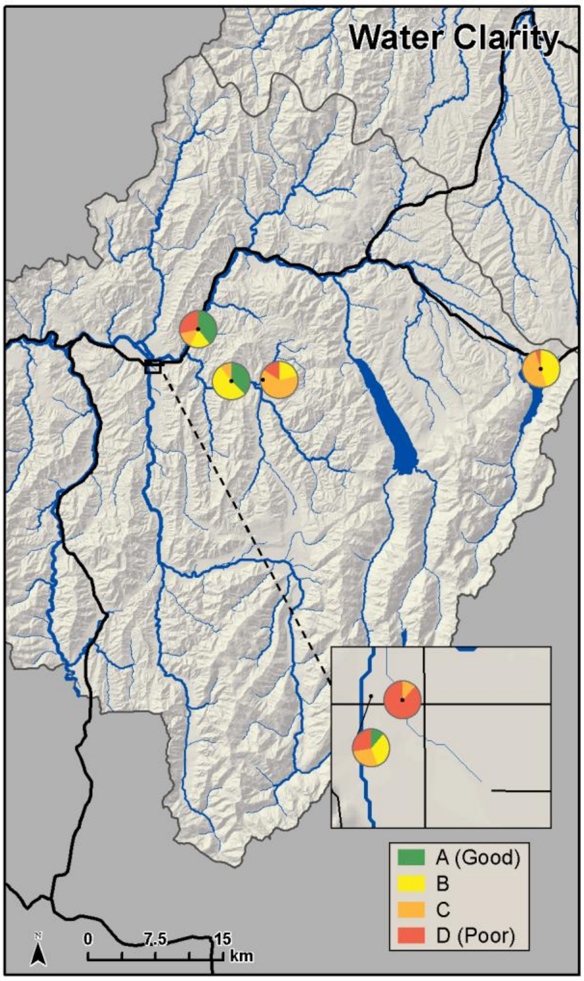


Figure 2. Proportion of water clarity records in each attribute state (A to D) for river water quality sites in the Buller Water Management Area (sites shown have a minimum of 10 samples).

Disease-causing organisms

At all sites monitored in the Buller Water Management Area, except Murchison Creek, the annual median *E. coli* concentrations were in the A band (less than 260 *E. coli*/100 ml) (Figure 3).

The overall median for Murchison Creek at SH6 was 960 (2005-2015). The annual median *E. coli* concentration for this site was over double the National Bottom Line (1000 *E. coli*/100 ml) in 2010 (median value 2200 *E. coli*/100 ml). The annual median value for 2014 was right on the National Bottom Line (median value 1000 *E. coli*/100 ml). These results make this site the worst performing, in terms of *E. coli* concentrations, in the Tasman District.

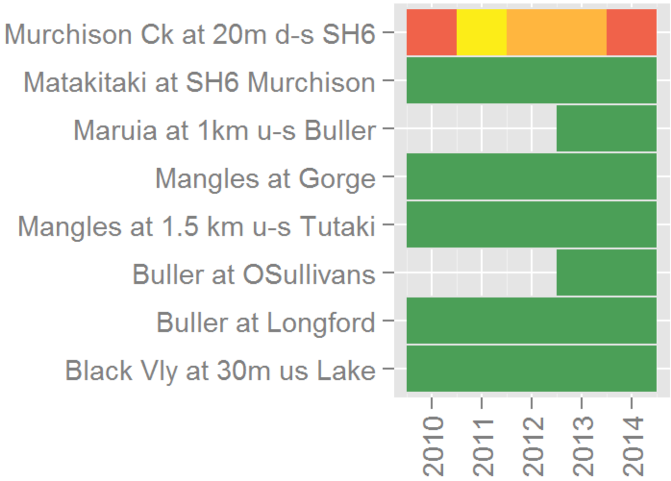


Figure 3. Tile plot of annual median *E. coli* values for sites in the Buller Water Management Area. Colours indicate attribute states A (green), B (yellow), C (orange) and D (red). Blanks indicate insufficient data (less than three records in a given year).

Filamentous Green Algae Cover & Periphyton Score

The coverage of filamentous green algae was most often in the A band (less than 10% coverage) or B band (less than 30% coverage) at all sites in the Buller Water Management Area (Figure 4). The exceptions were one record of moderate filamentous algae coverage from Mangles at 1.5km u-s Tutaki and two records of high coverage (greater than 50%) from Murchison Ck at 20 m d-s SH6. A similar pattern was seen in the periphyton scores[1]. That is, most periphyton scores were in the A or B bands across the Buller Water Management Area. Murchison Ck at 20 m d-s SH6 had a high proportion of periphyton scores in the C (< 30% coverage) or D bands (> 30% coverage), indicating poor water quality at this site.

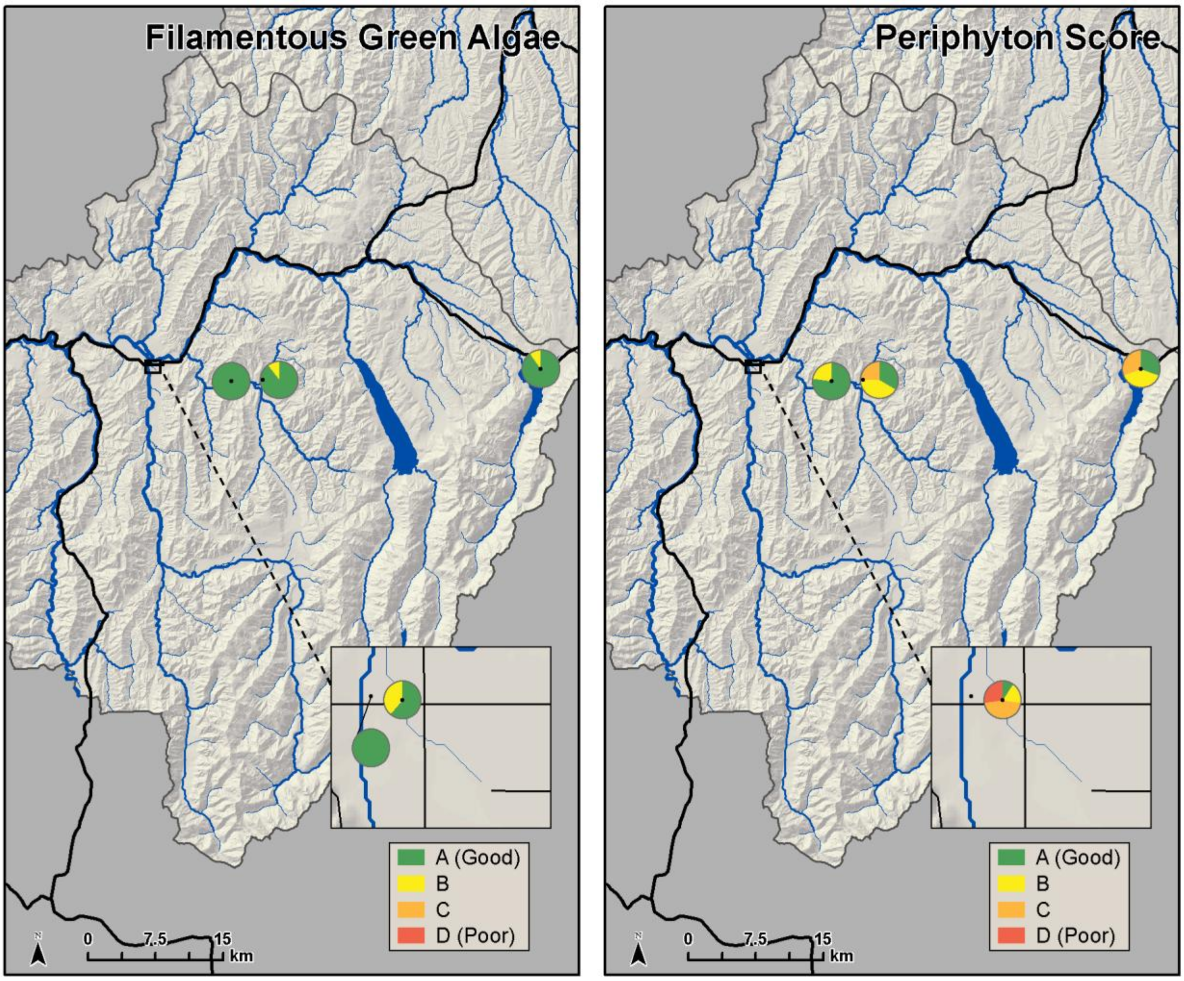


Figure 4. Coverage of filamentous green algae greater than 2cm in length (left) and periphyton community score (right) for sites in the Buller Water Management Area. Pie charts show the proportion of estimates in each attribute state (A to D) for sites with 10 or more observations (2010 to 2014 data).

[1] Rapid Assessment Method 2, NZ Periphyton Monitoring Manual, 2000.

Nutrients

At the two sites with nutrient results, Black Vly at 30 m u-s Lake and Buller at Longford, annual median nitrate concentrations were in band A (less than 1 g/m^3). Annual median ammonia concentrations at both sites were in band A (less than 0.03 g/m^3) and dissolved reactive phosphorus concentrations were satisfactory (less than 0.01 g/m^3).

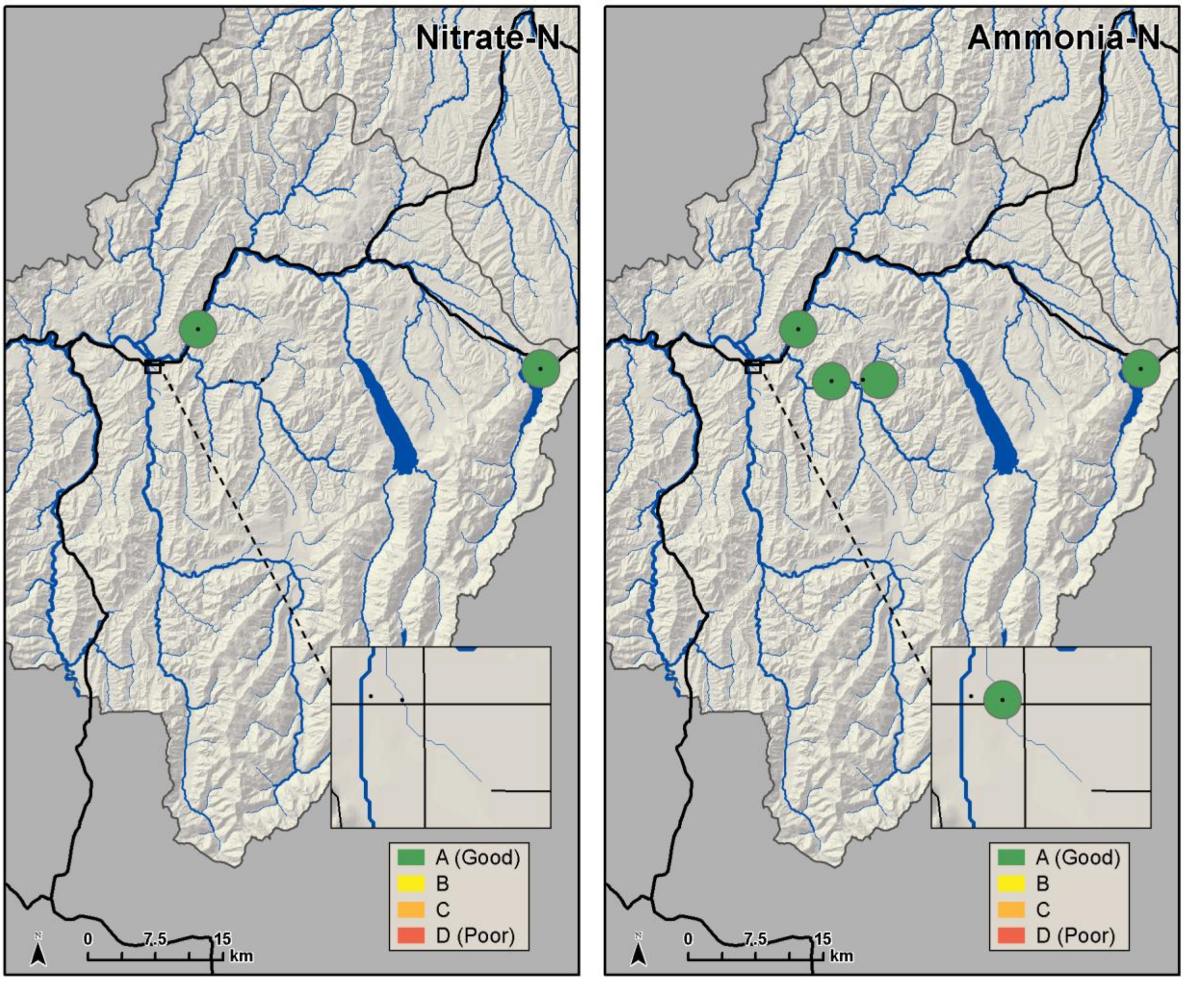


Figure 5. Nitrate (left) and ammonia (right) concentrations for sites in the Buller Water Management Area. Pie charts show the proportion of annual medians in each attribute state (A to D) for sites with 10 or more observations (2010 to 2014 data). Note that nitrate was not sampled in the Matakitaki and Murchison Creek in the inset box.

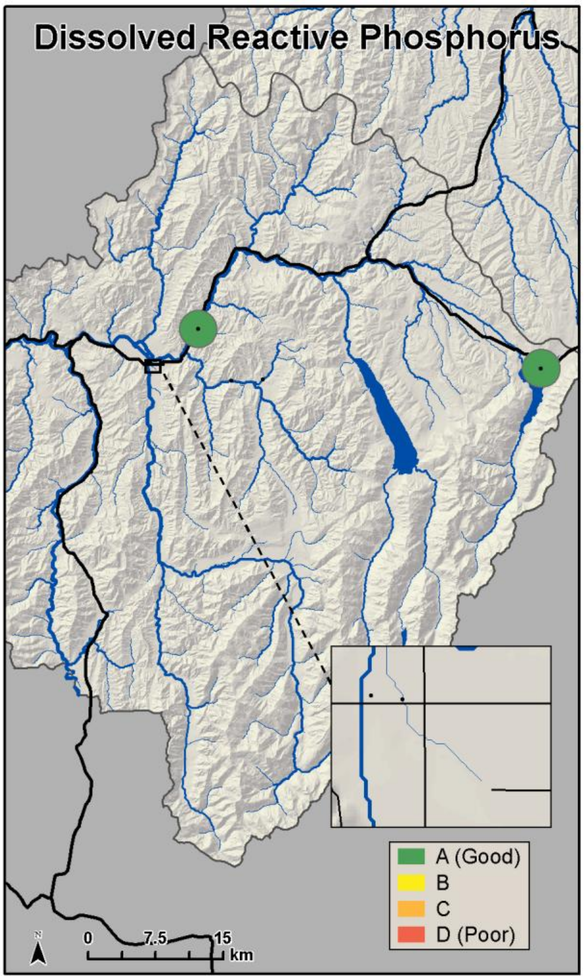


Figure 6. Dissolved reactive phosphorus concentrations for sites in the Buller Water Management Area. Pie charts show the proportion of records in each attribute state (A to D) for sites with 10 or more observations (2010 to 2014 data).

Resuspendable Sediment

There were several 'poor' re-suspendable solids scores recorded here (only 4 out of 18 scores were less than 2) indicating persistent problems with fine sediment deposition (Figure 7). While re-suspendable solids were not assessed in pools, fine sediment depths were measured with some areas over 500 mm. This is a rapid test and therefore can be easily achieved at a larger number of sites than the volumetric SBSV which is generally carried out at sites where there are sediment issues.

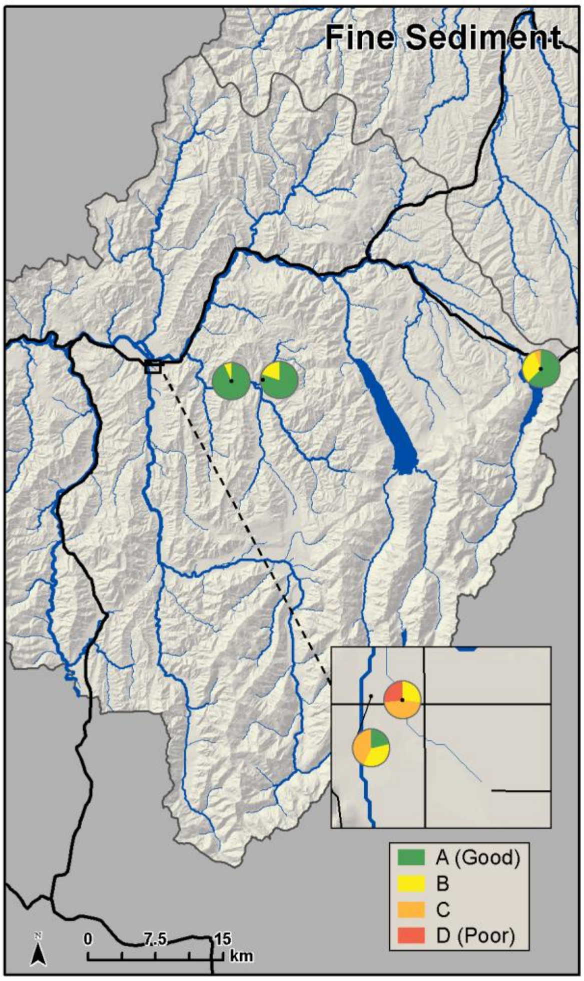


Figure 7. Proportion of resuspendable solids scores in each attribute state (A to D) for sites in the Buller Water Management Area.

Murchison Ck at 20 m d-s SH6 was the only site in the Buller Water Management Area for which there were records of volumetric SBSV (Figure 8). At this site, there was no difference in mean volumetric SBSV between 2013 and 2015.

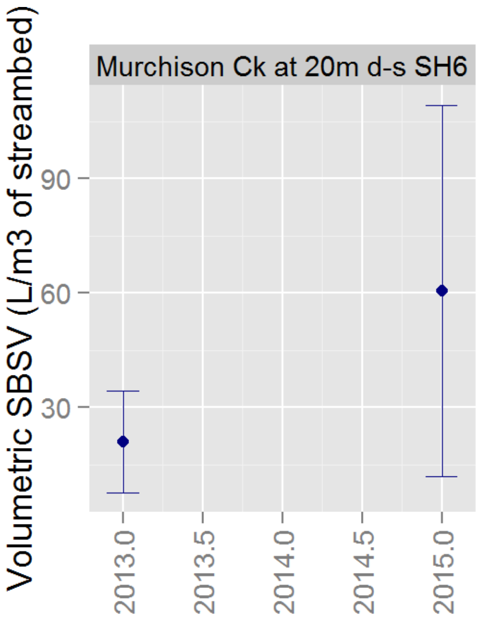


Figure 8. Mean volumetric suspendable benthic sediment volume (SBSV) from 2013 to 2015 (sampled during summer). The error bars show 95% confidence intervals.

Macroinvertebrate Community

At least three macroinvertebrate samples were collected from five sites in the Buller catchment from 2001 to March 2015 (Figure 9). During this period, the invertebrate community for Matakitaki at SH6 Murchison was excellent (MCI greater than 119, SQMCI greater than 6, n = 4). The most recent MCI result for this was within 5 units of the excellent quality class which allows it to be included in that quality class (using the fuzzy boundary concept recommended by Stark & Maxted, 2007). The invertebrate communities from Black Vly at 30 m u/s Lake and Mangles at Gorge were in the highest quality class for MCI but fell into the second-highest quality class for SQMCI in recent years. This should not be interpreted as a meaningful decline in the invertebrate communit, however, as there is considerable variation in both MCI and SQMCI results for these sites.

By far, the worst performing site in terms of invertebrate community indices was Murchison Ck at 20 m d-s SH6. At this site, MCI values in the last five years were fair (between 80 and 100) and SQMCI values alternated between fair and poor. The most recent results suggested a downward trend in the health of the invertebrate community at this site.

The decline in macroinvertebrate metrics at the Buller at Longford site over the period between 2006-2010 could be due to slips in the upper Howard River catchment, that appear to have stabilised now.

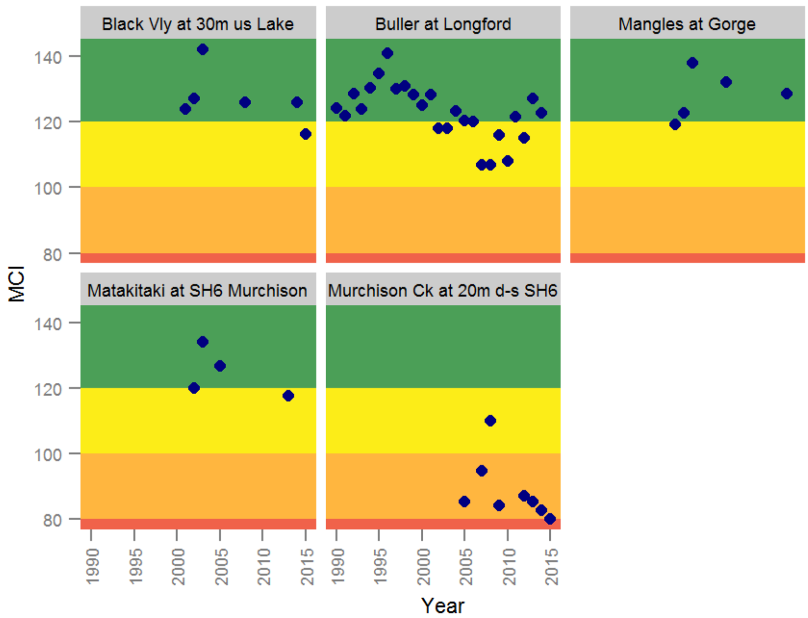


Figure 9. Macroinvertebrate community index (MCI) scores between 1990 and March 2015 for sites in the Buller Water Management Area. The background colours indicate quality classes: excellent (green), good (yellow), fair (orange) and poor (red).

Trends in the Buller WMA

The trend analysis for the Buller Water Management Area revealed meaningful changes in water clarity and Nitrate-N measurements over time (Table 2). Specifically, there was a degradation in Nitrate-N at Buller at Longford over the previous 10 years. Water clarity measurements improved at three sites and degraded at one site (Matakitaki at SH6 Murchison).

Table 2. Water quality trend results for sites in the Buller Water Management Area over the 10-year period 2005 to 2014 (highlighted in blue) and over the full record (from 15 to 26 years depending on the site). Seasonal Kendall trend tests were used for *E. coli* concentrations, water clarity measurements and nutrient concentrations (Ammonia-N, Nitrate-N and DRP). Mann-Kendall trend tests were used for invertebrate community metrics (for the NRWQN site Buller at Longford). The trends shown are significant ($p < 0.05$), meaningful (RSKSE > 1% per year) and the change in value between the start and end of the trend line is greater than the detection limit for the attribute (refer to the Methods sections for the detection limits). Statistics are shown in the Appendices.

Site name	Attribute	Effect ☺ ☹	N obs	N years
Buller at Longford	Nitrate-N	☹	117	10
Buller at Longford	QMCI	☹	25	25
Buller at Longford	Water Clarity	☺	312	26
Mangles at 1.5 km u-s Tutaki	Water Clarity	☺	36	10
Mangles at Gorge	Water Clarity	☺	37	10
Matakitaki at SH6 Murchison	Water Clarity	☹	37	10

A degrading trend in QMCI (quantitative MCI) was found for Buller at Longford over the past 25 years. There was also a significant (but not meaningful) decline in MCI at this site over the same time period ($p = 0.004$, RSKSE = -0.5% per year). Because the MCI results at this site have been consistently in attribute state A (MCI > 120) or B (MCI > 100), however, we are not currently concerned about the modest declining trends in QMCI and MCI at this site.

Black Valley Stream

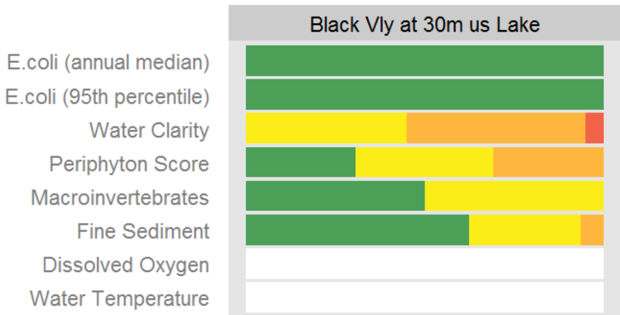
While a large proportion of this catchment is mountain-fed, there is about 70 ha of wetlands including Black Valley Swamp (60 ha). Swimming is popular in Kerr Bay including around the mouth of this stream.

Above: Black Valley Stream, looking upstream from Kerr Bay Rd (May 2008)

Black Valley stream has generally had **very good water quality** since the late 1990's when the St Arnaud sewage treatment scheme was installed. Median is 15 *E.coli*/100 ml, which is equivalent to a pristine forested stream.

The Easter 2005 rains caused the largest amount of flooding in this area in decades and caused a large amount of bank erosion in Black Valley Stream.

The **macroinvertebrate community** remained 'excellent' three years after this event but has **declined to 'good'** since. We cannot rule out this decline could be due to increasing urbanisation in the catchment as many of the common chemicals used in the urban area are deleterious to freshwater organisms (e.g. hydrocarbons, concrete residues, cleaning agents).



Site data summary plot. Colours indicate attribute states from A (good) to D (poor).
Refer to the interpretation guide for full details.

Willow clearance and riparian plant replacement with natives on Black Valley Stream downstream SH63.
From top: November 2002, October 2012, May 2015.

	Black Valley Stream
River Environment Class	Cool Wet Alluvial Hill-fed Pasture (probably includes wetland)
Catchment area (km^2)	18
Predominant land use upstream	Beach forest 50% (9 km^2) Wetland 33% (6km^2) Pasture 15% (2.7 km^2) Residential 1.5% (0.3 km^2)
Mean annual rainfall (mm)	1433
Mean annual flow (l/sec)*	NA
Lowest recorded flow (l/sec)	39 (Feb 2014)
Water quality record	Monthly: 200-present

* Estimate from WRENZ 2013. NA = not available

Above left: Looking downstream to mouth. Above right: About 100 m upstream of the lake

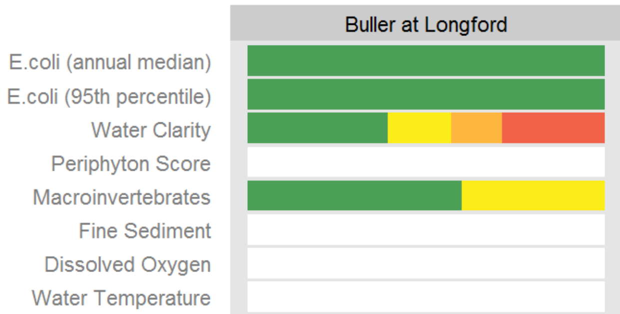
Buller River / Kawatiri Main Stem

The Buller River has the fifth largest average flow in New Zealand but has the highest flood flow record. It is 170km long with a 6500km^2 catchment. It is recognised for its outstanding wild and scenic values, as well as swimming, fishing and whitewater recreation (e.g. kayaking and rafting). A Water Conservation Order was placed on many parts of this catchment in 2001 placing restrictions on damming, altering flow, or water quality.

Buller River near Harleys Rock, downstream Howard River (September 2007). Clear water from the Buller River can be seen on the left of the photo (true right), and turbid water from the Howard River is coming in on the right of the photo (true left).

The Buller at Longford site upstream of Murchison is part of the National River Water Quality Network and is sampled monthly and at all flows. The Buller is used for contact recreation (kayaking) over most flows <100 m^3/sec. The **Buller River main stem is generally reasonably clear** (median water clarity: 3.64 m; data from 2010-2015), and is increasing at 1.8% of the median value per year. This is despite the existence of major active slips within the conservation estate in the upper Howard Valley, causing very poor water clarity at times in the Howard River.

Heavy fine sediment load to the Howard River, and then on down the Buller River, occurred for several years from 2006. Farmers in the Howard Valley (Basher, G. *pers. comm.*) explained that the sediment was coming from the true right branch of the Howard River about 6-8 km upstream of Howard Head Station, after a heavy downpour in 2006. While the stream mostly cleared within a week, the river became very discoloured after 20-30 mm of rain, and this lasts for 2-3 days with the effect slowly diminishing over the 5-6 years afterwards.



Site data summary plot. Colours indicate attribute states from A (good) to D (poor).
Refer to the interpretation guide for full details.

Macroinvertebrate condition seems to have been adversely affected by this sediment as all metrics have showed a degrading trend from 2006 and then a slow and full recovery by 2014.

The river is suitable for contact recreation approximately 95% of the time (Figure 10; 2014 annual median = 19 *E.coli* /100 ml). This 95% suitability is still too low in our view because it is a river that is very popular for whitewater kayaking (particularly from Gowan Bridge to below the Tasman District Council boundary) and swimming (particularly at the Riverview Campground in Murchison).

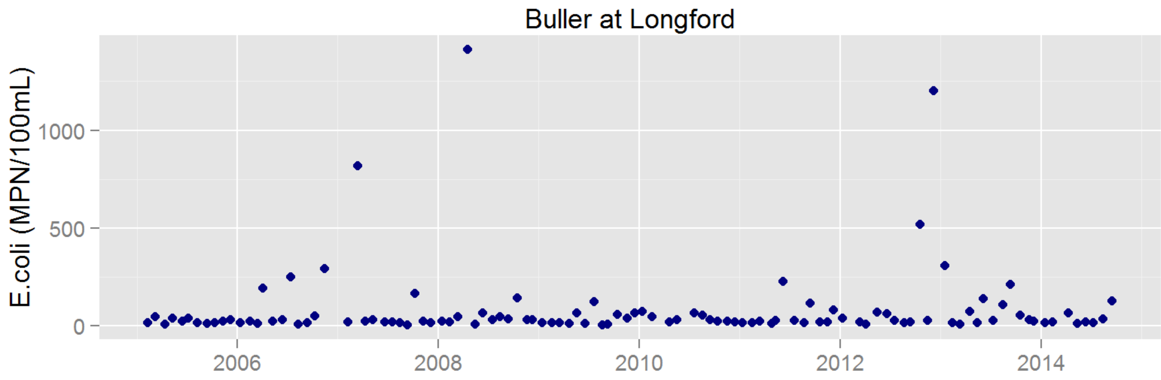


Figure 10. Buller at Longford *E. coli* concentration data from 2005 to 2014.

Nitrate concentrations are increasing at this site but are currently at relatively low levels (less than 1 g/m3; Figure 11).

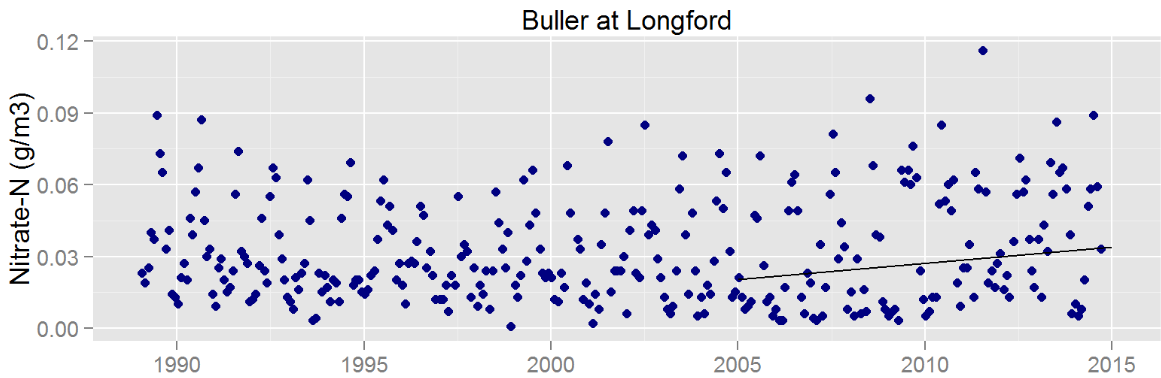


Figure 11. Buller at Longford Nitrate-N concentration data with 10-year trend line (p = 0.0005, RSKSE = 4.9% per year). There was no significant meaningful trend over the full record (26 years).

Howard River at Howard Head Station (February 2008), looking south to the Angelus Range where the source of the sediment is located.

	Buller at Longford
River Environment Class	Cool Wet Hard sedimentary Hill-fed Indigenous forest
Catchment area (km^2)	1410
Predominant land use upstream	Indigenous forest and alpine tussock and rock covers >85%
Mean annual rainfall (mm)	1560
Mean flow (l/sec)	73,829
Median flow (l/sec)	56,156
7-day Mean Annual Low flow (l/sec)	22,370
Lowest recorded flow (l/sec)	13,380
Water quality record	Monthly: 1989-present (NIWA) *E.coli* data from 2005

Mangles and Tutaki Rivers

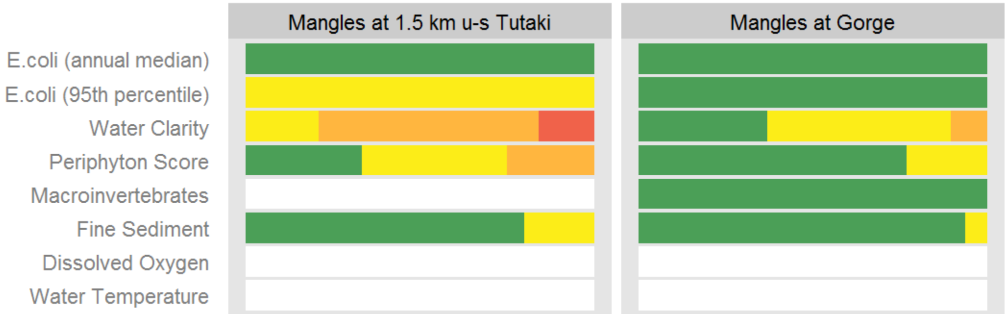
The bed in the upper reaches of this river has relatively high sand content as the geology is within the southern-most extent of the Separation Point Granite geological belt. This belt extends from the northern end of Abel Tasman National Park, including much of the tributaries of the west bank of the Motueka River, Lower Wangapeka, and the Sherry River.

Above: Mangles Rv at Gorge (May 2008).

The Mangles River is popular for whitewater boating activity when water levels are higher (usually in spring or within a few days after rain), and is a popular waterway for trout fishing

Faecal indicator bacteria concentrations in this river are generally low. The Mangles River upstream of the Tutaki River is consistently higher (median: 100 *E. coli* /100 ml) than downstream (Gorge site median: 40 *E. coli* /100 ml). This is because of dilution from the Tutaki River which has higher flows than the Mangles and lower average *E.coli* concentrations. Faecal indicator bacteria were sampled in the Tutaki River from 2002-03 and 2011-12 and were found to be very low (median 23 and 21 *E. coli* /100 ml respectively).
After 20-30 mm of rain in the catchment the site can quickly become unsuitable for contact recreation (typically 1000-2000 *E.coli*/100 ml; sampled over three flood events in 2012-13) but fortunately becomes suitable again within 24-36 hours of the rain ceasing.

Water clarity shows a similar pattern, with the upstream Tutaki site being, on average, almost half (median: 1.8 m) that of the downstream site (median: 3.5 m).



Site data summary plot. Colours indicate attribute states from A (good) to D (poor).
Refer to the interpretation guide for full details.

Slips in the steep native forest land in the Upper Mangles (Te Patiti Stream) were responsible for relatively heavy fine sediment loading to this river in the 2010 to 2011 period. This effect seems to be reducing now.

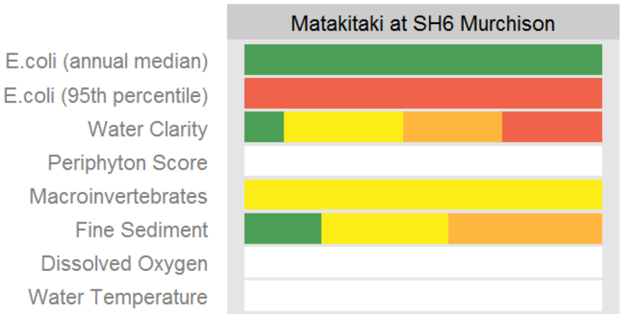
Mangles Rv u-s Tutaki Rv (April 2005)

	Mangles at Gorge
River Environment Class	Cool Wet Soft sedimentary (Separation Pt granite component also) Hill-fed Indigenous forest
Catchment area (km^2)	61
Predominant land use upstream	Indigenous forest ~78%
Mean annual rainfall (mm)	1600 (est)
Mean flow (l/sec)	9,860
Median Flow(l/sec)	6,019
7-day Mean Annual Low Flow (l/sec)	2,160
Lowest recorded flow	1,018
Water quality record	2000-present

Matakitaki River

The Matakitaki River is fed from mountainous terrain largely within Nelson Lakes National Park. The river is one of the most popular for whitewater kayaking in New Zealand (>2000 paddler days/year) and is used all year round and at all flows. Trout fishing is also popular in the catchment. Braided sections of the waterway are used for nesting by black-fronted terns, banded dotterel, black-billed gulls and oystercatchers.

Matakitaki River downstream SH6 (April 2005)



Site data summary plot. Colours indicate attribute states from A (good) to D (poor).
Refer to the interpretation guide for full details.

Water in this river is **extremely clear in the upper reaches** (median/max water clarity: 10.15 m/24.5 m upstream of Horse Terrace), but less clear downstream of the Glenroy River (median clarity at SH6: 2.7 m for 2010-2015 compared to 3.6 m for 2000-2015). Natural slips in the upper Glenroy River catchment (30 km upstream of the confluence of the Matakitaki River) are the cause of this lowered water clarity and high levels of fine sediment deposited on and within the bed. Sediment discharges from alluvial gold mining operations downstream of the Glenroy have been minimal over the period from 2005 to 2015 due to limited mining activity. This fine sediment is grey sandy silt with reasonable amounts of mica. As a consequence of the excessive sediment, the macroinvertebrate community condition is poor in this lower part of the river. Water clarity is degrading at this site (Figure 12).

E. coli concentrations at base flows are very low (median: 5 *E. coli*/100 m*l*) but at high flows levels are high enough (typically 2000-5000 *E. coli*/100 m*l*) to be a potential health risk if boaters inadvertently consume river water.

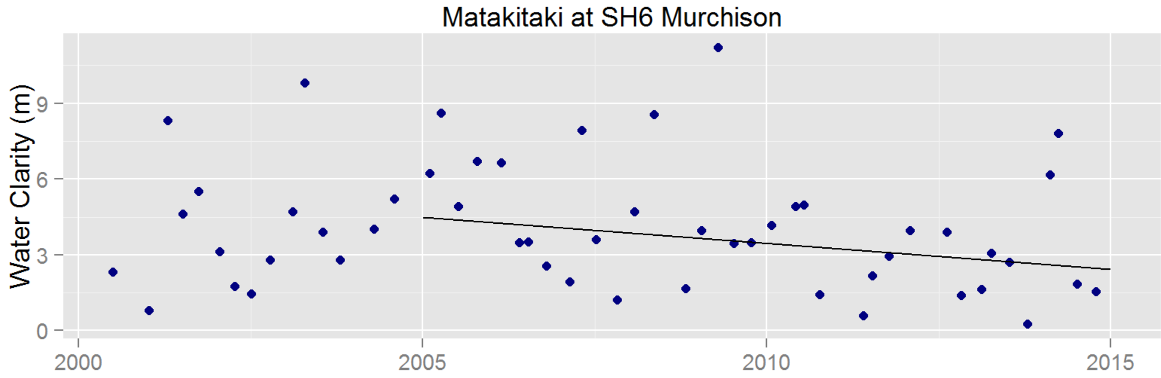


Figure 12. Matakitaki at SH6 Murchison water clarity data with 10-year trend line (p = 0.01, RSKSE = -5.9% per year). No significant meaningful trend was detected over the full record (15 years).

Fine sediment deposits, common at this site.

Table 3. Summary statistics for the Matakitaki River

	Matakitaki River at SH6
River Environment Class	Cool Extremely Wet Soft sedimentary Hill-fed Indigenous forest
Catchment area (km^2)	898.7
Predominant land use upstream	Beach forest 65% Bare and tussock alpine 30% Pasture 5%
Mean annual rainfall (mm)	1,999*
Mean annual flow (l/sec)	54,266*
Lowest recorded flow	NA
Water quality record	

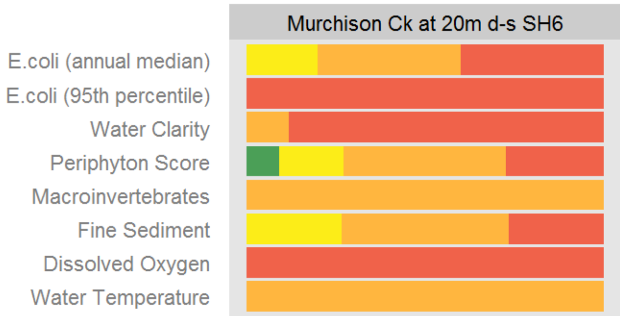
* Estimate from WRENZ 2013. NA = not available

Murchison (Ned's) Creek, Murchison

This spring-fed creek drains farmland and residential areas to the south and east of Murchison.

The creek has the **highest level of faecal indicator bacteria of any long-term monitoring site in the District** (median from 2010-2015: 960 *E.coli*/100 ml). The main risk to public health is through contact with creek water and then handling food, or by any other means consuming some of the contaminated water. This is particularly likely for children who play in the creek and people handling dogs after they have been in the creek. Faecal contamination appears to be widespread in this catchment with high levels in both the eastern (median 1950 *E.coli*/100 ml) and western tributaries (3300 *E.coli*/100 ml) (based on 4-6 samples). These branches confluence about 180 m upstream of SH6. Both branches have recorded *E.coli* concentrations over five times the secondary contact standard (Figure 13) for median *E.coli* at the various sampling points in the catchment).

Above: Murchison Creek 20 m upstream SH6 (April 2012)



Site data summary plot. Colours indicate attribute states from A (good) to D (poor). Refer to the interpretation guide for full details.

Microbial source tracking shows ruminant animal and wildfowl faecal matter as the main contributors to the faecal contaminant load in the stream. A human faecal source was found in September 2009, but not in March 2014 or May 2015 (dog faeces were not detected in the latter sample either). This shows that streams flowing through farmland in the catchment need to be fenced, and crossings need to be culverted to mitigate this issue. A stock truck effluent discharge to ground, about 2km due east of the SH6 monitoring site (mid-way along and about 50 m north of Canton Rd), may also contribute to the high faecal indicator bacteria levels (however, this operation ceased in June 2013, Lon Bradley, *pers com.*). Being spring-fed, this stream should be relatively clear, but water clarity is relatively low (median: 1.3 m). Deposits of sediment in the creek bed are over 500 mm thick in pools and deep runs within the creek.

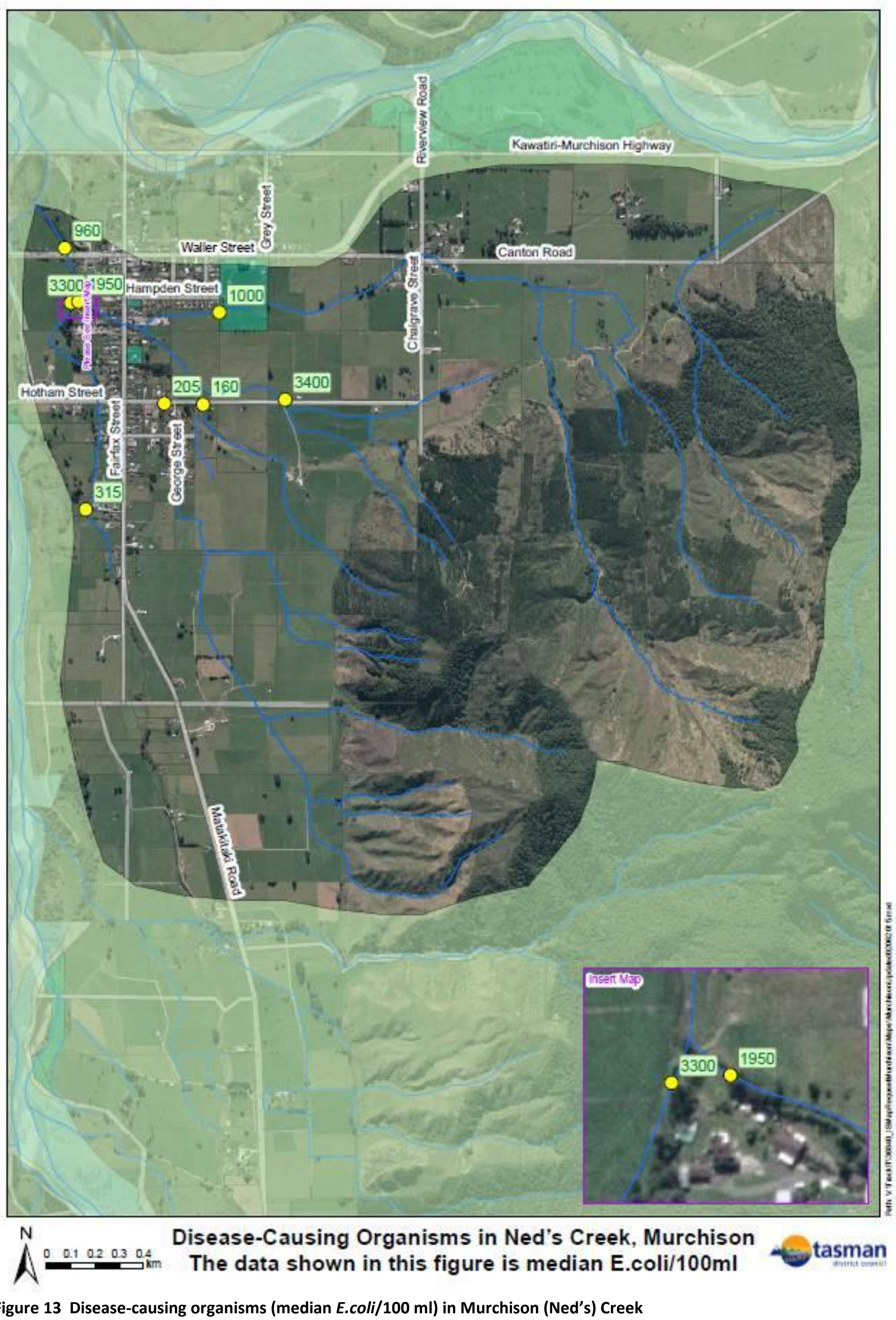


Figure 13 Disease-causing organisms (median *E.coli*/100 ml) in Murchison (Ned's) Creek

Fine sediment volume has averaged 60L/m^3 of the bed volume, which is considerable. The main sources of fine sediment are from discharges from transport operations (a truck wash facility discharging into the creek ceased in 2008), slips in the hill country to the south east of the township in 2011-12 (this loading of sediment reduced to almost nil by mid 2014, even at high flows) and farming activities (particularly stock trampling the banks). Its spring-fed nature, with relatively stable flows, also means that sediment in the creek is not readily flushed.

Above: Murchison (Ned's) Creek showing the thick fine sediment deposits and filamentous green algae (April 2012)

Dissolved oxygen levels were measured in March 2015. Daily minima were found to be generally over 60% (Figure 14). The spiky and erratic dissolved oxygen plot shown below is probably due to rain in the middle of the monitoring period (6 March), and possibly stock in the stream. This pattern is more closely reflected in the dissolved oxygen profile for the true right branch upstream of Fairfax (Figure 16) rather than the true left branch at the Kiwi Park Motels (Figure 15).

Figure 14. Dissolved oxygen % saturation at Murchison Creek 20 m downstream of SH6 from 2-9 March 2015. The national proposed bottom line for the daily 1-day minimum is shown by the red line.

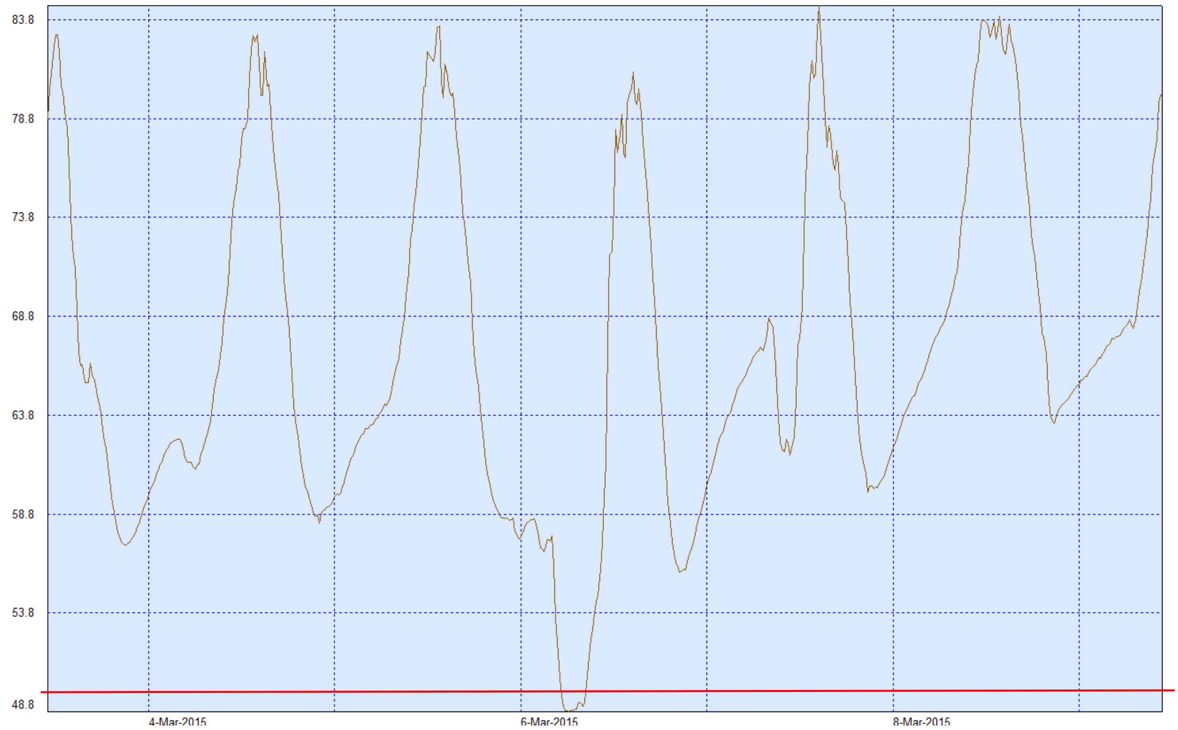


Figure 15. Dissolved oxygen % saturation at Murchison Creek upstream Kiwi Park Motel from 2-9 March 2015. The national proposed bottom line for the daily 1-day minimum is shown by the red line.

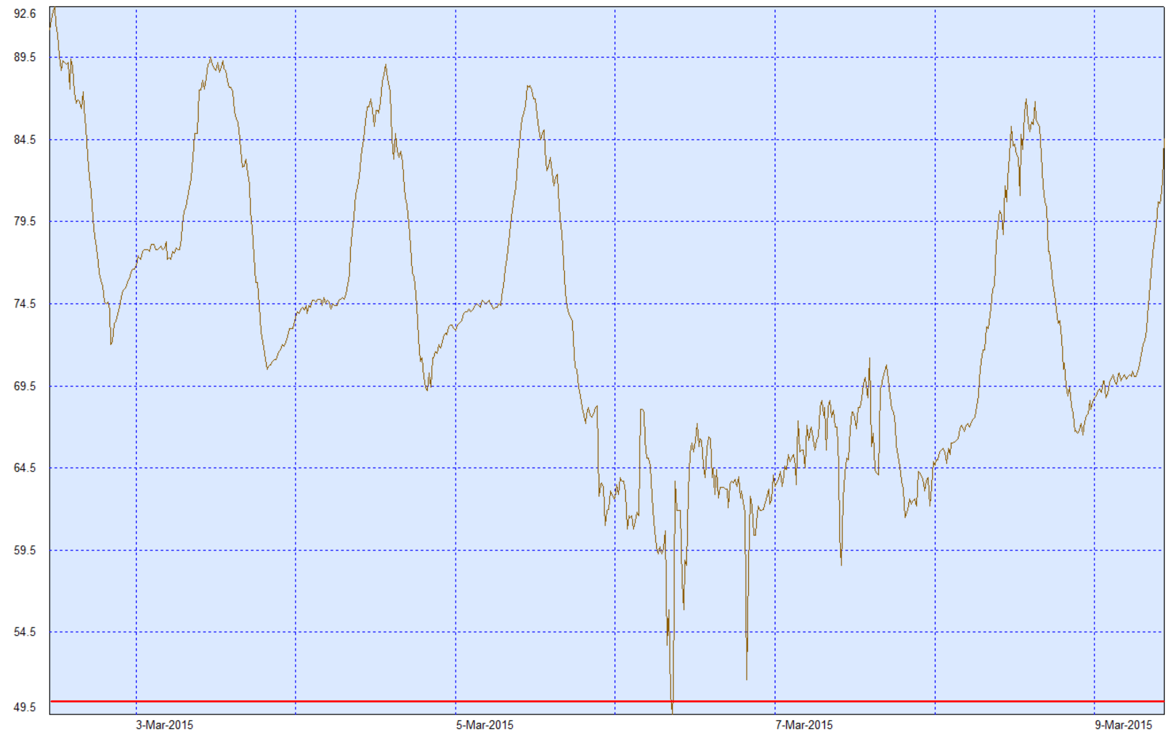


Figure 16. Dissolved oxygen % saturation at Murchison Creek upstream Fairfax St from 2-9 March 2015. The national proposed bottom line for the daily 1-day minimum is shown by the red line.

Periphyton cover in this creek from spring to autumn exceeds 30% for almost 30% of samples. Scums are a common occurrence.

The Buller Catchment Group led by Landcare Trust and farming leaders has begun work to improve water quality in this catchment. Council provided a total of 4.22 km of fencing materials to landowners in this catchment (2005-10: 1.27 km, 2010-15: 2.95km).

Left and bottom-right: Murchison Ck at SH6 (October 2008 and April 2007 (sediment discharge event)). Top right: Murchison Ck upstream Fairfax St (July 2007).

Table 4. Summary statistics for Murchison Creek

	Murchison Ck
River Environment Class	Cool Wet Alluvial Spring-fed Pasture
Catchment area (km^2)	7.8
Predominant land use upstream	Pasture 56% (4.4 km^2) Forestry & scrub on hills 37% (2.9 km^2) Urban 6.5% (0.5 km^2)
Mean annual rainfall (mm)	1,555*
Mean annual flow (l/sec)	270*
Lowest recorded flow (l/sec)	8.7
Water quality record	2005-present

* Estimate from WRENZ 2013. NA = not available

Doughboy Creek, 5km west of Murchison

This small to medium sized hill-fed stream has a catchment area of almost 20 km^2 about 80% of which is in native forest, about 10% in sheep and beef farming in the headwaters and 7.5% in intensive dairy farming on Four Rivers Plain. The stream bed has a high proportion of sand due to the geology of the catchment.

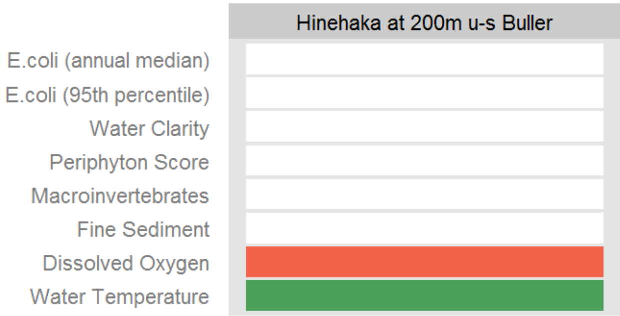
Above: Doughboy Creek 200 m upstream Buller River (March 2014)

While this stream has only been sampled since late 2013, *E.coli* concentrations are all within the stock drinking water guideline (median: 182 *E.coli*/100 ml). Water clarity is relatively poor in this stream at base flows (median: 1.7 m) when it would be expected to be good because of the relatively large amount of indigenous forest in the catchment.

Resuspendable solids (Shuffle method) indicate moderate-high levels of fine sediment in the bed. Conductivity is consistently high ranging from 240-250 µS/cm indicating a strong groundwater influence or other discharges from the catchment. Heavy trampling and soil loss from banks of this stream were evident in winter 2013. Better stock exclusion is required along this stream.

‘Hinehaka’ Creek, 5 km west of Murchison

This creek is fed by groundwater from under the Four Rivers Plain. The land cover is almost completely intensive pasture in this 1.7 km^2 catchment. There are almost no riparian trees in the catchment. In summer the bed is covered with aquatic plants rooted in the bed. Spring-fed creeks draining to large rivers often have high value to fish, particularly for rearing of juveniles and providing refuge during floods. These creeks are relatively rare in Tasman District.



Site data summary plot. Colours indicate attribute states from A (good) to D (poor).
Refer to the interpretation guide for full details.

While this stream has only been sampled since late 2013, most *E.coli* concentrations are within stock drinking water (median: 355 *E.coli*/100 ml, maxima: 1600 *E.coli*/100 ml). It is very difficult to measure water clarity in this waterway due to the growth of aquatic plants across the whole channel for much of the year and fine sediment depths of about 500 mm.

View upstream of Hinehaka Road (February 2014), note the lack of adequate riparian fencing.

Left: View upstream of Hinehaka Road (July 2014). Right: view downstream (October 2014)

Dissolved oxygen levels were measured in March 2015 revealing very low daily minima (commonly below 10% (Figure 17). The spiky and erratic dissolved oxygen plot shown below is probably due to rain in the middle of the monitoring period (6 March), and possibly stock in the stream. In a stream with almost complete coverage of aquatic plants it would be expected that daily maxima dissolved oxygen would be supersaturated due to photosynthetic activity. However, this is not the case; maybe because of high organic content (degrading plant matter) of the sediment or a groundwater influence with very low dissolved oxygen content.

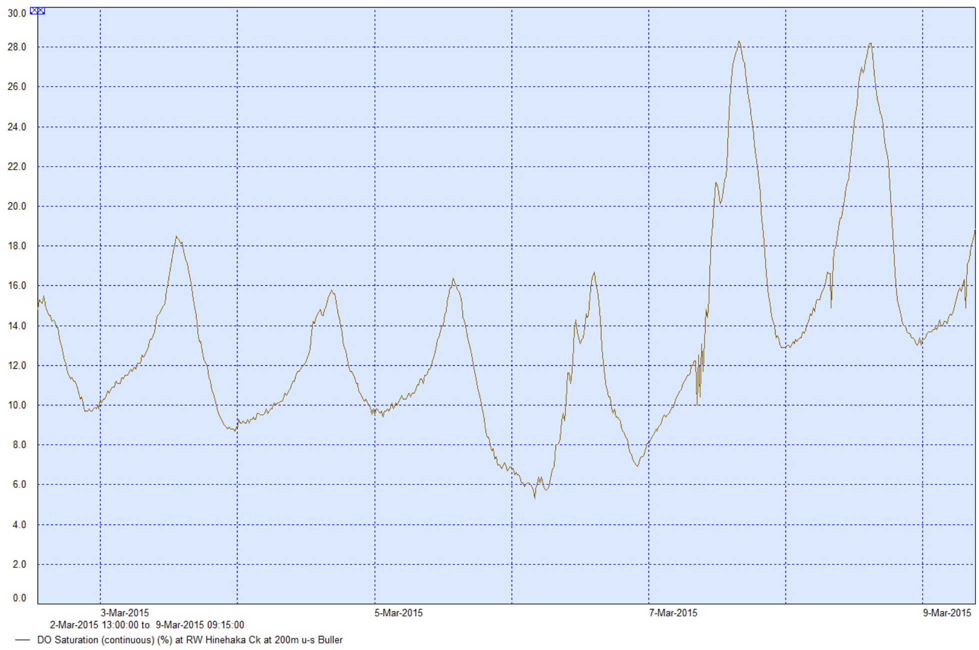


Figure 17 Dissolved oxygen (% saturation) for Hinehaka Creek near Hinehaka Rd (3-9 March, 2015). These concentrations are well below the national proposed bottom line for the daily 1-day minimum.

Maximum water temperatures recorded over the March 2015 was 19°C which is very suitable for aquatic life.

Buller River at O'Sullivans, 11 km west of Murchison

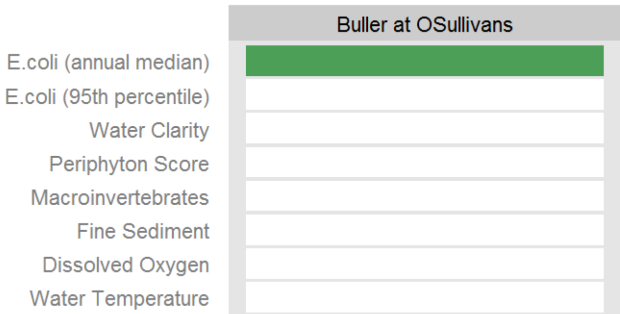
This reach of the Buller is particularly popular with whitewater kayakers and rafters.

Above: Buller River upstream O'Sullivan Bridge (SH6) (November 2012)

It is very suitable for this purpose at base flows (median: 5 *E.coli*/100 ml, maxima: 75 *E.coli*/100 ml; based on 10 samples since November 2012). Water clarity is variable ranging from 0.3 to 6.8 m (median: 1.9 m).

After 20-30 mm of rain in the catchment the site can quickly become unsuitable for contact recreation due to high faecal bacterial counts (typically 1500-4000 *E.coli*/100 ml; sampled over three flood events in 2012-13) but becomes suitable again within 24 to 36 hours of the rain ceasing. Sampling over these events showed this site to have about 30-50% higher *E.coli* concentrations than at the Riverview Campground site on the northern side of Murchison.

Median base flow water clarity at this site was relatively low compared to Buller and Mangles sites further upstream (median of 2 m over 9 samples from 2013-2015, compared to median of 3.6 m at Longford from 2010-2015).



Site data summary plot. Colours indicate attribute states from A (good) to D (poor).
Refer to the interpretation guide for full details.

Maruia River 1.5km upstream Buller

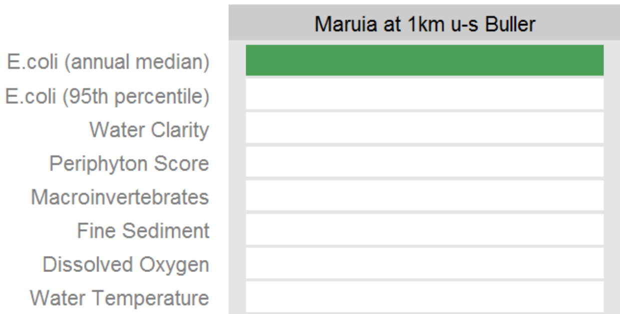
The Maruia River is 80 km long and begins in the Spenser Mountains near Lewis Pass. It has high trout fish and boating values.

Faecal indicator bacteria concentrations at base flows are very low (median: 12 *E.coli*/100 ml, maxima: 75 *E.coli*/100 ml; based on 10 samples since November 2012).

Water clarity is very variable ranging from 0.4 to 8.8 m (median: 3.5 m).

Above: Maruia River 1.5 km upstream Buller River (November 2012)

After 20-30 mm of rain in the catchment this site can quickly become unsuitable for contact recreation due to high faecal bacteria counts (typically 1000-2000 *E.coli*/100 ml; sampled over three flood events in 2012-13) but become suitable again within 24 to 36 hours of the rain ceasing.



Site data summary plot. Colours indicate attribute states from A (good) to D (poor).
Refer to the interpretation guide for full details.