Manuherekia River Low Flow Monitoring – April 2024

Prepared for:

Manuherekia Catchment Group

By:

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freestone
freshwater science

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Acknowledgements:

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1. Introduction

The Manuherekia Catchment Group (MCG) contracted Freestone Freshwater Ltd. to undertake ecological monitoring to assess the ecological conditions present in the Manuherekia catchment following a prolonged period of dry conditions and low flows in the 2023-2024 hydrological year.

The Otago Regional Council (ORC) undertakes monthly surveys of periphyton and habitat conditions at four sites in the Manuherekia catchment as part of its State of the Environment (SOE) monitoring programme. In addition to these long-term biomonitoring sites, a further nine sites were surveyed in early April to broaden the coverage of periphyton and macroinvertebrate sampling at the end of this dry season (see Section 2.1) to assess the ecological state of waterways in the Manuherekia catchment. This survey included sites that were located upstream of major irrigation off-takes as reference sites (or control sites) to assist in the interpretation of the results of monitoring at sites downstream of irrigation takes.

1.1. Purpose

The purpose of this report is to present the results of ecological monitoring undertaken at sites in the Manuherekia catchment on 5th/6th April 2024 and to compare this to the results of long-term monitoring results to assess the ecological state of waterways in the Manuherekia catchment following an extended period of low flows.

2. Methods

2.1. Monitoring sites

Nine sites were surveyed on the 5th and 6th of April 2024 at the end of an irrigation season characterised by extended periods of low flows (Table 1). Further to this, data from the four long-term ORC biomonitoring sites was used. These long-term sites are sampled on a monthly basis by ORC as part of its SOE monitoring programme (marked in blue in Table 1).

Table 1 Location of low flow survey sites in the Manuherekia catchment. ORC biomonitoring sites are highlighted in blue.

Site name	Description	NZTM	
		Easting	Northing
Dunstan Creek at Beattie Road (ORC SOE)	~25m downstream of bridge	1344762	5018627
Manuherekia at Blackstone (ORC SOE)	In vicinity of bridge	1346627	5014356
Manuherekia at Ophir (ORC SOE)	Immediately downstream of bridge	1331771	4999074
Manuherekia at Galloway (ORC SOE)	~230 m upstream of Galloway Road bridge	1319841	4986021
Upper Manuherekia at ds Forks	Immediately upstream of flow site	1355169	5038916
Manuherekia downstream of MIS intake	At track approximately 1 km downstream of MIS intake	1328841	4997133
Dunstan Creek at Loop Road	Immediately downstream of road bridge	1346596	5025913
Dunstan Creek at Confluence	~60 m upstream of Rail Trail bridge	1344625	5012983
Lauder Creek at Cattleyards (control)	Upstream of major irrigation takes	1332170	5016412
Lauder Creek at Rail Trail	~20 m upstream of Rail Trail bridge	1339006	5006366
Thomsons Creek at race (control)	Upstream of major irrigation takes	1329190	5012712
Thomsons Creek upstream of Sluice Channel	~70 m upstream of Sluice Channel confluence	1331173	5000428
Chatto Creek at confluence	~80 m upstream of confluence	1325194	4992109

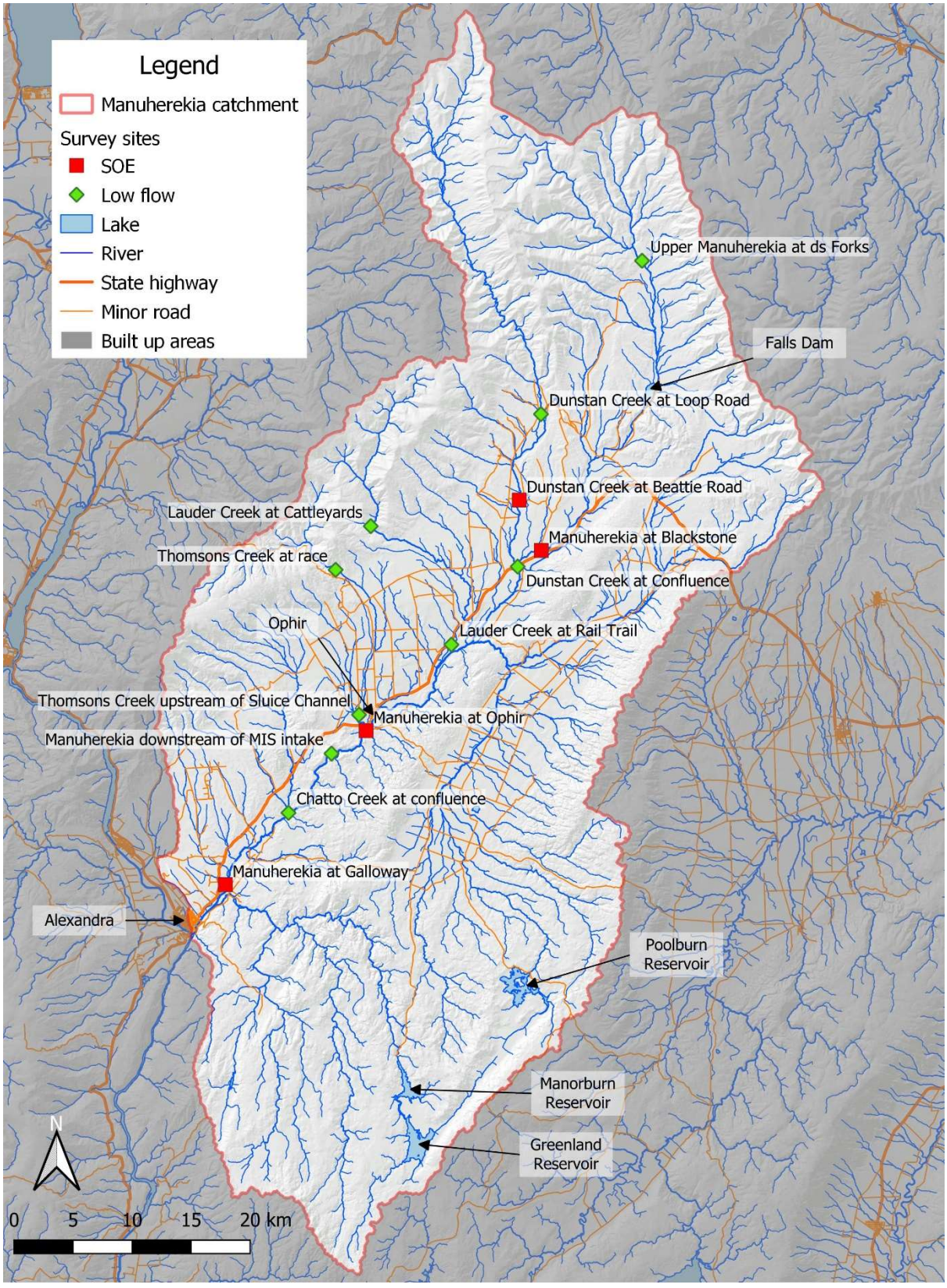

Figure 1 Map of the Manuherekia catchment showing long-term biomonitoring sites (monitored by ORC) and sites surveyed as part of low flow surveys on 5th-6th April 2024.

2.2. Flow conditions

Flows in the Manuherekia River were relatively stable and low from early December 2023, with minor freshes[1] occurring in late December and late February (Figure 2). However, flows between early December and early April averaged 1.2 m^3/s, with flows below 1.5 m^3/s on 88% of the days (88 d of 121 d) over this period, and was below 1 m^3/s on 26% of days (31 d of 121 d) over this period (Figure 2).

A fresh (small, high-flow event) occurred on the 12th/13th April 2024, which may have affected periphyton community composition and biomass in the Manuherekia catchment, which prevented comparison of results from the 5th/6th April survey with the April results of ORC biomonitoring, so the results of the early April survey were compared with results from 12 March 2024.

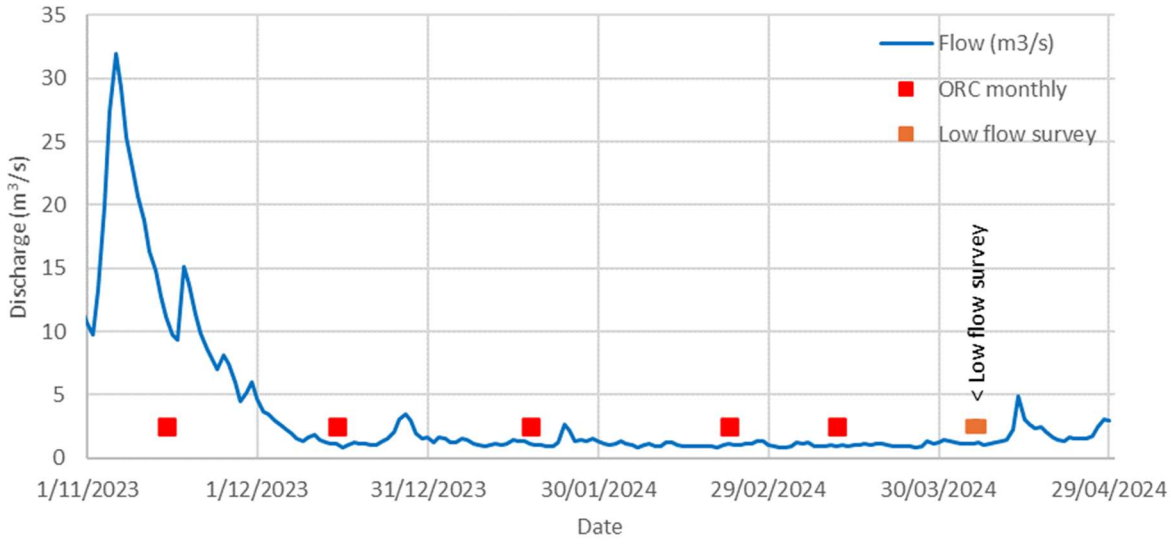

Figure 2 Hydrograph for flows in the Manuherekia River at Campground prior to sampling on 5th/6th April 2024.

[1] A fresh is a small high-flow event

2.3. Periphyton

Periphyton cover to be assessed using the Rapid Assessment Method 2 (RAM2) as described in Biggs & Kilroy (2000). This method involves estimating the periphyton percentage cover at five points across the river on four transects within a 100 m reach. Thus, 20 estimates of periphyton percentage cover (to the nearest 5%) are obtained with the periphyton classified into 12 categories (Table 2). Note that some periphyton taxa are found in several categories because it is not only their presence, but also the thickness of the mat, that is important for the evaluation of water quality (Table 2).

Periphyton biomass was analysed using Method QM-1b as described in Biggs and Kilroy (2000) by SLR Consulting.

Table 2 **Periphyton categories used in RAM-2 periphyton assessments, with enrichment indicator scores and taxa that could be expected to dominate the benthic periphyton biomass. (* diatom epiphytes can give green filaments a brown colouring) (from Biggs & Kilroy 2000).**

Periphyton category (on exposed surfaces)		Periphyton enrichment indicator score	Typical taxa
Thin mat/film: (under 0.5 mm thick)	Green	7	*Cymbella, Achnanthidium, Cocconeis, Ulothrix, Stigeoclonium* (basal cells), young *Spirogyra*
	Light brown	10	Assorted diatoms and cyanobacteria (*Cocconeis, Fragilaria, Synedra, Cymbella, Lyngbya, Amphithrix*)
	Black/dark brown	10	Assorted cyanobacteria (*Schizothrix, Calothrix, Lyngbya*)
Medium mat: (0.5 – 3 mm thick)	Green	5	*Stigeoclonium, Bulbochaete, Chaetophora, Oedogonium, Spirogyra, Ulothrix*
	Light brown (± dark green/black bobbles)	7	*Gomphonema, Gomphoneis, Synedra, Cymbella, Fragilaria, Navicula, Nostoc*
	Black/dark brown	9	*Tolypothrix, Schizothrix, Phormidium, Lyngbya, Rivularia*
Thick mat: (over 3 mm thick)	Green/light brown	4	*Navicula, Gomphoneis, Synedra, Rhoicosphenia, Ulothrix, Oedogonium, Microspora, Spirogyra, Vaucheria*
	Black/dark brown	7	*Phormidium, Schizothrix, Audouinella, Batrachospermum, Nostoc*
Filaments, short: (under 2 cm long)	Green	5	*Ulothrix, Oedogonium, Microspora, Spirogyra, Cladophora*
	Brown/reddish	5	*Cladophora*, Oedogonium*, Rhoicosphenia, Navicula, Batrachospermum, Diatoma*
Filaments, long: (over 2 cm long)	Green	1	*Ulothrix, Oedogonium, Microspora, Zygnema, Spirogyra, Cladophora, Rhizoclonium*
	Brown/reddish	4	*Melosira, Cladophora*, Rhizoclonium**

2.4. Macroinvertebrate community

Macroinvertebrates were assessed by collecting a composite kick-net sample from the site according to collection protocol 'C1: hard-bottomed semi-quantitative' as described in Stark et al. (2001)[2]. Analysis of samples followed protocol 'P1: coded abundance' as in Stark et al. (2001) by SLR Consulting. The tolerance scores used to calculate MCI and SQMCI scores are based on Greenwood *et al.* (2015)[3].

3. Results & Discussion

3.1. Fine sediment cover

Fine sediment cover for the survey sites is presented in Table 3. The fine sediment cover at most sites was within the 20% cover guideline for the protection of benthic biodiversity (Clapcott et al. 2011), with the exception of the Manuherekia at Galloway (Table 3). However, sediment size varies longitudinally along the course of a river and can vary markedly depending on local and upstream geology and it is not possible to determine the contribution of the low flows to the cover of fine sediment observed in this survey.

Table 3 **Fine sediment cover at sites in the Manuherekia catchment on 12 March 2024 and 5th/6th April 2024. * = ORC long-term sites, data for these sites courtesy of ORC.**

Site	Date	Fine sediment cover (%)
Upper Manuherekia at ds Forks	5/04/2024	0
Manuherekia at Blackstone Hill*	12/03/2024	13.5
Manuherekia at Ophir*	12/03/2024	10
Manuherekia downstream of MIS intake	6/04/2024	4.5
Manuherekia at Galloway*	12/03/2024	34.5
Dunstan Creek at Loop Road	5/04/2024	0
Dunstan Creek at Beattie Road*	12/03/2024	15
Dunstan Creek at Confluence	5/04/2024	0
Lauder Creek at Cattle yards	6/04/2024	3
Lauder Creek at Rail Trail	6/04/2024	11.5
Thomsons Creek at race	6/04/2024	3.75
Thomsons Creek upstream of Sluice Channel	5/04/2024	4
Chatto Creek at confluence	6/04/2024	18.75

[2] Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR (2001): Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

[3] Greenwood M, Booker D, Stark J, Suren A & Clapcott J (2015). Updating MCI tolerance values for freshwater invertebrate taxa. Prepared for Environment Southland and Hawkes Bay Regional Council. NIWA Client Report CHC2015-008. 34 p. plus appendices.

3.2. Periphyton

3.2.1. Periphyton biomass

Long-term monitoring

Periphyton biomass (benthic chlorophyll *a*) and cover has been monitored on a monthly basis since July 2019. Based on chlorophyll a concentrations collected between July 2021-June 2024, the Dunstan Creek and Beattie Road, Manuherekia at Blackstone Hill and Galloway sites were in B-band, while the Manuherekia at Ophir site was in C-band (Table 4).

The values for the Manuherekia at Blackstone Hill and Galloway meet the baseline and target attribute states set out in the proposed Land & Water Regional Plan (LWRP) and are indicative of occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat (as per Table 2 of the NPSFM). The periphyton biomass at both the Dunstan Creek at Beattie Road and the Manuherekia at Ophir exceeded the target attribute state proposed in consultation information for the pLWRP.

Table 4 **Comparison of chlorophyll a concentrations at four sites in the Manuherekia catchment with Table 2 of the National Objectives Framework of NPS-FM and the baseline and target attribute states proposed for the Otago Land & Water Regional Plan[4]. Calculations based on data from the period July 2021 – June 2024. Data courtesy of ORC.**

		Proposed LWRP		2021-2024	
Site	n	Baseline attribute state	Target attribute state	92nd percentile	NOF band
Dunstan Creek at Beattie Road	31	A	A	112.1	B
Manuherikia at Blackstone Hill	23	B	B	90.4	B
Manuherikia at Ophir	22	B	B	179.6	C
Manuherikia at Galloway	25	B	B	75.5	B

Long-term chlorophyll *a* concentrations observed at each of these sites in relation to flows in the nearest relevant flow site are presented in Figure 3-Figure 6. These figures show that the biomass of periphyton at these sites is typically low, although instances of higher periphyton biomasses can be associated with periods of low, stable flows (Figures Figure 3-Figure 6).

[4] https://www.orc.govt.nz/your-council/plans-and-strategies/water-plans-and-policies/freshwater-management-units/cluthamata-au/manuherekia-rohe-area/

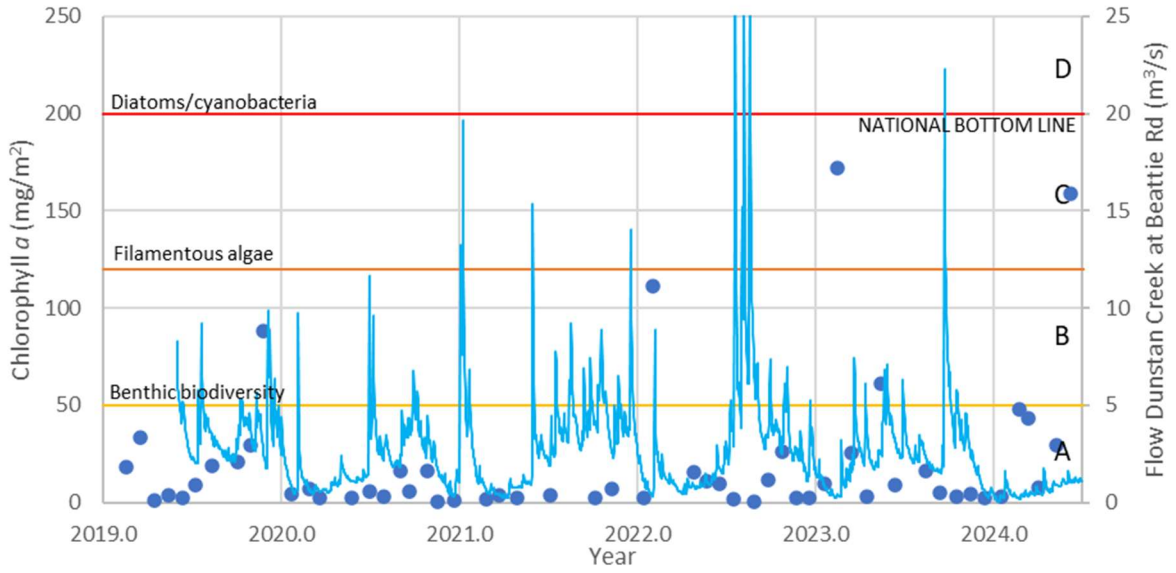

Figure 3 Chlorophyll a concentrations in the Dunstan Creek at Beattie Road over the period 2019-2024. Blue line is the mean daily flow in Dunstan Creek at Beattie Road. Flow data courtesy of ORC.

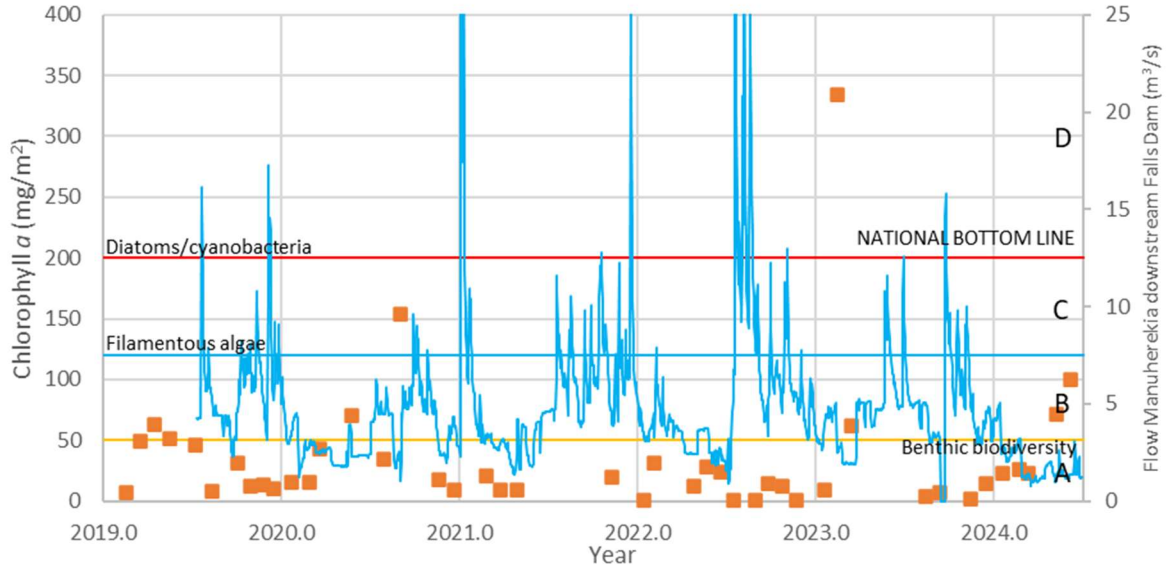

Figure 4 Chlorophyll a concentrations in the Manuherekia at Blackstone Hill over the period 2019-2024. Blue line is the mean daily flow in Manuherekia at Ophir. Flow data courtesy of ORC

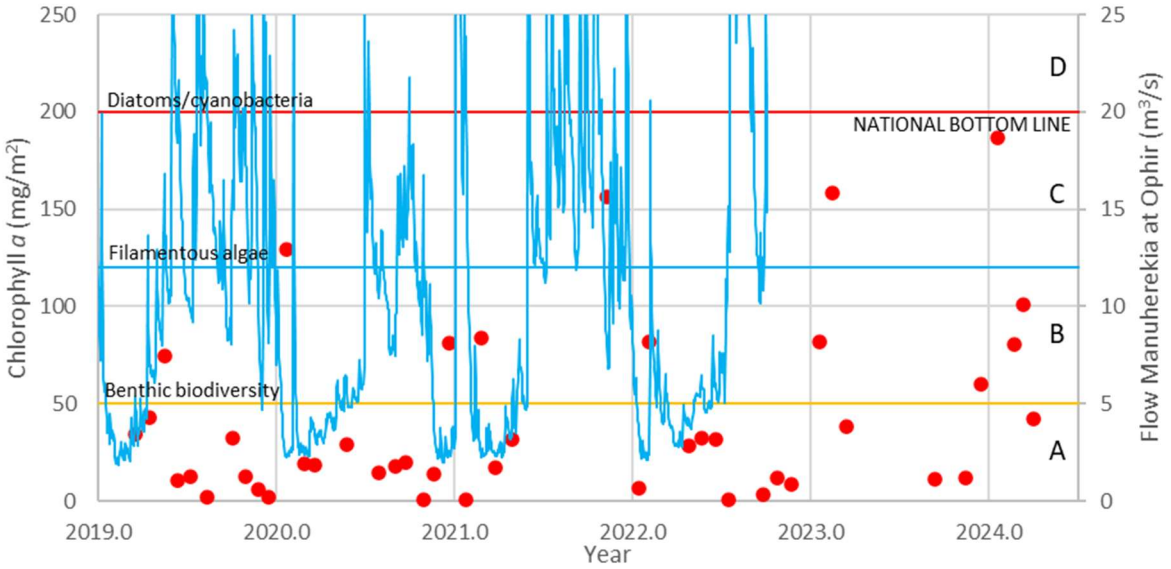

Figure 5 Chlorophyll a concentrations in the Manuherekia River at Ophir over the period 2019-2024. Blue line is the mean daily flow in Manuherekia at Ophir. Flow data courtesy of ORC

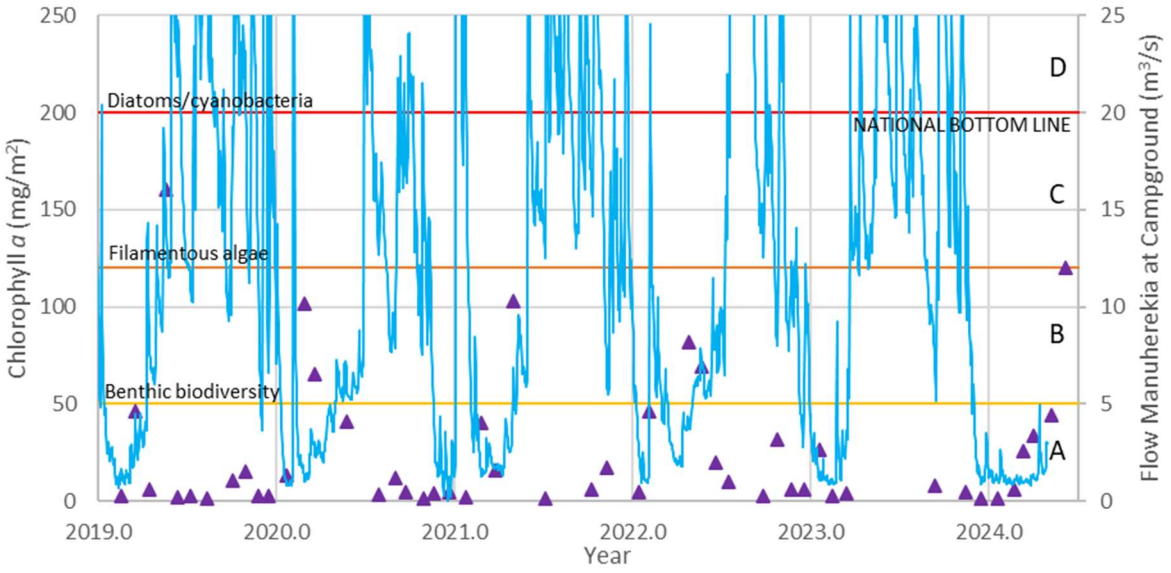

Figure 6 Chlorophyll a concentrations in the Manuherekia River at Galloway over the period 2019-2024. Blue line is the mean daily flow in Manuherekia at Campground. Flow data courtesy of ORC.

Low flow monitoring

Periphyton biomass was low at most mainstem sites surveyed in March/April 2024, although the concentration in the Manuherekia River at Ophir (101 mg/m^2) exceeded the guideline for benthic biodiversity (50 mg/m^2 of Biggs 2000) (Table 5). Values at tributary sites were also low (<50 mg/m^2) (Table 5). These results indicate that the low flows experienced in the 2023/2024 season did not result in elevated periphyton biomasses at most of the monitored sites.

The elevated periphyton biomass observed in the Manuherekia at Ophir is above the guideline for benthic biodiversity but was within guidelines for aesthetics/recreation and trout habitat and angling (120 mg/m^2 for filamentous algae and 200 mg/m^2 for diatoms/cyanobacteria). This value represents the 5th highest periphyton biomass observed at the Ophir monitoring site since monitoring began in 2019 (44 sampling occasions). Given the low biomass of periphyton measured at the other sites on the mainstem of the Manuherekia, local factors, such as the discharge from the Omakau wastewater treatment plant and Thomsons Creek, are likely to have contributed to the elevated biomass observed at the Ophir site. Both the wastewater treatment plant and Thomsons Creek enter the Manuherekia River a short distance upstream of the Ophir monitoring site and introduce substantial nutrient loads to the river at this point.

Table 5 **Periphyton biomass at the survey sites on 12 March 2024 (ORC biomonitoring sites) and 5th/6th April 2024 survey. ORC long-term monitoring sites are marked with asterisks (*), data for these sites courtesy of ORC. Green values are within the guideline values for protection of benthic biodiversity (50 mg/m^2), yellow values exceed the guideline values for protection of benthic biodiversity, but are within guidelines for aesthetics/recreation and trout habitat and angling (120 mg/m^2 for filamentous algae and 200 mg/m^2 for diatoms/cyanobacteria)**

Site	Date	Chlorophyll *a* (mg/m^2)
Upper Manuherekia d/s Forks	5/04/2024	10.6
Manuherekia at Blackstone Hill*	12/03/2024	22.4
Manuherekia at Ophir*	12/03/2024	101
Manuherekia d/s MIS take	6/04/2024	5.0
Manuherekia at Galloway*	12/03/2024	25.5
Dunstan Creek at Beattie Road	12/03/2024	43.1
Dunstan Loop Road	5/04/2024	16.1
Dunstan Creek at confluence	5/04/2024	1.7
Lauder Cattle Yards	5/04/2024	2.3
Lauder at Rail Trail	6/04/2024	6.2
Thomsons Creek race	6/04/2024	5.6
Thomsons Creek u/s Sluice Channel	5/04/2024	10.1
Chatto Creek at u/s confluence	6/04/2024	8.3

3.2.2. Community composition

Manuherekia River sites

On 5th April 2024, the periphyton community in the upper Manuherekia at d/s Forks was dominated by the colonial cyanobacterium *Nostoc* (12% cover) with small amounts of the invasive diatom *Didymosphenia geminata* (identified as medium light brown mats – Table 6). This community is typical in high-elevation sites with low levels of nutrient enrichment.

On 12 March 2024, the periphyton community at the Manuherekia at Blackstone Hill site was a mix of sludge (unconsolidated algae), thin and medium light-brown mats and long brown/reddish filamentous algae (Table 7). The periphyton cover at this site is typically dominated by light brown films or medium mats, or thick mats, with this likely to include the invasive diatom, *D. geminata*, which has been identified at this site since 2008 (Olsen 2023). Long filamentous algae were among the most abundant periphyton types on a third of occasions (Olsen 2023). The community observed on 12 March 2024 is consistent with long-term patterns in community composition and the presence of long filaments observed at this site is consistent with the stable flows experienced in early 2024 but is not an uncommon occurrence at this site.

On 12 March 2024, the periphyton community at the Manuherekia at Ophir site was dominated by medium light-brown mats and long brown/reddish filamentous algae (Table 7). Periphyton cover at the Manuherekia at Ophir is typically dominated by thin light brown films. Medium or thick light brown mats were among the most abundant periphyton (Olsen 2023). Short and/or long filamentous algae have been present on occasion and were among the most abundant periphyton types but did not exceed 30% cover on any of the sampling occasions (Olsen 2023). The community observed at this site on 12 March 2024 is consistent with long-term patterns in community composition although the cover of long filaments observed at this site on 12 March 2024 was greater than is typically observed at this site and exceeded guidelines for the protection of aesthetics/recreation and trout habitat and angling (Biggs 2000). This is likely to reflect a combination of the nutrient enrichment at this site (resulting from the combination of the discharges from the Omakau WWTP and Thomsons Creek) and the stable flows experienced in early 2024.

The periphyton community in the Manuherekia at d/s MIS take on 6th April 2024 was dominated by thin light brown mats – Table 6). The periphyton community at this site was consistent with low levels of nutrient enrichment.

On 12 March 2024, the periphyton community at the Manuherekia at Galloway site was dominated by medium light-brown mats and long brown/reddish filamentous algae (Table 7). Periphyton cover at the Manuherekia at Galloway is typically dominated by thin films (usually diatoms – light brown films) (Olsen 2023). Filamentous algae are often present at this site, but cover is typically low (>5%) and rarely exceeded 30% cover (Olsen 2023). The community observed at this site on 12 March 2024 is consistent with long-term patterns in community composition and the presence of long filaments observed at this site on 12 March 2024 is consistent with the stable flows experienced in early 2024 but is not an uncommon occurrence at this site and did not exceed 30% cover.

Dunstan Creek sites

On 12 March 2024, the periphyton community at the Dunstan Creek at Beattie Road was dominated by thin light brown films with 16.5% cover of thick black/dark brown mats (likely to be a benthic cyanobacterium, such as *Phormidium*) (Table 7). Periphyton community composition at Dunstan Creek at Beattie Road is typically dominated by thin light brown films with medium light brown mats and short filamentous algae also among the most abundant periphyton type at this site (Olsen 2023). The

abundance of benthic cyanobacteria observed at this site on 12 March 2024 is not a common occurrence at this site, with cover of medium and thick mats exceeding 10% on two other occasions.

On 5th April 2024, the periphyton community at the Dunstan Creek at Loop Road was dominated by medium and thick black/dark brown mats (75% cover), while the Dunstan Creek at confluence site was dominated by thin light-brown films (Table 6).

Lauder Creek sites

On 5th April 2024, the periphyton community at both sites in Lauder Creek were dominated by thin light brown films with low cover by medium and thick light brown mats (Table 6). The community at Lauder Creek at Cattle Yards also included low cover by *Nostoc* (Table 6). Both sites having similar, low biomass periphyton communities suggest that the dry conditions experienced in early 2024 had little impact on periphyton communities at the Rail Trail site.

Thomsons Creek sites

On 5th/6th April 2024, the periphyton community at both sites in Thomsons Creek were dominated by thin light brown films (Table 6). The community at Thomsons Creek at Race also had low cover of medium light brown mats, *Nostoc* and bryophytes[5] (Table 6). The community at Thomsons Creek upstream of Sluice Channel had low cover of medium dark brown/black mats and moderate cover by long filamentous algae (Table 6). The abundance of long filamentous green algae at the downstream site may have been exacerbated by the stable low flow conditions but may also be attributed to changes in water quality and habitat between the two sites.

Chatto Creek site

The periphyton community observed in the lower reaches of Chatto Creek on 6th April 2024 was dominated by thin light brown films, with patches of medium dark brown/black mats and macrophytes[6] (Table 6). This community is not indicative of adverse environmental conditions resulting from the low stable flows in early 2024.

[5] Bryophytes include liverworts, hornworts, and mosses

[6]

Table 6 Periphyton community composition at nine sites in the Manuherekia catchment on 5th/6th April 2024.

Category	Thickness	Upper Manuherekia at ds Forks	Manuherekia downstream of MIS take (Tiger Hill Gorge)	Dunstan Creek at Loop Road	Dunstan Creek at confluence	Lauder at Cattleyards	Lauder at Rail Trail	Thomsons Creek at Race	Thomsons Creek at us Sluice Channel	Chatto Creek at confluence
Date		5/04/2024	5/04/2024	5/04/2024	5/04/2024	6/04/2024	6/04/2024	6/04/2024	5/04/2024	6/04/2024
Thin green film	<0.5mm	0	0	0	0	0	0	0	0	0
Thin light brown film	<0.5mm	0	99.3	0	98.5	90.55	88.5	96.4	82	78.15
Thin black/dark brown film	<0.5mm	0	0	0	1	0	0	0	0	0
Medium light brown mat	0.5-3mm	1	0	0	0	5.25	10	2.25	0	0
Medium black/dark brown mat	0.5-3mm	11.65	0.6	38	0.5	0	0	0.85	0	1.25
Thick light brown mat	>3mm	1.7	0	0	0	0.25	0	0	0	0
Thick black/dark brown mat	>3mm	0	0.1	37.25	0	3.95	0	0	2.25	0
Short green filaments	<2cm	0.5	0	0	0	0	0	0	0	0
Short brown/reddish filaments	<2cm	0	0	0	0	0	0	0	0	0
Long green filaments	>2cm	0	0	0	0	0	0	0	15.75	0
Long brown/reddish filaments	>2cm	0	0	0	0	0	0	0	0	0
Sludge		0	0	0	0	0	0	0	0	0
Bryophytes		0	0	0	0	0	0	0.5	0	0
Macrophytes		0	0	0	0	0	0	0	0	8.55
Total algal % cover		14.85	100	75.25	100	100	98.5	100	100	87.95
Chlorophyll *a* (mg/m^2)		10.6	5.0	16.1	1.7	2.3	6.2	5.6	10.1	8.3

Table 7 Periphyton community composition at four long-term biomonitoring sites in the Manuherekia catchment monitored by ORC on 12 March 2024. Data courtesy of ORC.

Category	Thickness	Dunstan Creek at Beattie Rd	Manuherekia at Blackstone Hill	Manuherekia at Ophir	Manuherekia at Galloway
Date		12/03/2024	12/03/2024	12/03/2024	12/03/2024
Thin green film	<0.5mm	0	0	0	0
Thin light brown film	<0.5mm	60.5	25	3	24.5
Thin black/dark brown film	<0.5mm	2	0	0	0
Medium light brown mat	0.5-3mm	1.5	19	62	19.5
Medium black/dark brown mat	0.5-3mm	1.5	0	0	0
Thick light brown mat	>3mm	0	0	0	0
Thick black/dark brown mat	>3mm	16.5	0	3.5	0
Short green filaments	<2cm	0	0	0	0
Short brown/reddish filaments	<2cm	1.5	0	0	0
Long green filaments	>2cm	0	0	8	1.5
Long brown/reddish filaments	>2cm	1.5	17.5	63.5	17
Sludge		0	32	11	3
Bryophytes		0	0	0	0
Macrophytes		0	0	0	0
Total algal % cover		85	61.5	140[7]	62.5
Chlorophyll *a* (mg/m^2)		43.1	22.4	101	25.5

3.3. Macroinvertebrates

3.3.1. Macroinvertebrate indices

Macroinvertebrate indices at most mainstem sites on 5th/6th April 2024 were indicative of good water/habitat quality (B-band), although the MCI score for the Manuherekia at Ophir was indicative of fair water/habitat quality (C-band) (Table 8). The MCI scores at the three mainstem sites that have proposed target attribute states in the pLWRP meet or exceed these targets (Table 12). The MCI and SQMCI scores in the upper Manuhereikia d/s Forks on 5th/6th April 2024 were in A-band, indicating excellent water/habitat quality at this site (Table 8).

The MCI scores at the Manuherekia River at the Blackstone Hill and Galloway sites on 5th April 2024 were above the long-term median value for these sites, while the MCI score for the Ophir monitoring site on this occasion was less than the minimum value previously recorded for this site, indicating poor water/habitat quality at this site on this occasion (Table 12). The SQMCI score for the Manuherekia River at Blackstone Hill was close to the long-term median value, while the SQMCI scores for both the Ophir and Galloway sites were below the long-term median score, with the score for the Galloway site lower than the lowest score between 2019 and 2024 (Table 12). Overall, there is some indication that water and/or habitat quality was degraded in the Manuherekia River at the Ophir monitoring site, whilst conditions at the Blackstone Hill monitoring site were close to the long-term average. Macroinvertebrate indices at the Galloway site indicate that, whilst the macroinvertebrate community overall was consistent with previous sampling occasions, the relative abundance of species that are tolerant to poor water and/or habitat quality was higher than on previous sampling occasions.

[7] Note that it is possible to get periphyton cover that sums to more than 100%. An example is if filamentous algae overlay other periphyton types.

MCI and SQMCI scores at the three sites in Dunstan Creek on 5th/6th April 2024 were in A-band, indicating excellent water/habitat quality at these sites (Table 8). The MCI and SQMCI scores at the Dunstan Creek at Beattie Road site on 5th April 2024 were above the long-term median value for this site (Table 12). Thus, there is no evidence of degraded water/habitat conditions in Dunstan Creek during the low flow conditions in the 2023/24 irrigation season.

Macroinvertebrate indices at the upstream site in Lauder Creek was in A-band, while the downstream site was in C-band indicating fair water/habitat quality suggesting a deterioration in ecological state between these two sites (Table 8). However, this is consistent with the deterioration in water quality observed between these two sites (Hudson & Shelley 2019) and may not reflect the effects of low flows on the ecological state of the Lauder at Rail Trail site.

Similarly, the indices at the upstream site in Thomsons Creek was in B-band, while the downstream site was in C-band indicating fair water/habitat quality suggesting a deterioration in ecological state between these two sites (Table 8). However, as for the Lauder Creek sites, the change between these sites is consistent with the deterioration in water quality observed between these two sites (Hudson & Shelley 2019) and may not reflect the effects of low flows on the ecological state of Thomsons Creek upstream of the Sluice Channel.

Table 8 Summary of macroinvertebrate indices for sites in the Manuherekia catchment on 5 th/6th April 2024. The values presented for 5th/6th April 2024 are based on tolerance values of Greenwood et al. (2015). * = ORC long-term sites, data for these sites courtesy of ORC.

	pLWRP targets	5th/6th April 2024	
	MCI	MCI score	SQMCI score
Upper Manuherekia River d/s forks		138	6.98
Manuherekia River @ Blackstone*	B	112	6.44
Manuherekia River @ Ophir*	C	104	6.17
Manuherekia River d/s MIS take		111	5.93
Manuherekia River @ Galloway*	C	118	6.30
Dunstan Creek @ Loop Road		136	7.26
Dunstan Creek @ Beattie Road*	B	136	6.84
Dunstan Creek @ confluence		136	6.59
Lauder Creek @ cattle yards		137	6.52
Lauder Creek @ Rail Trail		109	5.49
Thomsons Creek @ race		128	5.80
Thomsons Creek u/s sluice channel	C	105	5.37
Chatto Creek @ confluence		111	5.53

Table 9 Comparison of macroinvertebrate indices for sites in the Manuherekia catchment on 5th/6th April 2024 with long-term statistics for the four long-term biomonitoring sites in the Manuherekia catchment . The values presented for 5th/6th April 2024 presented in this table are based on tolerance values of Stark & Maxted (2007) for consistency with the methodology used in long-term sampling. * = ORC long-term sites, data for these sites courtesy of ORC.

	MCI (2010-2024)			SQMCI/QMCI (2010-2024)			pLWRP targets	5th/6th April 2024	
	Min	Max	Median	Min	Max	Median	MCI	MCI score	SQMCI score
Manuherekia River @ Blackstone	88	117	101	4.69	7.65	6.31	B	103	6.26
Manuherekia River @ Ophir	95	111	105	4.97	6.87	6.09	C	94	5.32
Manuherekia River @ Galloway	86†	105†	105†	5.71†	6.91†	6.11†	C	116	5.41
Dunstan Creek @ Beattie Road	93	126	118	5.99	7.6	6.65	B	124	6.91

† Time period considered 2019-2024

3.3.2. Macroinvertebrate community composition

Manuherekia River sites

The macroinvertebrate community in the Manuherekia River ds Forks was numerically dominated by the mayfly *Deleatidium* and the net-spinning caddis fly *Hydropsyche* and overall, the community composition at this site was indicative of excellent water/habitat quality.

Riffle beetles (Elmidae), the mayfly *Deleatidium*, the net-spinning caddis fly *Hydropsyche*, and the sand-cased caddis fly *Pycnocentria* were the most abundant macroinvertebrate taxa at the Ophir monitoring site. This is consistent with the results of historical sampling at this site, with the mayfly *Deleatidium* was consistently the most abundant macroinvertebrate taxon at the Ophir monitoring site, while the net-spinning caddis fly *Hydropsyche* was among the most abundant taxa at this site at times.

The macroinvertebrate community in the Manuherekia River ds MIS intake on 5th April 2024 was numerically dominated by the mayfly *Deleatidium* and the net-spinning caddis fly *Hydropsyche*. Overall, the community composition at this site was indicative of excellent water/habitat quality.

Riffle beetles (Elmidae), the mayfly *Deleatidium*, the net-spinning caddis fly *Hydropsyche*, and the sand-cased caddis fly *Pycnocentrodes* and the mudsnail *Potamopyrgus* were the most abundant macroinvertebrate taxa at the Manuherekia at Galloway on 5th April 2024. This is consistent with previous sampling, where the mayfly *Deleatidium* was consistently the most abundant macroinvertebrate taxon at this site, and the net-spinning caddis fly *Aoteapsyche* was among the most abundant taxa at this site along with sandfly larvae (*Austrosimulium*), the mudsnail *Potamopyrgus* and the sand-cased caddis *Pycnocentrodes*. The macroinvertebrate community at the Galloway site on 5th April 2023 was consistent with good to excellent water/habitat quality.

Full macroinvertebrate data from 5th/6th April 2024 is presented in Appendix A.

Dunstan Creek sites

The most abundant macroinvertebrate taxa in Dunstan Creek at Beattie Road on 5th April 2024 were riffle beetles (Elmidae), the mayfly *Deleatidium*, the dobsonfly larvae *Archichaudliodes diversus*, the horn-cased caddis fly *Olinga* and the sand-cased caddis flies *Pycnocentrodes* and *Pycnocentria.* This is consistent with the community composition observed in previous sampling at this site (Olsen 2023) and is indicative of excellent water/habitat quality.

The most abundant macroinvertebrate taxa in Dunstan Creek at Loop Road on 5th April 2024 was the horn-cased caddis fly *Olinga*, with riffle beetles (Elmidae), chironomid midges (Orthocladiinae), the mayfly *Deleatidium*, sand-cased caddis flies *Pycnocentrodes* and *Pycnocentria* were also among the most abundant taxa. These taxa are indicative of excellent water/habitat quality, although the abundance of chironomid midges is likely to reflect the coverage of benthic cyanobacteria mats at this site (see Section 3.2.2).

The most abundant macroinvertebrate taxa in Dunstan Creek at the confluence on 5th April 2024 were riffle beetles (Elmidae), the mayfly *Deleatidium*, the horn-cased caddis fly *Olinga* and the sand-cased caddis flies *Pycnocentrodes* and *Pycnocentria.* The net-spinning caddis fly *Hydropsyche* and the mudsnail *Potamopyrgus* These taxa are indicative of excellent water/habitat quality, although the abundance of *Potamopyrgus* is likely to reflect the stability of flows prior to the survey.

Lauder Creek sites

The most abundant macroinvertebrate taxa in Lauder Creek at Cattle Yards on 5th April 2024 were riffle beetles (Elmidae), the mayfly *Deleatidium*, the mudsnail *Potamopyrgus*, the cased caddis fly *Beraeoptera,* the horn-cased caddis *Olinga* and the sand-cased caddis flies *Pycnocentrodes* and *Pycnocentria.* This is indicative of excellent water/habitat quality.

The most abundant macroinvertebrate taxa in Lauder Creek at Rail Trail on 6th April 2024 were the mayfly *Deleatidium*, the cased caddis *Hudsonema* and the sand-cased caddis fly *Pycnocentrodes*. These taxa are indicative of fair to good water/habitat quality.

The differences in macroinvertebrate community between the two sites on Lauder Creek are consistent with a deterioration in water and/or habitat quality between these two sites, although it is not possible to distinguish the effects of the water quality, habitat and flows between these two sites.

Thomsons Creek sites

The most abundant macroinvertebrate taxa in Thomsons Creek at Race on 6th April 2024 were the mayfly *Deleatidium*, the mudsnail *Potamopyrgus*, Oligochaete worms and the cased caddis fly *Pycnocentrodes.* This is indicative of good to excellent water/habitat quality.

The most abundant macroinvertebrate taxa in Thomsons Creek upstream of the Sluice Channel on 5th April 2024 were riffle beetles (Elmidae), the mayfly *Deleatidium*, the mudsnail *Potamopyrgus*, Oligochaete worms, the cased caddis *Hudsonema,* and the sand-cased caddis flies *Pycnocentrodes* and *Pycnocentria.* This is indicative of fair to good water/habitat quality.

The differences in macroinvertebrate community between the two sites on Thomsons Creek are consistent with a deterioration in water and/or habitat quality between these two sites, although it is not possible to distinguish the effects of the water quality, habitat and flows between these two sites.

Chatto Creek Site

The most abundant macroinvertebrate taxa in the lower reaches of Chatto Creek on 6th April 2024 were the mayfly *Deleatidium*, the mudsnail *Potamopyrgus* and the sand-cased caddis flies *Pycnocentria.* The macroinvertebrate community at this site was indicative of good water/habitat quality.

4. Summary

4.1. Periphyton

Periphyton biomasses on 12 March 2024 (ORC biomonitoring sites) or 5th/6th April 2024 were within guidelines at all sites except the Manuherekia at Ophir, which exceeded the guideline for the protection of aquatic biodiversity (50 mg/m^2; Biggs 2000) (Table 10). Cover of cyanobacteria mats exceeded guideline levels at the Dunstan Creek at Loop Road, while filamentous algae cover at the Manuherekia at Ophir site exceeded the cover guideline (Table 10). Benthic cyanobacteria have been observed in Dunstan Creek at Loop Road previously, and without long-term monitoring at this site, it is not possible to put the observation from 5th April 2204 into contect. These results suggest that the impacts of the low, stable flow conditions experienced in the 2023/24 irrigation season on periphyton were limited to two sites out of the thirteen surveyed.

Table 10 Comparison of periphyton biomass with biomass and cover guidelines (from Biggs 2000).

	Periphyton biomass guidelines			Periphyton composition	
Site name	Biodiversity	Aesthetics/ recreation (1 November-30 April)	Trout habitat/angling	Diatoms/ cyanobacteria cover (60% >0.3 mm thick)	Filamentous algae (30% >2 cm long)
Dunstan Creek at Beattie Road (ORC SOE)	✓	✓	✓	✓	✓
Manuherekia at Blackstone (ORC SOE)	✓	✓	✓	✓	✓
Manuherekia at Ophir (ORC SOE)	x	✓	✓	✓	x
Manuherekia at Galloway (ORC SOE)	✓	✓	✓	✓	✓
Upper Manuherekia at ds Forks	✓	✓	✓	✓	✓
Manuherekia ds of MIS intake	✓	✓	✓	✓	✓
Dunstan Creek at Loop Road	✓	✓	✓	x	✓
Dunstan Creek at Confluence	✓	✓	✓	✓	✓
Lauder Creek at Cattleyards	✓	✓	✓	✓	✓
Lauder Creek at Rail Trail	✓	✓	✓	✓	✓
Thomsons Creek at race	✓	✓	✓	✓	✓
Thomsons Creek upstream of Sluice Channel	✓	✓	✓	✓	✓
Chatto Creek at confluence	✓	✓	✓	✓	✓

4.2. Macroinvertebrates

Macroinvertebrate indices at most sites fell within the A- or B-band, with the exception of the Manuherekia at Ophir (MCI), Lauder Creek at Rail Trail and Thomsons Creek upstream of Sluice Channel, which fell within the C-band (Table 11). Macroinvertebrate indices for the four long-term sites met the proposed target attribute state (Table 11). The MCI and SQMCI scores measured at the Manuherekia at Ophir on 5th/6th April 2024 were below the long-term median scores for this site, while the SQMCI score measured at the Manuherekia at Galloway on 5th/6th April 2024 was below the long-term median scores for this site (Table 11).

Table 11 Comparison of macroinvertebrate indices with target attribute states and long-term statistics for long-term monitoring sites. * = ORC long-term sites, data for these sites courtesy of ORC.

Site name	Macroinvertebrate attribute state		Comparison with pLWRP target attribute state	Comparison with long-term statistics	
	MCI	SQMCI	MCI	MCI	SQMCI
Upper Manuherekia at ds Forks	A	A	-	-	-
Manuherekia at Blackstone*	B	B	✓	✓	✓
Manuherekia at Ophir*	C	B	✓	x	x
Manuherekia downstream of MIS intake	B	B	-	-	-
Manuherekia at Galloway*	B	B	✓	✓	x
Dunstan Creek at Loop Road	A	A	-		
Dunstan Creek at Beattie Road*	A	A	✓	✓	✓
Dunstan Creek at Confluence	A	A	-	-	-
Lauder Creek at Cattleyards	A	A	-	-	-
Lauder Creek at Rail Trail	C	C	-	-	-
Thomsons Creek at race	B	B	-	-	-
Thomsons Creek upstream of Sluice Channel	C	C			
Chatto Creek at confluence	B	B	-	-	-

4.3. Overall conclusions

Overall, the sampling undertaken late in the 2023/24 irrigation season found that the ecological state of the broader Manuherekia catchment was typically good to excellent, with periphyton biomass and cover meeting environmental guidelines and macroinvertebrate communities that reflected good to excellent water and/or habitat quality.

High cover by cyanobacteria in Dunstan Creek at Loop Road does not appear to have affected macroinvertebrate communities at this site (which were indicative of excellent water/habitat quality) but may have posed a health risk to humans and animals. Whilst the macroinvertebrate community indices for sites in the lower reaches of Lauder Creek and Thomsons Creek were substantially lower than those at the upstream (reference) sites, the role of the low flows in these outcomes is unclear, as water quality is known to decline markedly between the upper and lower reaches (Hudson & Shelley 2019) and periphyton biomass at both of these sites was well within guideline levels.

The Manuherekia at Ophir stood out as exceeding periphyton guidelines and the macroinvertebrate community at this site indicated that the state of this site was worse than is typical for this site. Given that this site stands out when compared to other sites on the mainstem of the Manuherekia, it is likely that local factors have contributed to the degradation observed at this site. It is likely that the low, stable flows observed in the 2023/24 contributed to these outcomes, most likely when combined with high nutrient inputs from both the wastewater treatment plant and Thomsons Creek, which enter the Manuherekia River a short distance upstream of the Ophir monitoring site.

5. References

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Appendix A

Macroinvertebrate data

Table 12 Macroinvertebrates collected from the sites in the Manuherekia catchment on 5th/6th April 2024. R = 'rare' (1-4 individuals per sample), C = 'common' (5-19 individuals per sample), A = 'abundant' (20-99 individuals per sample), VA = very abundant (100-299 individuals per sample), VVA = >500 individuals per sample).

ORDER	TAXON	Tolerance value	Upper Manuherekia River d/s forks	Manuherekia River @ Blackstone	Manuherekia River @ Ophir	Manuherekia River d/s MIS take	Manuherekia River @ Galloway
COLEOPTERA	*Berosus*	4					
	Elmidae	6	VA	VVA	VVA	VVA	VVA
	Hydraenidae	8					
CRUSTACEA	Ostracoda	3		C	A	R	A
	Paracalliope	5			C		
DIPTERA	*Aphrophila*	9	A				
	Austrosimulium	6					VA
	Eriopterini	9	R				
	Lobodiamesa	3					
	Maoridiamesa	7	C				
	Muscidae	4	C	A	C	R	
	Orthocladiinae	4	VA	A	VA	C	
	Polypedilum	2					R
	Tabanidae	8					
	Tanytarsini	5	VA	C	VA		
EPHEMEROPTERA	*Austroclima*	6	VA	VA	A	VA	A
	Coloburiscus	9	VA				
	Deleatidium	7	VVA	VVA	VVA	VVA	VVA
	Nesameletus	8	A			C	C
MECOPTERA	*Nannochorista*	7					
MEGALOPTERA	*Archichauliodes*	8	A	C	C	A	R
MOLLUSCA	*Physa = Physella*	2		C	VA	VA	A
	Potamopyrgus	5			VA	VVA	VVA
	Sphaeriidae	2					
NEMATOMORPHA		5					
NEMERTEA		2		A	C		
OLIGOCHAETA		5		A	A	R	
PLATYHELMINTHES		4		C	C	R	
PLECOPTERA	*Megaleptoperla*	7					
	Stenoperla	9	C				
	Zelandobius	7	C		C		
	Zelandoperla	8	R				
TRICHOPTERA	*Beraeoptera*	7	VA		A		
	Costachorema	9		R			
	Helicopsyche	9					
	Hudsonema	4	C	A	A	R	A
	Hydrobiosis	8	A	A	A	C	A
	Hydropsyche (Aoteapsyche)	8	VVA	VVA	VVA	VA	VVA
	Neurochorema	6	A	R	C		
	Olinga	9	VA	VA			A
	Oxyethira	3			A		
	Psilochorema	7	C	C		C	A
	Pycnocentria	5	VA	VVA	VA	A	VA
	Pycnocentrodes	6	VA	VA	VVA	VVA	VVA

Table 12 Macroinvertebrates collected from the sites in the Manuherekia catchment on 5th/6th April 2024. R = 'rare' (1-4 individuals per sample), C = 'common' (5-19 individuals per sample), A = 'abundant' (20-99 individuals per sample), VA = very abundant (100-299 individuals per sample), VVA = >500 individuals per sample).

ORDER	TAXON	Tolerance value	Upper Manuherekia River d/s forks	Manuherekia River @ Blackstone	Manuherekia River @ Ophir	Manuherekia River d/s MIS take	Manuherekia River @ Galloway
Number of taxa			24	21	23	18	17
Number of EPT taxa (incl. Hydroptilidae)			16	11	11	9	10
Number of EPT taxa (excl. Hydroptilidae)			16	11	10	9	10
% EPT taxa (incl. Hydroptilidae)			66.7	52.4	47.8	50.0	58.8
% EPT taxa (excl. Hydroptilidae)			66.7	52.4	43.5	50.0	58.8
MCI score			138	112	104	111	118
SQMCI score			6.98	6.44	6.17	5.93	6.30

Table 12 Macroinvertebrates collected from the sites in the Manuherekia catchment on 5th/6th April 2024. R = 'rare' (1-4 individuals per sample), C = 'common' (5-19 individuals per sample), A = 'abundant' (20-99 individuals per sample), VA = very abundant (100-299 individuals per sample), VVA = >500 individuals per sample).

ORDER	TAXON	Tolerance value	Dunstan Creek @ Loop Road	Dunstan Creek @ Beattie Road	Dunstan Creek @ confluence	Lauder Creek @ cattle yards	Lauder Creek @ Rail Trail
COLEOPTERA	*Berosus*	4					
	Elmidae	6	VA	VVA	VVA	VA	VA
	Hydraenidae	8					
CRUSTACEA	Ostracoda	3		A		R	R
	Paracalliope	5					VA
DIPTERA	*Aphrophila*	9	R	R	R		
	Austrosimulium	6		A	R	C	
	Eriopterini	9	R	C	R	R	
	Lobodiamesa	3		C			
	Maoridiamesa	7				R	
	Muscidae	4	R		C		R
	Orthocladiinae	4	VA	VA		A	C
	Polypedilum	2					
	Tabanidae	8		R			
	Tanytarsini	5	C		R		
EPHEMEROPTERA	*Austroclima*	6	C	A	C	VA	
	Coloburiscus	9		C	C	C	
	Deleatidium	7	VA	VVA	VVA	VVA	VVA
	Nesameletus	8	R	C	R	VA	
MECOPTERA	*Nannochorista*	7					
MEGALOPTERA	*Archichauliodes*	8	A	VVA	A	R	C
MOLLUSCA	*Physa = Physella*	2					R
	Potamopyrgus	5	A	C	VA	VVA	VA
	Sphaeriidae	2					
NEMATOMORPHA		5			R		
NEMERTEA		2					
OLIGOCHAETA		5	C	A	A	VA	VA
PLATYHELMINTHES		4					
PLECOPTERA	*Megaleptoperla*	7				R	
	Stenoperla	9	R	C	C	C	
	Zelandobius	7		A	R		
	Zelandoperla	8		C		A	
TRICHOPTERA	*Beraeoptera*	7		A	A	VVA	
	Costachorema	9	R	C	R	R	
	Helicopsyche	9				A	
	Hudsonema	4		A	A	A	VVA
	Hydrobiosis	8	C	A	A	C	A
	Hydropsyche (Aoteapsyche)	8	A	VA	VA	VA	VA
	Neurochorema	6	R		R	R	
	Olinga	9	VVA	VVA	VVA	VVA	
	Oxyethira	3					
	Psilochorema	7	A	A	A	C	A
	Pycnocentria	5	VA	VVA	VVA	VVA	VVA
	Pycnocentrodes	6	VA	VA	VVA	VVA	A

Table 12 Macroinvertebrates collected from the sites in the Manuherekia catchment on 5th/6th April 2024. R = 'rare' (1-4 individuals per sample), C = 'common' (5-19 individuals per sample), A = 'abundant' (20-99 individuals per sample), VA = very abundant (100-299 individuals per sample), VVA = >500 individuals per sample).

ORDER	TAXON	Tolerance value	Dunstan Creek @ Loop Road	Dunstan Creek @ Beattie Road	Dunstan Creek @ confluence	Lauder Creek @ cattle yards	Lauder Creek @ Rail Trail
Number of taxa			21	27	26	27	16
Number of EPT taxa (incl. Hydroptilidae)			12	16	16	18	7
Number of EPT taxa (excl. Hydroptilidae)			12	16	16	18	7
% EPT taxa (incl. Hydroptilidae)			57.1	59.3	61.5	66.7	43.8
% EPT taxa (excl. Hydroptilidae)			57.1	59.3	61.5	66.7	43.8
MCI score			136	136	136	137	109
SQMCI score			7.26	6.84	6.59	6.52	5.49

Table 12 Macroinvertebrates collected from the sites in the Manuherekia catchment on 5th/6th April 2024. R = 'rare' (1-4 individuals per sample), C = 'common' (5-19 individuals per sample), A = 'abundant' (20-99 individuals per sample), VA = very abundant (100-299 individuals per sample), VVA = >500 individuals per sample).

ORDER	TAXON	Tolerance value	Thomsons Creek @ race	Thomsons Creek u/s sluice channel	Chatto Creek @ confluence
COLEOPTERA	*Berosus*	4		R	
	Elmidae	6	A	VVA	A
	Hydraenidae	8	R		
CRUSTACEA	Ostracoda	3	A	VA	R
	Paracalliope	5		VA	A
DIPTERA	*Aphrophila*	9	R		
	Austrosimulium	6			R
	Eriopterini	9			
	Lobodiamesa	3			
	Maoridiamesa	7	R		R
	Muscidae	4	C	C	
	Orthocladiinae	4	R	C	C
	Polypedilum	2			
	Tabanidae	8			
	Tanytarsini	5	R		
EPHEMEROPTERA	*Austroclima*	6	VA	A	
	Coloburiscus	9			
	Deleatidium	7	VVA	VVA	VVA
	Nesameletus	8	R		
MECOPTERA	*Nannochorista*	7	R		
MEGALOPTERA	*Archichauliodes*	8	R	C	A
MOLLUSCA	*Physa = Physella*	2		VA	R
	Potamopyrgus	5	VVA	VVA	VVA
	Sphaeriidae	2		C	VA
NEMATOMORPHA		5			
NEMERTEA		2			R
OLIGOCHAETA		5	VVA	VVA	A
PLATYHELMINTHES		4	R	C	A
PLECOPTERA	*Megaleptoperla*	7			
	Stenoperla	9			
	Zelandobius	7			
	Zelandoperla	8	R		
TRICHOPTERA	*Beraeoptera*	7	A		
	Costachorema	9	R		R
	Helicopsyche	9			
	Hudsonema	4	VA	VVA	A
	Hydrobiosis	8	R	A	A
	Hydropsyche (Aoteapsyche)	8	A	VA	C
	Neurochorema	6	R		
	Olinga	9	VA	A	A
	Oxyethira	3		C	
	Psilochorema	7	C	A	C
	Pycnocentria	5	VA	VVA	VVA
	Pycnocentrodes	6	VVA	VVA	VA

Table 12 Macroinvertebrates collected from the sites in the Manuherekia catchment on 5th/6th April 2024. R = 'rare' (1-4 individuals per sample), C = 'common' (5-19 individuals per sample), A = 'abundant' (20-99 individuals per sample), VA = very abundant (100-299 individuals per sample), VVA = >500 individuals per sample).

ORDER	TAXON	Tolerance value	Thomsons Creek @ race	Thomsons Creek u/s sluice channel	Chatto Creek @ confluence
Number of taxa			27	22	22
Number of EPT taxa (incl. Hydroptilidae)			14	10	9
Number of EPT taxa (excl. Hydroptilidae)			14	9	9
% EPT taxa (incl. Hydroptilidae)			51.9	45.5	40.9
% EPT taxa (excl. Hydroptilidae)			51.9	40.9	40.9
MCI score			128	105	111
SQMCI score			5.80	5.37	5.53