Monitoring of the Phased Implementation of the Manuherekia Catchment Management Plan

November 2025 – March 2026

Manuherekia River at /s MICSL Take

Prepared for:

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Table of Contents

1. Introduction

The Manuherekia Catchment Group (MCG) started the phased implementation of the Catchment Management Plan (CMP) developed by the late Matt Hickey of Water Resource Management as part of preparations for the reconsenting of deemed permits and the minimum flow setting process in the Manuherekia catchment. The purpose of the CMP was to manage the Manuherekia catchment as a whole, by establishing residual flows to provide for in-stream values in tributaries and to contribute to the minimum flow at the Campground minimum flow site near Alexandra and ensuring that flows are sufficient to provide for in-stream values along the length of the Manuherekia River itself.

The CMP breaks the catchment down into three catchment flow management zones – Above Falls Dam, Manuherekia and Ida Valley Management Zones. The Manuherekia Management Zone is further broken down into five Tributary Water Management Zones – Dunstan Creek, Lauder Creek, Thomson Creek, Chatto Creek and Manor Burn. The CMP sets out minimum[1] or residual[2] flows at four sites on the mainstem of the Manuherekia River (Tier 1 flow restrictions):

- 720 l/s residual flow at below Falls Dam
- 500 l/s residual flow at OAIC's intake
- 820 l/s minimum flow at Ophir
- 1,100 l/s minimum flow at Campground

Further to the mainstem minimum/residual flows on the mainstem, tributary residual flows measured in the tributary just upstream of the confluence with the Manuherekia apply to all water permits in the tributary catchment (Tier 2 flow restrictions):

- 250 l/s residual flow from Dunstan Creek
- 100 l/s residual flow from Lauder Creek
- 70 l/s residual flow from Thomsons Creek
- 100 l/s residual flow from Chatto Creek
- 15 l/s residual flow from the Lower Manorburn Dam

Site specific residual flows applied to individual water permits to maintain instream values immediately downstream of the point of take (Tier 3 flow restrictions).

These three tiers of flow restrictions would be applied in the Water Management Zones as follows:

1) Above Falls Dam Management Zone – all water permits would have tier 1 and tier 3 flow restrictions applied.
2) Manuherekia Management Zone – all water permits with points of take from the main stem would have the tier 1 minimum flow at Campground applied and all water permits in the Tributaries Management Zones would have the tier 1 minimum flows applied, tier 2 tributary residual flows applied, and any tier 3 site specific residual flow applied.

[1] A minimum flow applies at a flow monitoring location within a catchment and all water users subject to that minimum flow must cease taking water (except stock drinking water and essential domestic water) when flows drop below the minimum flow at that flow monitoring flow. Minimum flows are set as part of a regional planning process.

[2] Residual flows apply to individual consent(s) and is a flow to be maintained immediately downstream of a point of take. Residual flows are set as part of a consenting process.

3) Ida Valley Management Zone – water permits in the Ida Valley would only be subject to tier 3 flow restrictions[3].

The CMP was first partially (50%) implemented in the 2024/25 season and again in the 2025/26 season.

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 ten sites were surveyed each month between December and March in both the 2024/25 (Olsen 2025) and 2025/26 irrigation seasons to broaden the coverage of periphyton and macroinvertebrate sampling during the phased implementation of CMP (see Section 2.1). This survey included sites that were located upstream of major irrigation off-takes as reference sites (or control sites) to provide an indication of the state of periphyton and macroinvertebrate communities at sites that were upstream of (and therefore unaffected by) water abstraction. The data collected from these reference sites 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 four occasions between December 2025 and March 2026 and to compare the results of this monitoring to the results of long-term monitoring results to assess the ecological state of waterways in the Manuherekia catchment during the phased implementation of the CMP.

[3] The Ida Valley has a dry climate and its natural discharge to the Manuherekia River during low flow periods is small. Most of the water that is used for irrigation is stored in the Poolburn and Upper Manorburn Dams that are filled during the previous years of winter and spring snow melt inflows. Hence tier 1 minimum flow limits would not be applied.

2. Methods

2.1. Monitoring sites

Periphyton was surveyed at ten sites in the Manuherekia catchment on four occasions between December 2025 and March 2026 (Table 1; Figure 1). Of these survey sites, four were located upstream of major irrigation off-takes, for use as reference (or control) sites (marked in blue in Table 1). These sites provide an indication of the state of periphyton and macroinvertebrate communities at sites that were unaffected by water abstraction. The data collected from these reference sites assist in the interpretation of the results of monitoring at sites downstream of irrigation takes.

Further to the sites surveyed, data collected from the four additional long-term biomonitoring sites was requested from Otago Regional Council and is included in this analysis. These long-term sites are sampled on a monthly basis by ORC as part of its SOE monitoring programme (marked in green in Table 1 and Figure 1).

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

Management Zone	Site name	Site type	NZTM		Monitoring	
			Easting	Northing	Periphyton	Macroinverts
Manuherekia	Upper Manuherekia at ds Forks	Control site	1355169	5038916	Y	Y
	Manuherekia at Blackstone	ORC SOE	1346627	5014356	Y	Y
	Manuherekia at Ophir	ORC SOE	1331771	4999074	Y	Y
	Manuherekia downstream of MICSL intake	Impact site	1328841	4997133	Y	Y
	Manuherekia at Galloway	ORC SOE	1319841	4986021	Y	Y
Dunstan Creek	Dunstan Creek at Gorge	Control site	1344649	5033051	Y	Y
	Dunstan Creek at Loop Road	Impact site	1346596	5025913	Y	Y
	Dunstan Creek at Beattie Road	ORC SOE	1344762	5018627	Y	Y
	Dunstan Creek at Confluence	Impact site	1344625	5012983	Y	Y
Lauder Creek	Lauder Creek at Cattleyards	Control site	1332170	5016412	Y	Y
	Lauder Creek at Rail Trail	Impact site	1339006	5006366	Y	Y
Thomsons Creek	Thomsons Creek at race	Control site	1329190	5012712	Y	Y
	Thomsons Creek upstream of Sluice Channel	Impact site	1331173	5000428	Y	Y
Chatto Creek	Chatto Creek at confluence	Impact site	1325194	4992109	Y	Y

2.2. Flow conditions

Flows at most hydrological monitoring sites in the Manuherekia catchment were high in September, October and much of November 2025, with peak flows (>6 times the median flow for most sites) occurring in on 5 October 2025. Flows dropped from these highs during November, but a series of rainfall events kept flows elevated for much of the season (Figure 2). A high flow event in late January exceeded 3-times the median flow at hydrological monitoring sites in the mainstem, Dunstan Creek and Lauder Creek (Figure 2).

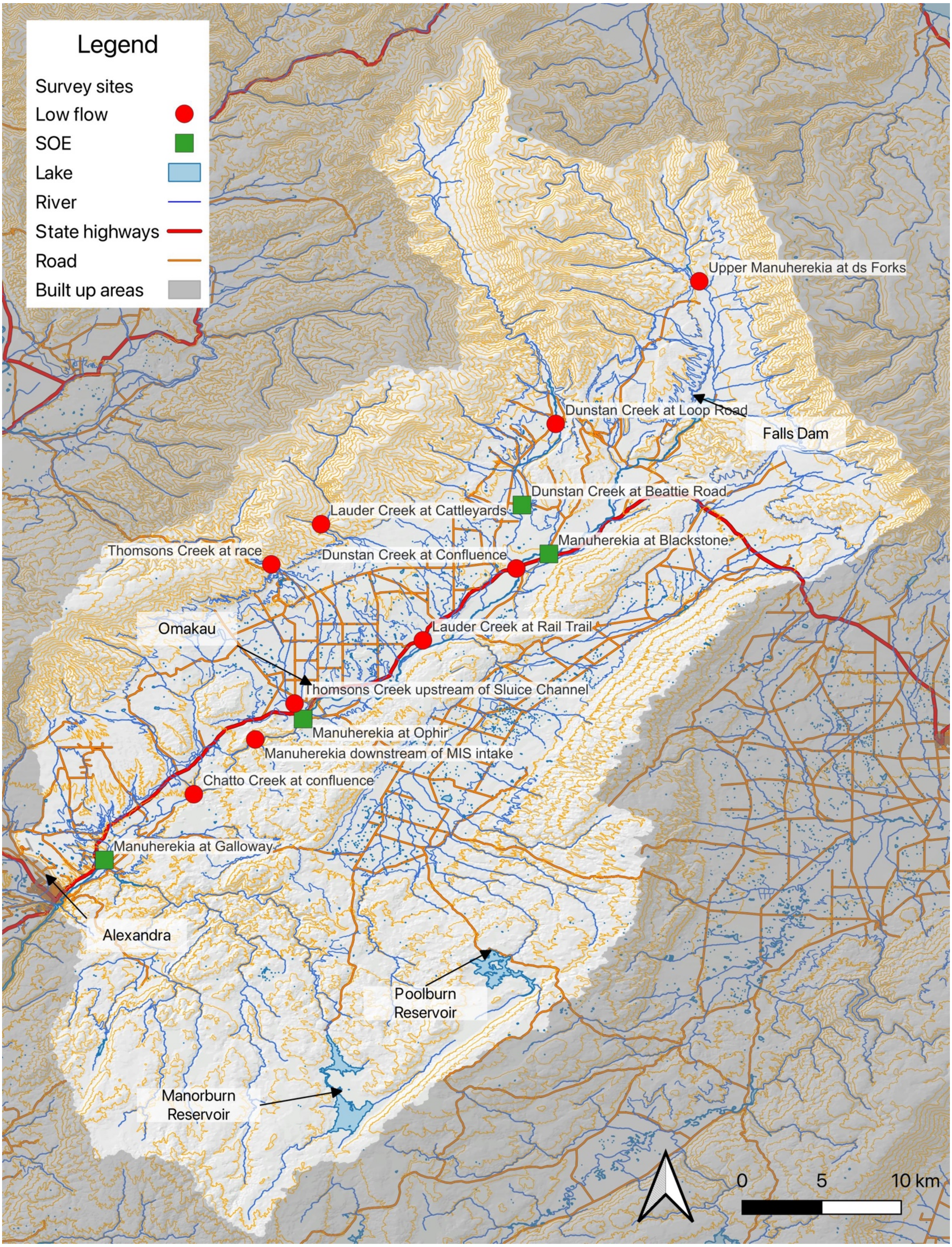

Figure 1 **Map of the Manuherekia catchment showing long-term biomonitoring sites (monitored by ORC) and sites surveyed as part of CMP monitoring surveys between December 2025 and March 2026.**

Figure 2 **Hydrograph for flows at sites in the Manuherekia catchment during periphyton surveys (green squares [this study], dark green diamonds [ORC sites]) and macroinvertebrate sampling (purple triangles) between November 2025 and March 2026.**

2.3. Periphyton

Periphyton cover was 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, Microcoleus* (formerly *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) . Analysis of samples followed protocol 'P2: 200 Individual Fixed Count with Scan for Rare Taxa' as in Stark et al. (2001) by SLR Consulting. ORC collected macroinvertebrate samples from the Manuherekia catchment in March 2026. Given that the purpose of this monitoring was to capture the ecological state of sites in the broader Manuherekia catchment in response to flow management and irrigation, macroinvertebrate samples were collected from all sites (including SoE sites) on 11th or 12th February 2026.

MCI scores were calculated as the sum of the tolerance scores for each taxa present in the sample divided by the taxon richness, multiplied by 20 while the QMCI was calculated by first multiplying the tolerance score for each taxon by the abundance of that taxon, summing the products for each taxa and dividing by the total abundance in the sample (following Stark 1985), The tolerance scores used to calculate MCI and SQMCI scores are based on Greenwood et al. (2015) (see Appendix C for comparison with tolerance scores of Stark & Maxted 2007). The Average Score Per Metric was calculated by standardising MCI scores by dividing 200, standardising EPT taxa by dividing by 29 and %EPT abundance by dividing by 100. These standardised metrics were summed and the result divided by 3, giving an ASPM between 0 and 1 (following the methods outlined in the footnote to Table 15 of the National Objectives Framework, based on the original method of Collier 2008).

3. Results & Discussion

3.1. Periphyton

3.1.1. Antecedent flows

Periphyton biomass at any time reflects the balance of two opposing processes: biomass accrual and biomass loss. The rate of cell division controls the rate of biomass accrual and is controlled by factors such as the availability of nutrients, light and water temperature (Biggs 2000a). Meanwhile, the rate of biomass loss is governed by physical disturbance (substrate instability, water velocity (shear stresses) and suspended solids) and grazing (by invertebrates) (Biggs 2000). Consequently, when interpreting the results of periphyton surveys, it is important to consider the hydrological conditions prior to sampling occasions. Flows in excess of 3-times the long-term median flow are used as a rule of thumb to indicate flows that are high enough to reduce periphyton biomass at a site and the frequency of events of events of this magnitude (abbreviated to FRE3) is the most commonly hydrological metric used to characterise the hydrological conditions for periphyton at a site (Clausen & Biggs 1997). The amount of time between an event of 3x median flows and a sampling event is commonly referred to as the accrual period, or the period of time that processes that favour periphyton biomass accrual exceed the effect of processes that lead to biomass loss.

Table 3 summarises hydrological conditions at hydrological monitoring sites closest to biomonitoring sites sampled by ORC in the Manuherekia catchment between December 2025 and March 2026. Table 4 summarises hydrological conditions at the seven hydrological sites closest to sites surveyed as part of this study between December 2025 and March 2026.

As described in Section 2.2, hydrological conditions in the Manuherekia catchment over the 2025/26 season were characterised by high flows during spring (September – mid-November 2025) with flows dropping below median flows but remaining elevated for the remainder of the irrigation season. Flows at all hydrological monitoring sites exceeded the median flow between mid-September and mid-November, with these elevated flows continuing until late December 2025 at many of these sites (Figure 2). High flow events in late October 2025 and late January exceeded 3x median flow at most sites and flows of this magnitude are expected to have affected periphyton communities, resulting in shorter accrual periods prior to surveys in February and March for sites in the mainstem, Dunstan Creek and Lauder Creek (Table 3, Table 4).

Biggs (2000b) presents a graph of the relationship between accrual period and maximum benthic chlorophyll *a* biomass based on sampling of 30 New Zealand rivers sampled every 2-4 weeks for at least 13 months, with peak periphyton biomass occurring after an accrual period of between 70 and 120 days. As outlined above, periphyton biomass accrual and is controlled by factors such as the availability of nutrients, light and water temperature. Spring flows in the Manuherekia are often high as a result of rainfall and snowmelt and this, combined with the seasonal changes in light intensity[4], mean that the highest risk period for periphyton proliferation in the Manuherekia catchment is expected to coincide with the later part of the irrigation season (late February/March). CMP monitoring in the Manuherekia in the 2024/25 season tracked the development of the periphyton across a long accrual period (>120 d) typical of low flow seasons that occur in the Manuherekia catchment (Olsen 2025). In contrast to the 2024/25 surveys, conditions during this survey were characterised by frequent rainfall, resulting in elevated flows and shorter accrual periods (Table 3, Table 4).

[4] Peak solar radiation occurs between October and February with lowest values in June based on data from NIWA SolarView Calculator.

Table 3 Summary of flow conditions at the hydrological monitoring sites closest to ORC biomonitoring sites on each occasion ORC surveyed periphyton at sites on the Manuherekia River and Dunstan Creek at Beattie Road. Flow data for Ophir courtesy of Earth Sciences New Zealand.

			Accrual time	Antecedent flows		
Hydrological site	Survey dates	Mean flow during survey (l/s)	(Days since 3x median)	7-d maximum flow	14-d maximum flow	28-d maximum flow
Manuherekia at Blackstone	03-Dec-25	4473	30	5096	5096	12262
	07-Jan-26	3730	65	6507	6507	6507
	03-Feb-26	8081	6	16712	34490	34490
	05-Mar-26	3670	36	4715	4715	5619
	01-Apr-26	2742	61	2742	2742	2742
Manuherikia at Ophir	03-Dec-25	6352	33	7840	7840	19690
	07-Jan-26	5180	68	9151	9151	9151
	03-Feb-26	11833	7	25451	37648	37648
	05-Mar-26	4957	37	6272	6272	7831
	01-Apr-26	4349*	64	4349	4349	4957
Manuherekia at Campground	03-Dec-25	6310	31	8991	8991	27714
	07-Jan-26	4671	66	8596	8596	8596
	03-Feb-26	13274	7	33497	54354	54354
	05-Mar-26	5184	37	6822	6822	12814
	01-Apr-26	4088	64	4088	4088	5184
Dunstan Creek at Beattie Road 100m Downstream	03-Dec-25	2161	30	2377	2377	6958
	07-Jan-26	1867	65	3404	3404	3404
	03-Feb-26	3322	8	5263	9656	9656
	05-Mar-26	1165	38	2090	2090	2971
	01-Apr-26	877	65	1137	1137	1399

* Actually the mean daily flow on 30/3/26

Table 4 Summary of flow conditions at the hydrological monitoring sites closest to the sites surveyed in this study on each sampling occasion in the 2025-2026 season.

Hydrological site	Survey dates	Mean flow during survey (l/s)	Accrual time (Days since 3x median)	Antecedent flows (l/2) 7-d maximum flow	14-d maximum flow	28-d maximum flow
Manuherikia downstream of Fork	12-Dec-25	2213	41	2820	3240	3750
	14-Jan-26	1928	74	2385	3899	3899
	11-Feb-26	2347	15	2979	5085	11285
	20-Mar-26	1466	52	1787	2332	2943
Manuherikia at Chatto Creek u/s	12-Dec-25	2922	39	4897	5996	10481
	13-Jan-26	1798	71	3126	6643	6643
	11-Feb-26	3164	14	7941	21667	46135
	20-Mar-26	2321	51	2321	2344	4289
Dunstan Creek at Gorge 500m Downstream	12-Dec-25	1354	38	1693	1893	3156
	14-Jan-26	1338	71	1783	3272	3272
	11-Feb-26	1540	16	1890	3221	7236
	20-Mar-26	927	53	1083	1267	1729
Dunstan Creek at Beattie Road 100m Downstream	12-Dec-25	1401	39	1801	2260	3963
	14-Jan-26	1291	72	1867	3404	3404
	11-Feb-26	1686	16	2655	4428	9656
	20-Mar-26	736	53	1188	1399	2090
Lauder Creek at Cattle Yards	13-Dec-25	677	42	1079	1079	1545
	14-Jan-26	696	74	863	1728	1728
	12-Feb-26	838	17	1053	1677	5778
	21-Mar-26	473	54	516	727	840
Lauder Creek at Rail Trail	12-Dec-25	598	41	1614	3016	3712
	14-Jan-26	547	74	1728	1728	1728
	11-Feb-26	784	16	5778	5778	5778
	20-Mar-26	248	53	1034	1053	5778
Thomsons Creek at Diversion Weir u/s	13-Dec-25	430	40	598	637	1184
	14-Jan-26	405	72	502	1395	1395
	12-Feb-26	504	101	591	861	1492
	21-Mar-26	305	138	321	404	532
Thomsons Creek at SH85	12-Dec-25	344	41	695	810	1212
	13-Jan-26	239	73	357	1153	1153
	11-Feb-26	216	102	585	1196	1801
	20-Mar-26	173	139	206	252	569
Chatto Creek at Manuherekia Confluence 100m Upstream	13-Dec-25	895	44	1231	1571	2082
	13-Jan-26	587	75	799	1008	1207
	12-Feb-26	696	105	873	1262	2285
	21-Mar-26	490	142	677	683	999

3.1.2. Community composition

Manuherekia River sites

The periphyton community in the Upper Manuherekia at d/s Forks typified by low cover by mats or filaments, with most of the bed comprising of bare rock (no periphyton) or thin films on most occasions (Figure 3). The limited cover by thicker growths included the colonial cyanobacterium *Nostoc* (2-10% cover) and medium/thick light brown mats (including the invasive diatom *Didymosphenia geminata;* 0.25-14%) (Figure 3).

Nostoc is commonly found in fast-flowing, high-elevation sites with low levels of nutrient enrichment and coarse substrate (including bedrock) (Biggs & Kilroy 2000).

Didymosphenia geminata (hereafter, Didymo) spread rapidly after its incursion into New Zealand was recognised by Kilroy (2004) and it had been detected in many of the major catchments in the South Island by 2007 (Kilroy & Unwin 2011). Didymo has now been in the Clutha/Mata-Au catchment for at least 20 years and in the Manuherekia catchment for at least 18 years (Kilroy & Unwin 2011). Didymo commonly forms very high biomass, thick mats that cover much of the riverbed in lake outlet rivers, including the Mararoa River (where it was first identified in New Zealand; Kilroy 2004), Waiau, the Clutha/Mata-Au, Hāwea, Waitaki, Hurunui, Buller and Gowan Rivers and this has been recognised in the Manuherekia River below Falls Dam (see Manuherekia at Blackstone Hill below). Such sites are expected to have conditions that are suitable for the development of high periphyton cover and biomass including stable hydrological conditions (with high flow events moderated by the influence of lakes) and coarse substrates (dominated by boulders and cobbles). Lake outlet rivers often have low dissolved nutrient concentrations, as a result of uptake by phytoplankton within the lake, with nutrients exported from the lakes as seston (live and dead phytoplankton, live and dead zooplankton and particulate organic matter) rather than forms that are bioavailable to periphyton. Bothwell et al. (2014) summarises research in New Zealand rivers to understand the drivers of Didymo bloom formation in New Zealand rivers following the recognition that Didymo blooms did not seem to occur in spring-fed rivers despite multiple introductions. Bothwell et al. (2014) concluded that stalk production in Didymo (and therefore the production of Didymo blooms) was a response to phosphorus limitation. This accounts for patterns in the distribution of Didymo within the Manuherekia catchment, with Didymo observed in upland sites with low phosphorus concentrations, including the Upper Manuherekia at d/s Forks.

The periphyton community at the Manuherekia at Blackstone Hill between December 2025 and April 2026 was dominated by bare substrate or thin films (59-97%), with limited cover by light brown mats, filamentous algae and sludge (Figure 3). Sludge refers to "unconsolidated algae that is easily detached", which is typically used to refer to detached, dead or senescent[5] algae that may accumulate on channel edges or low velocity areas. Filamentous algae cover was highest in January 2026 (20%), but substantially lower in subsequent surveys (<1-8%) (Figure 3).

The periphyton cover at the Blackstone Hill site has previously been dominated by light brown mats, with this likely to include Didymo, which has been identified at this site since 2008 (Olsen 2023). The reduction in cover by filamentous algae at this site between the January and February 2026 surveys is likely to be a result of . The Manuherekia at Blackstone Hill site is the closest site on the mainstem of the Manuherekia to Falls Dam (approximately 19 km downstream of Falls Dam) and there are few tributaries that enter the Manuherekia between Falls Dam and the Blackstone site (Mata and Station Creeks), meaning that flows at the Blackstone site are largely controlled by the outflows from Falls Dam. Such stable flow conditions along with the low phosphorus concentrations observed at this site (Hudson & Shelley 2019) are favourable for the development of Didymo blooms. The Blackstone site is immediately downstream of the Omakau Area Irrigation Company Ltd. (OAIC) main race intake, which is consented to take up to 1,981 l/s from the Manuherekia River. The composition and cover of periphyton at the Blackstone site is consistent with the stabilising effects of Falls Dam and good water quality at this site rather than an effect of the operation of the OAIC take.

[5] Scenescence refers to the process of cellular ageing or deterioration of cell function

Periphyton cover at the Manuherekia at Ophir was low between January and April 2026 with cover dominated by bare substrate or thin films (84-100%) (Figure 3). On the December 2025 survey, the periphyton community at Ophir was dominated by black/dark brown mats (38%) and filamentous algae (8% long filamentous, 4% short filamentous; Figure 3). Cover by long filamentous algae and total cover by medium and thick mats were within guideline values for the protection of aesthetics/recreation and trout habitat and angling (Biggs 2000) on all sampling occasions. The cover of benthic cyanobacteria at this site in the December 2025 survey exceeded the Alert (Orange) level (>20%), but was less than the Alert (Red) level (50%) for potentially toxic benthic cyanobacteria in recreational water (Ministry for the Environment (MfE) & Ministry of Health (MoH) 2009). These guidelines apply to sites used for contact recreation. Under these guidelines, Alert (Orange mode) level triggers increased sampling and erection of signs warning the public of the potential risks whereas Action (Red mode) triggers public notification of the potential risks to health of cyanobacteria. Cover of black/dark brown mats

The periphyton cover and composition observed at the Ophir site in December 2025 was consistent with long-term patterns in community composition at this site, but cover on subsequent occasions was substantially lower than previously observed at this site. The higher cover of mats and filaments typically observed at this site compared with other sites on the mainstem of the Manuherekia is likely to be a result of nutrient enrichment at this site, particularly from the Omakau WWTP and Thomsons Creek inflows that enter the mainstem of the Manuherekia immediately upstream of the Ophir site (Hickey & Olsen 2020). The increase in DRP immediately upstream of the Ophir monitoring site is expected to be less favourable for Didymo proliferation (Bothwell *et al.* 2014) and is likely to account for the reduced incidence of thick Didymo mats at sites downstream of Ophir. Water abstraction is not expected to materially affect habitat suitability for Didymo, but will increase the risk of the proliferation of filamentous algae (based on the analysis of Olsen *et al.* 2017).

The periphyton community in the Manuherekia at d/s MICSL take was dominated by bare substrate and thin light brown mats on all sampling occasions (Figure 3). Cover by mats was generally low (<14%), with cover of benthic cyanobacteria on all occasions (<10%) well within Alert (Orange) level (>20%) for potentially toxic benthic cyanobacteria in recreational water (MfE & MoH 2009). The low periphyton cover at this site likely reflects the confined nature of this reach, the steepness of the channel in this reach and topographic shading of the channel. This reach is immediately downstream of the Manuherekia Irrigation Co-operative Society Ltd. (MICSL) take in downstream of Omakau/Ophir which is consented to take up to 2,703.1 l/s from the Manuherekia River. The very low cover of periphyton at this site indicates that the operation of the MICSL take did not affect periphyton cover or composition in the 2025/26 irrigation season.

Periphyton cover at the Manuherekia at Galloway site between December 2025 and April 2026 was dominated by bare substrate and thin films (93-100%) with very low cover by mats or filamentous algae on all occasions (Figure 3). Cover by long filamentous algae and total cover by mats were well within guideline values for the protection of aesthetics/recreation and trout habitat and angling (Biggs 2000) on all sampling occasions. The Galloway site is located in the lower reaches of the Manuherekia River, downstream of most water takes and is the lowest reach in the Manuherekia River where the channel flowed unconstrained over a wide, gravel bed and was not shaded by surrounding topography. These characteristics increase the risk of periphyton proliferation. Periphyton cover and biomass at the Galloway site in the 2025/26 season was much lower than in the 2024/25 season (Olsen 2025).

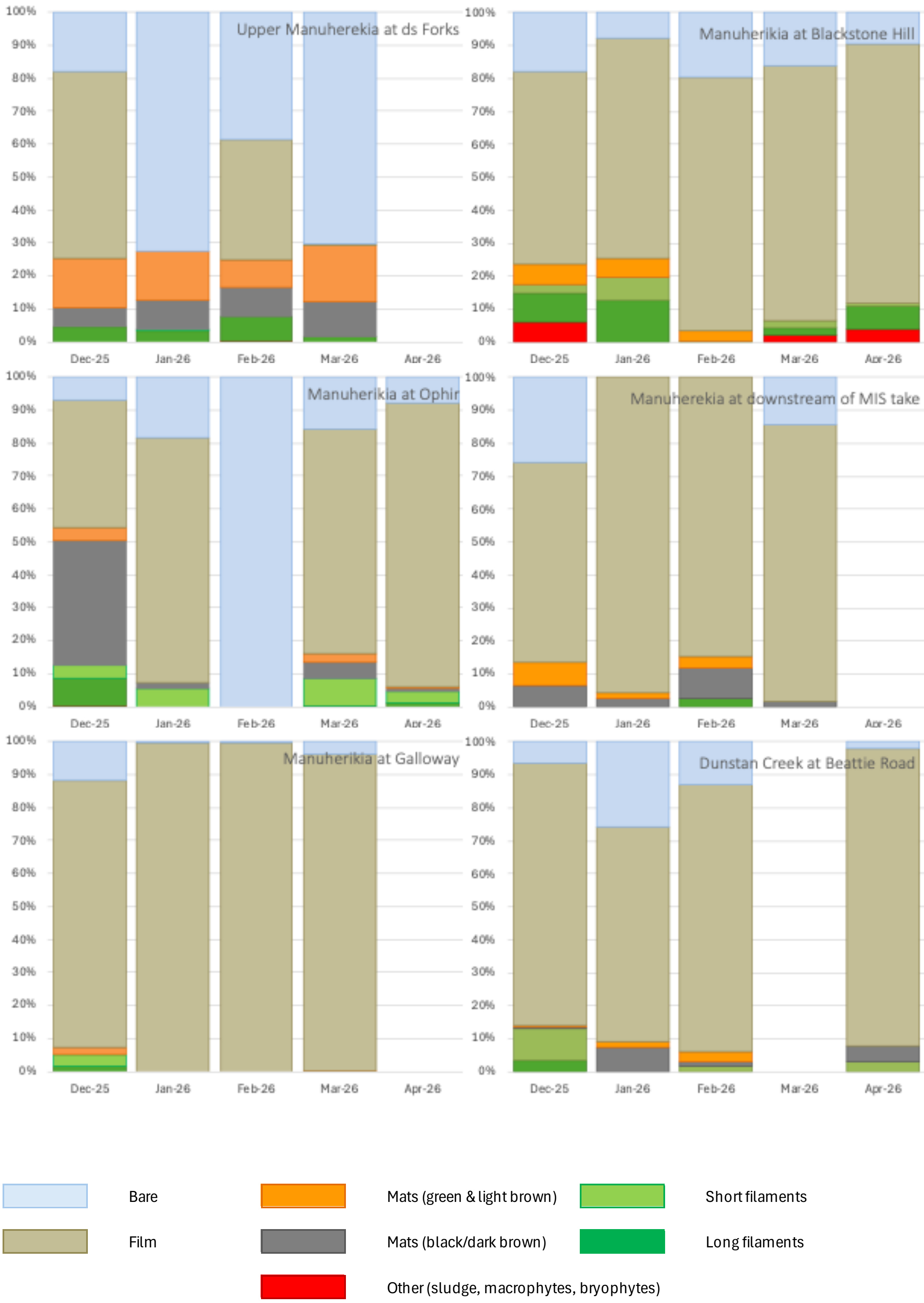

Figure 3 Periphyton cover at the four sites in the Manuherekia River and Dunstan Creek at Beattie Road between December 2025 and April 2026. Data for Manuherekia River at Blackstone Hill, Ophir and Galloway and Dunstan Creek at Beattie Road are courtesy of ORC.

Dunstan Creek sites

The periphyton community at the Dunstan Creek at Gorge site was dominated by green/light brown mats (33-71% cover; predominantly Didymo) on all survey occasions (Figure 4). Long filamentous algae cover increased between the December and February surveys, but decreased between the February and March surveys (Figure 4). Cover by long filamentous algae at this site in the 2025/26 season (<1-6%) was well within the 30% cover guideline for the protection of aesthetics/recreation and trout habitat and angling of Biggs (2000). Dark brown/black mats (*Nostoc*) were present at this site on all occasions (Figure 4). The Gorge site was upstream of water takes in the Dunstan Creek catchment. The dominance of Didymo at this site is consistent with the observation that it dominates upland sites with low phosphorus concentrations. Similarly, the abundance of *Nostoc* at the Gorge site is consistent with its preference for fast-flowing, high-elevation sites with low levels of nutrient enrichment and coarse substrate (Biggs & Kilroy 2000).

Periphyton at the Dunstan Creek at Loop Road site was dominated by green/light brown mats (48-77% cover; predominantly Didymo) on all survey occasions (Figure 4). Filamentous algae were present on all occasions, but cover was higher in the December 2025 and January 2026 surveys (both 19%), while cover in the February and March 2025 surveys was low (~2.5%; Figure 4). Dark brown/black mats were present in the January survey (<1% cover), but were not observed on other sampling occasions (16%, Figure 4). There are no water takes from the mainstem of Dunstan Creek upstream of the Loop Road site, with consented water takes from two tributaries being the only water takes likely to affect this site. These consents (RM11.129.01 and RM17.195.02) have a total maximum rate of take of 111.3 l/s, although both consents have residual flow conditions (50 l/s and 9 l/s respectively) and these are likely to limit the rate of take possible during low flow conditions, since the residual flow must be maintained downstream of the point of take at all times that the take is in operation. Given that the abstraction upstream of this site is limited to tributaries and was likely restricted by residual flows during the 2024/25 irrigation season, the risk of the water abstraction affecting the cover and composition of periphyton at this site is considered to be low. The higher cover by Didymo and very low cover by dark brown/black mats in the 2025/26 season compared to the 2024/25 season (Olsen 2025) are likely to reflect the higher flows and flow variability in the 2025/26 season.

The periphyton community at the Dunstan Creek at Beattie Road was dominated by thin films on all sampling occasions, with low cover by filamentous algae and dark brown/black mats (benthic cyanobacteria) on all occasions. Figure 3 shows periphyton composition at Beattie Road between December 2025 and April 2026 for comparison with other SoE sites monitored by ORC while Figure 4 shows composition between December 2025 and March 2026 for comparison with other Dunstan Creek sites surveyed for this study. The Dunstan Creek at Beattie Road site is downstream of most water takes in the Dunstan Creek catchment. The low cover of mats and filamentous algae at this site indicates that these takes did not adversely affect periphyton cover or composition in the 2025/26 irrigation season.

Periphyton community composition at Dunstan Creek at the confluence was dominated by bare substrate and/or thin films (57-84% cover; Figure 4). Dark brown/black mats (likely dominated by the benthic cyanobacteria *Microcoleus*) were present at this site on all occasions (13-28% cover), while cover by medium light brown mats was low on most survey occasions, except the February 2026 survey (Figure 4). Filamentous algae were present at low levels (>2.5%) on most survey occasions (Figure 4). The confluence site is downstream of all water takes in the Dunstan Creek catchment. Periphyton cover and composition at this site during the 2025/26 season is well within guidelines for the protection of aesthetics/recreation and trout habitat and angling (Biggs 2000) but the cover of benthic cyanobacteria in December and March 2026 surveys exceeded the Alert (Orange) level (>20%) for potentially toxic benthic cyanobacteria in recreational water (MfE & MoH 2009).

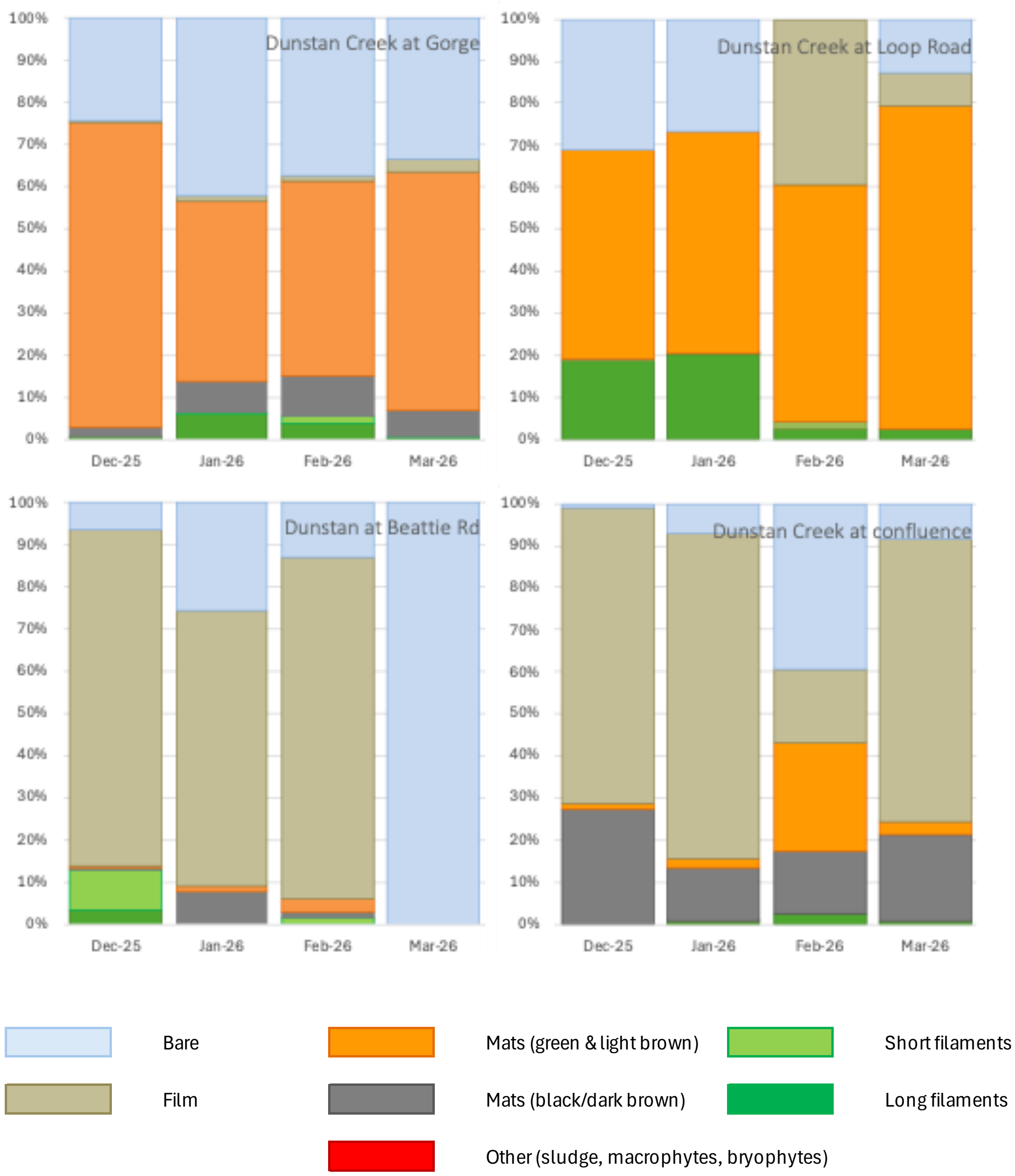

Figure 4 Periphyton cover at the four sites in Dunstan Creek between December 2025 and March 2026. Data for Dunstan Creek at Beattie Road is courtesy of ORC.

Lauder Creek sites

The periphyton community in Lauder Creek at Yards was dominated by bare substrate or thin light brown films on all occasions (63-87%), with highest cover by light brown mats (including Didymo) in the December 2025 and January 2026 surveys (Figure 5). The community at Lauder Creek at Cattle Yards also included low cover of black/dark brown mats (mostly the colonial cyanobacterium Nostoc, but also a colonial cyanobacterium tentatively identified as *Placoma regulare*). In comparison, the periphyton cover in Lauder Creek at Rail Trail was more mixed with higher cover of light brown mats and greater cover by filamentous algae, with highest cover of long filamentous green algae observed in the January 2026 survey (19%; Figure 5). Cover of medium black/dark brown mats at this site included the red alga *Audouinella* (Figure 5).

The Lauder at Yards site is upstream of water takes in the Lauder Creek catchment. The presence of Didymo at this site is consistent with the observation that it dominates upland sites with low phosphorus concentrations. Similarly, the presence of *Nostoc* at this site is consistent with its preference for fast-flowing, high-elevation sites with low levels of nutrient enrichment and coarse substrate (Biggs & Kilroy 2000). Periphyton cover at both sites in Lauder Creek during the 2025/26 survey was within the Biggs (2000) guidelines on all survey occasions (Figure 5).

Thomsons Creek sites

The periphyton community in Thomsons Creek at Diversion Weir was dominated by thin light brown films on all occasions (89-97%), with low cover by medium light brown mats, black/dark brown mats (including *Nostoc*) (Figure 5). In comparison, periphyton cover in Thomsons Creek at upstream Sluice Channel was dominated by thin light brown films on all occasions (69-100%), although macrophytes (*Ranunculus trichophyllus*) were present in the February survey (Figure 5).

The Thomsons Creek at Diversion Weir site is upstream of water takes in the Thomsons Creek catchment. The presence of *Nostoc* at this site is consistent with its preference for fast-flowing, high-elevation sites with low levels of nutrient enrichment and coarse substrate (Biggs & Kilroy 2000). Periphyton cover at the upstream Sluice Channel site was generally within the Biggs (2000) guidelines, although the cover of medium mats exceeded the guideline for aesthetics/recreation (60% cover) in the February 2025 survey (77%). The presence of long filamentous green algae at the upstream Sluice Channel site likely reflect the more enriched conditions present at this site (which leads to faster accrual rate) and lower water velocities (which contributes to faster growth of filamentous algae, as high velocities and/or turbulence can snap filaments, slowing accrual) at this site compared to the upstream site as well as the long accrual period (>120 d).

Chatto Creek site

The periphyton community in Chatto Creek at Confluence site was dominated by thin films on most occasions, with cover by medium black/dark brown mats present on all occasions (Figure 5). These medium black/dark brown mats were dominated by the red alga *Audouinella* (Figure 7) with the highest cover observed in the January 2026 survey (57%; Figure 5). Periphyton cover at the Chatto Creek at Confluence site was within the Biggs (2000) guidelines on all sampling occasions.

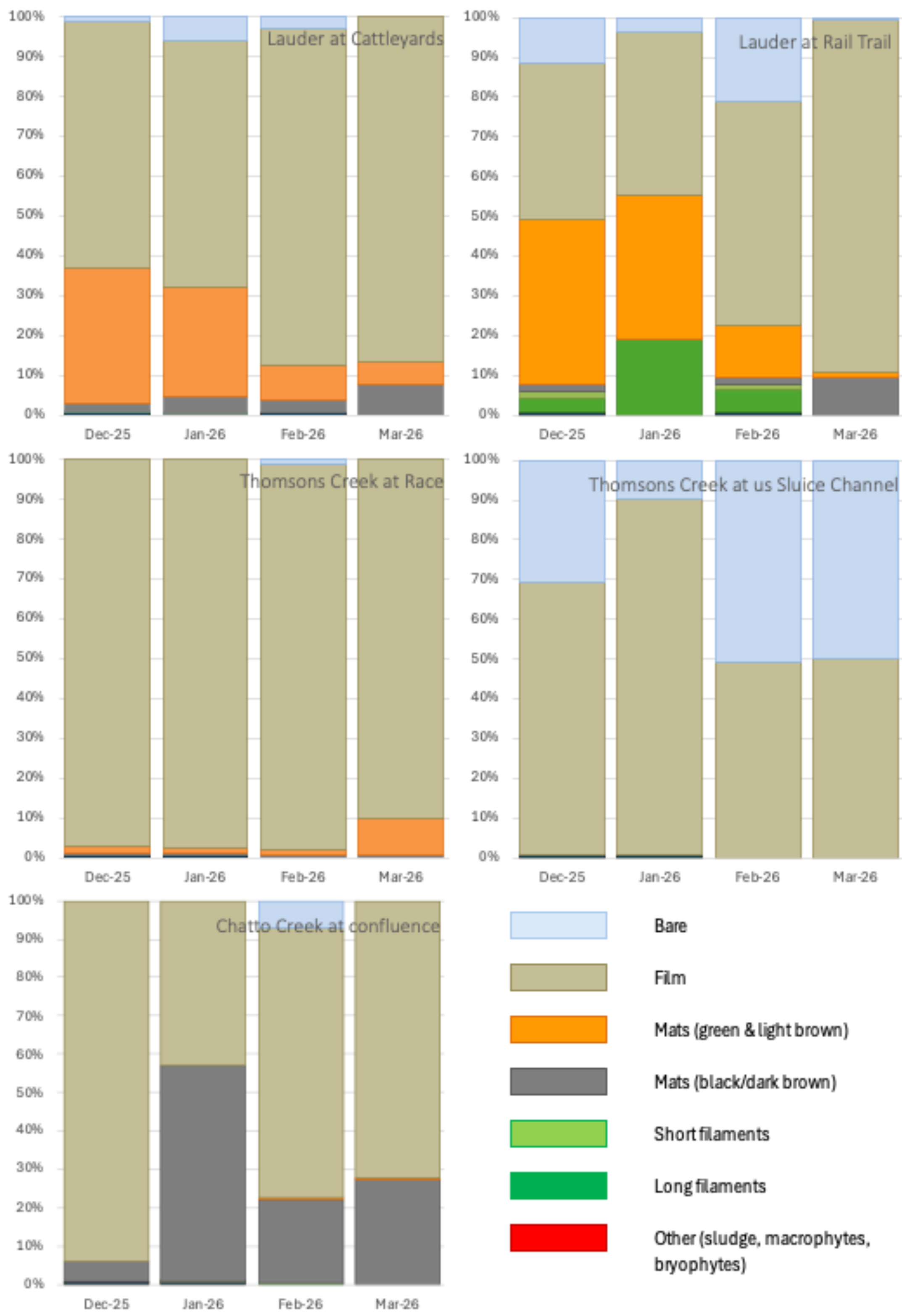

Figure 5 **Periphyton cover at sites in Lauder Creek, Thomsons Creek and Chatto Creek between December 2025 and March 2026.**

Figure 6 Underwater photograph of periphyton types observed in Lauder Creek at Yards in January 2026.

Figure 7 Underwater photograph of the red alga *Audouinella* observed in Chatto Creek at confluence in March 2026.

3.1.3. Periphyton biomass

Periphyton biomass at mainstem sites surveyed between December 2025 and March 2026 was generally low, although periphyton biomass in the Manuherekia River at Ophir exceeded the guideline for benthic biodiversity (50 mg/m^2 of Biggs 2000) in December 2025. Periphyton biomass at all mainstem sites was within the other guideline values of Biggs (2000) including the 120 mg/m^2 guideline for periphyton communities dominated by filamentous algae and 200 mg/m^2 for communities dominated by mats of diatom/cyanobacteria (Table 5).

The elevated biomass observed at the Ophir site in the December 2025 survey compared to other mainstem sites is consistent with previous surveys and is likely attributable to local factors such as nutrients from the Omakau WWTP discharge and Thomsons Creek, both of which enter the Manuherekia River a short distance upstream of the Ophir monitoring site.

The periphyton biomass observed in Dunstan Creek at Gorge in the December 2025 and March 2026 surveys exceeded the guideline for benthic biodiversity (Table 5). Biomass at the Loop Road site increased between December and January but was lower in February and March surveys (Table 5), likely due to a high flow event in late January (as evident in Figure 2b). Periphyton biomass at the Beattie Road site increased from a low level in December 2025 to 30 mg/m^2 in January 2026 but dropped back to low levels in the February 2026 (Table 5). No data was available for March. Biomass at the confluence site exceeded guidelines for benthic biodiversity in both the January and February 2026 surveys (Table 5).

Biomass in the upper Lauder Creek (Cattleyards) was within guideline values on all occasions, while periphyton biomass in the lower Lauder Creek site (at Rail Trail) exceeded the guideline for benthic biodiversity in December and January surveys (Table 5).

Periphyton biomasses observed at both sites in Thomsons Creek (u/s Diversion Weir and upstream Sluice Channel) were consistently low and were well within guideline values on all occasions on all sampling occasions (Table 5).

The biomass of periphyton in Chatto Creek exceeded guidelines for benthic biodiversity in January (151 mg/m^2) and March 2026 (141 mg/m^2) (Table 5).

Biomass accrual

Figure 8 presents plots of benthic periphyton biomass (measured as chlorophyll *a* per unit area) against the accrual time (time since the last flows exceeding three times the long-term median flow at the nearest flow site). These plots help visualise how quickly periphyton biomass accrued at the survey sites in the absence of high flow events that might have reduced the biomass of periphyton. This provides valuable site-specific information to inform the assessment of the risk of the development of nuisance growths of periphyton in the Manuherekia catchment.

Biomass at the Upper Manuherekia at d/s Forks site increased with increasing accrual period while biomass at the other sites on the Manuherekia mainstem showed variable relationships with accrual period (Figure 8a).

The periphyton biomass observed in Dunstan Creek at Loop Road and Beattie Road increased with increasing accrual period, while relationships at the Gorge and Confluence sites were less clear (Figure 8b).

Biomass in the upper Lauder Creek (Cattleyards) showed a generally increasing relationship with accrual time (Figure 8c). In comparison, biomass at the Lauder Creek at Rail Trail site generally increased with accrual time, this relationship for this site was more variable (Figure 8c). Biomass at both sites in Thomsons Creek was consistently low on all sampling occasions (Figure 8c) suggesting that the rate of biomass accrual was very low during this season. Periphyton biomass in Chatto Creek generally increased with accrual time, the relationship for this site was variable (Figure 8c).

In contrast to the 2024/25 irrigation season, hydrological conditions in the 2025/26 season did not represent a continuous accrual period with high flows in late January reducing periphyton biomass (Table 5), which may account for the variability in the relationships between accrual time and periphyton biomass observed in the 2025/26 season reflecting differences in growth conditions between sampling occasions.

Table 5 Periphyton biomass at sites in the Manuherekia catchment between December 2025 and March 2026. ORC long-term monitoring sites are shaded green and the data for these sites is courtesy of ORC. Values shaded yellow exceed the guideline values for protection of benthic biodiversity (50 mg/m^2) 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), orange values exceed the guideline values for aesthetics/recreation and trout habitat and angling (120 mg/m^2 for filamentous algae and 200 mg/m^2 for diatoms/cyanobacteria)

Site	Chlorophyll a (mg per m2)			
	12-Dec-25	14-Jan-26	11-Feb-26	20-Mar-26
Upper Manuherekia River d/s Forks	23.8	35.7	20.0	44.4
Manuherikia at Blackstone Hill	3.4	4.7	0.8	18.4
Manuherikia at Ophir	75.4	7.4		5.7
Manuherekia River d/s MICSL Take	3.9	6.2	17.4	3.9
Manuherikia at Galloway	7.3	3.0	0.9	32.9
Dunstan Creek at Gorge	54.3	30.6	45.7	84.1
Dunstan Creek at Loop Road	48.0	53.3	22.4	30.2
Dunstan Creek at Beattie Road	4.4	29.9	7.5	
Dunstan Creek at Confluence	33.8	81.0	50.0	23.9
Lauder Creek at Yards	29.8	34.6	10.7	18.7
Lauder Creek at Rail Trail	104.6	66.8	13.2	27.1
Thomsons Creek at Race	3.2	5.4	3.3	9.5
Thomsons Creek u/s sluice channel	1.9	3.2	2.4	4.8
Chatto Creek at Confluence	43.5	151.2*	41.0	141.5*

* Periphyton community in Chatto Creek on both occasions was dominated by mats

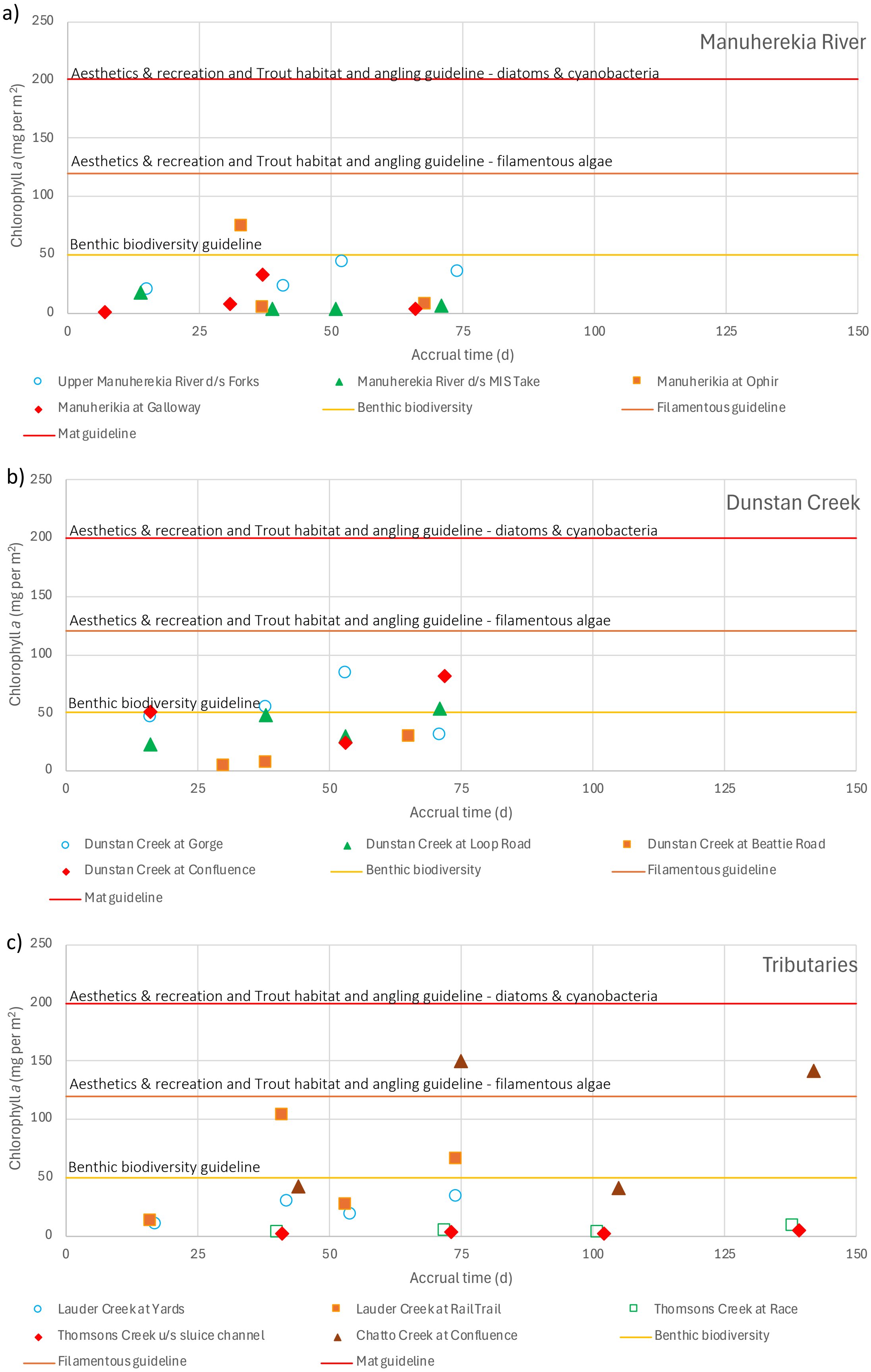

Figure 8 Plots of the relationships between benthic biomass of periphyton (as measured by chlorophyll *a*) and accrual time at sites on the (a) Manuherekia River, (b) Dunstan Creek and (c) tributaries surveyed in the 2025/26 irrigation season. Horizontal lines represent biomass guidelines from Biggs (2000).

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 April 2022-March 2025, 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 6).

The values for the Manuherekia at Blackstone Hill and Galloway meet the baseline and target attribute states set out in the proposed Otago Land & Water Regional Plan (pOLWRP) 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 pOLWRP (Table 6), although the value for Dunstan Creek at Beattie Road is close to the threshold for A-band (<50 mg/m^2).

Table 6 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[6]. Calculations based on data from the period July 2022 – June 2025. Data courtesy of ORC.

		Proposed LWRP		2022-2025	
Site	n	Baseline attribute state	Target attribute state	92nd percentile	NOF band
Dunstan Creek at Beattie Road	34	A	A	63	B
Manuherikia at Blackstone Hill	26	B	B	72	B
Manuherikia at Ophir	22	B	B	188	C
Manuherikia at Galloway	26	B	B	85	B

3.2. Macroinvertebrates

3.2.1. Manuherekia River sites

The macroinvertebrate community at most sites in the Manuherekia River in March 2026 were numerically dominated by the common mayfly *Deleatidium* with riffle beetles (Elmidae) also among the most abundant taxa most sites (Table 7). The net-spinning caddis fly *Hydropsyche* and horn-cased caddis fly larvae (*Olinga*) were also abundant at the Blackstone site (Table 7). The community composition at the all sites were consistent with the results of historical sampling at these sites (Olsen 2023, 2024, 2025). Full macroinvertebrate data from 20th/21st March 2026 is presented in Appendix B.

In the 2024/25 season, ORC collected macroinvertebrate samples in December/January, but samples in the 2025/26 season were collected from long-term monitoring sites in 4th – 8th March 2026. These data are presented in Table 8. The community composition in these samples was similar to that in samples collected as part of this study with the common mayfly *Deleatidium* and riffle beetles (Elmidae) being the most abundant taxa at all sites (Table 8). However, the number of invertebrates per sample indicates that the samples collected by ORC were substantially smaller than those collected as part of this study (Table 7 and Table 8).

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

Macroinvertebrate indices

MCI and QMCI scores for the Upper Manuherekia at ds Forks (reference site) and downstream of the MICSL Take sites in the March 2026 survey were in A-band, indicating that water and/or habitat quality at this site was excellent, while the ASPM score for the Upper Manuherekia at ds Forks was also in A-band consistent with a macroinvertebrate community with high ecological integrity, consistent with the reference conditions present at this site, while the ASPM score for the downstream of the MICSL Take site was in B-band indicating mild to moderate loss of ecological integrity (Table 11).

MCI and QMCI scores for the mainstem at Blackstone, Ophir and Galloway sites on 7th February 2025 were in B-band indicating mild organic pollution or nutrient enrichment, while ASPM scores for these sites were in B-band indicating mild to moderate loss of ecological integrity (Table 11). (Table 11).

MCI scores for the mainstem of the Manuherekia meet or exceed the target attribute state for MCI proposed in the proposed Otago Land and Water Plan (pOLWP) and scores for long-term monitoring sites (Blackstone, Ophir and Galloway) in March 2025 exceeded the long-term median scores for these sites (Table 11).

Macroinvertebrate metrics for sites on the mainstem of the Manuherekia River in March 2026 do not indicate that water abstraction affected the composition of macroinvertebrate communities in the Manuherekia River.

Table 7 Summary of macroinvertebrate community composition at five sites on the Manuherekia River in March 2026. Only taxa with >100 individuals at one or more sites are included. Full macroinvertebrate data is presented in Appendix B.

ORDER	TAXON	TV	TV (Greenwood et al. 2015)	Manuherekia d/s Forks	Manuherekia at Blackstone	Manuherekia at Ophir	Manuherekia d/s MICSC take	Manuherekia at Campground
				20/03/2026	20/03/2026	20/03/2026	21/03/2026	20/03/2026
CRUSTACEA	*Paracalliope*	5	5			20		1
COLEOPTERA	Elmidae	6	6	400	1760	1940	470	3640
DIPTERA	*Austrosimulium*	3	6	40	1	1		100
	Orthocladiinae	2	4	80	60			
	Tanytarsini	3	5	60	1			
EPHEMEROPTERA	*Austroclima*	9	6	20	20	160	160	1
	Deleatidium	8	7	2360	2120	2500	1640	3500
PLECOPTERA	*Zelandobius*	5	7	1				20
TRICHOPTERA	*Beraeoptera*	8	7	40				
	Hudsonema	6	4	20	60	20		
	Hydrobiosis	5	8	100	20	1	10	40
	Hydropsyche (Aoteapsyche)	4	8	960	100	380	200	100
	Olinga	9	9	780		80	1	
	Pycnocentria	7	5	20	80	460	30	200
	Pycnocentrodes	5	6	80	100	460	330	60
OLIGOCHAETA		1	5	140	280	80	60	80
MOLLUSCA	Potamopyrgus	4	5	1	20	420	60	100
Number of taxa				**32**	**18**	**19**	**16**	**14**
Number of invertebrates (per sample)				**5292**	**4646**	**6528**	**3014**	**7844**
Number of EPT taxa				**19**	**9**	**11**	**10**	**8**
% EPT taxa				**59**	**50**	**58**	**63**	**57**
% EPT abundance				**85**	**54**	**62**	**80**	**50**
MCI score				**138**	**123**	**125**	**131**	**121**
QMCI score				**7.29**	**6.38**	**6.38**	**6.64**	**6.44**
ASPM				**0.65**	**0.48**	**0.53**	**0.54**	**0.48**

Table 8 Summary of macroinvertebrate community composition at four long-term monitoring sites in the Manuherekia catchment sampled by ORC in March 2026. Only taxa with >100 individuals at one or more sites are included. Full macroinvertebrate data is presented in Appendix B. Data courtesy of ORC.

ORDER	TAXON	TV	TV (Greenwood et al. 2015)	Dunstan Creek at Beattie Road 05/03/2026	Manuherikia at Blackstone 05/03/2026	Manuherikia at Ophir 08/03/2026	Manuherikia at Galloway 04/03/2026
CRUSTACEA	*Paracalliope*	5	5				
COLEOPTERA	Elmidae	6	6	1020	520	1110	496
DIPTERA	*Austrosimulium*	3	6	1	10		1
	Orthocladiinae	2	4	15		5	4
	Tanytarsini	3	5	20		10	
EPHEMEROPTERA	*Austroclima*	9	6		1	45	1
	Deleatidium	8	7	330	700	615	236
PLECOPTERA	*Zelandobius*	5	7	5		1	
TRICHOPTERA	*Beraeoptera*	8	7				
	Hudsonema	6	4	10	45		4
	Hydrobiosis	5	8	5	1	1	
	Hydropsyche (Aoteapsyche)	4	8	20	25	115	4
	Olinga	9	9	25	10		
	Pycnocentria	7	5	145	20	85	8
	Pycnocentrodes	5	6	40	1	150	4
OLIGOCHAETA		1	5	15	40	15	16
MOLLUSCA	Potamopyrgus	4	5	20	1		1
Number of taxa				**21**	**18**	**16**	**22**
Number of invertebrates (per sample)				**1729**	**1392**	**2178**	**820**
Number of EPT taxa				**11**	**9**	**9**	**9**
% EPT taxa				**52**	**50**	**56**	**41**
% EPT abundance				**34**	**58**	**47**	**32**
MCI score				**129**	**124**	**128**	**106**
QMCI score				**6.13**	**6.47**	**6.35**	**6.13**
ASPM				**0.52**	**0.48**	**0.50**	**0.42**

3.2.2. Dunstan Creek sites

The composition of the macroinvertebrate community varied between sites in Dunstan Creek during the March 2026 survey (Table 9). The most abundant macroinvertebrate taxon in Dunstan Creek at Gorge (reference site) and the Loop Road site were oligochaete worms, with horn-cased caddis fly larvae (*Olinga*), chironomid midge larvae (Orthocladiinae) and the common mayfly *Deleatidium* also abundant (Table 9). The abundance of oligochaete worms and chironomid midges at this site was consistent with the high biomass and cover of Didymo at these sites in the March 2026 survey (see Section3.1.2).

The common mayfly *Deleatidium* was the most abundant taxon at the Beattie Road and Confluence sites with riffle beetles (Elmidae) also abundant at both these sites, and chironomid midge larvae (Orthocladiinae) were also abundant at the confluence site (Table 9).

Macroinvertebrate indices

The MCI and QMCI scores for the Dunstan Creek at Gorge (reference site) in the March 2026 survey were in B-band indicating mild organic pollution or nutrient enrichment, while the ASPM score (B-band) was consistent with a macroinvertebrate community with mild to moderate loss of ecological integrity (Table 11). The MCI score for the Dunstan Creek at Loop Road in the March 2026 survey was in B-band indicating mild organic pollution or nutrient enrichment, while the QMCI score (C-band) indicated moderate organic pollution or nutrient enrichment (Table 11). The ASPM score (B-band) was consistent with a macroinvertebrate community with mild to moderate loss of ecological integrity (Table 11). The high cover and biomass of Didymo at the Loop Road site on this occasion likely contributed to the low QMCI score observed at this site on this occasion (see Section 3.1.2).

MCI scores at the two other sites in Dunstan Creek in the March 2026 survey were in A-band, indicating excellent water/habitat quality at these sites (Table 8). QMCI scores at the Beattie Road and Confluence sites (B-band) were consistent with mild organic pollution or nutrient enrichment at these sites (Table 8). The ASPM scores for both these sites fell in B-band indicating a macroinvertebrate community with mild to moderate loss of ecological integrity (Table 11).

The MCI scores for most sites in Dunstan Creek in March 2026 exceeded the target attribute state for MCI proposed in the pOLWP with the exception of the Loop Road site, which was likely due to high cover and biomass of Didymo at this site (Table 8).

Changes in macroinvertebrate indices from upstream to downstream sites in Dunstan Creek were consistent with macroinvertebrate communities being in better state at downstream sites than at the upstream sites. Thus, there is no indication that water abstraction adversely affected macroinvertebrate community composition in Dunstan Creek in the 2025/26 season and the lower scores observed at the upstream sites may reflect the effect of Didymo on the macroinvertebrate community.

Table 9 Summary of macroinvertebrate community composition at four sites on the Dunstan Creek in March 2026. Only taxa with >100 individuals at one or more sites are included. Full macroinvertebrate data is presented in Appendix B.

ORDER	TAXON	TV	TV (Greenwood et al. 2015)	Dunstan Creek at Gorge 20/03/2026	Dunstan Creek at Loop Road 20/03/2026	Dunstan Creek at Beatie road 20/03/2026	Dunstan Creek at Confluence 20/03/2026
CRUSTACEA	*Paracalliope*	5	5				
COLEOPTERA	Elmidae	6	6	240	280	1020	1840
DIPTERA	*Austrosimulium*	3	6			1	1
	Orthocladiinae	2	4	700	860	180	820
	Tanytarsini	3	5	160	280	20	240
EPHEMEROPTERA	*Austroclima*	9	6	400	80	1	40
	Deleatidium	8	7	680	300	1660	2100
PLECOPTERA	*Zelandobius*	5	7	40	120		
TRICHOPTERA	*Beraeoptera*	8	7				
	Hudsonema	6	4	20	20	1	40
	Hydrobiosis	5	8	40	20	100	120
	Hydropsyche (Aoteapsyche)	4	8	220	1	80	200
	Olinga	9	9	920	240	120	60
	Pycnocentria	7	5	140	200	600	280
	Pycnocentrodes	5	6	180	180	60	420
OLIGOCHAETA		1	5	2360	1240	140	220
MOLLUSCA	Potamopyrgus	4	5	60	240	120	140
Number of taxa				**28**	**22**	**28**	**27**
Number of invertebrates (per sample)				**6504**	**4343**	**4194**	**6630**
Number of EPT taxa				**15**	**12**	**16**	**14**
% EPT taxa				**54**	**55**	**57**	**52**
% EPT abundance				**43**	**29**	**63**	**50**
MCI score				**124**	**122**	**131**	**130**
QMCI score				**5.98**	**5.43**	**6.30**	**6.06**
ASPM				**0.56**	**0.52**	**0.59**	**0.55**

3.2.3. Lauder Creek sites

The most abundant macroinvertebrate taxa in Lauder Creek at Cattle Yards (reference site) in the March 2026 survey were the mudsnail *Potamopyrgus*, the horn-cased caddis *Olinga* and the sand-cased caddis fly *Pycnocentria* while the Lauder Creek at Rail Trail was dominated by the common mayfly *Deleatidium*, the sand-cased caddis fly *Pycnocentria* (Table 10). The macroinvertebrate community at the downstream site on Lauder Creek includes more taxa that are tolerant of poor water and/or habitat quality compared to the upstream site (Table 10) although it is not possible to distinguish the relative impacts of the changes in water quality, habitat and flows between these two sites.

Macroinvertebrate indices

The MCI score for Lauder Creek at Cattleyards (reference site) in the March 2026 survey was in A-band consistent with reference conditions while the QMCI score for this site were in B-band consistent with mild to moderate effects on macroinvertebrate community at this site (Table 11). The ASPM score for this site was in A-band consistent with a macroinvertebrate community with high ecological integrity, consistent with the reference conditions present at this site. In comparison, the MCI and QMCI scores for Lauder Creek at Rail Trail fell in B-band, suggesting moderate organic pollution or nutrient enrichment while the ASPM score for this site was in B-band consistent with mild to moderate effects on macroinvertebrate community at this site (Table 11).

The macroinvertebrate community in the lower Lauder Creek included more taxa that were tolerant of degraded conditions, but the tolerance of the most abundant taxa at both sites was similar. These changes are consistent with the deterioration in water quality observed between these two sites (Hudson & Shelley 2019) although it is possible that water abstraction contributed to the differences in macroinvertebrate community composition between these two sites in Lauder Creek.

3.2.4. Thomsons Creek sites

The most abundant macroinvertebrate taxa in Thomsons Creek at Race in the March 2026 survey were the sand-cased caddis fly *Pycnocentria and* the mudsnail *Potamopyrgus* while the most abundant macroinvertebrate taxa in Thomsons Creek upstream of the Sluice Channel were riffle beetles (Elmidae), the mayfly *Deleatidium*, and the mudsnail *Potamopyrgus* (Table 10). 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 between the contribution of changes in water quality, habitat and flows to differences in community composition between these two sites.

Macroinvertebrate indices

MCI and QMCI scores for both sites in Thomsons Creek in the March 2026 survey were in B-band consistent with mild to moderate effects on macroinvertebrate community at this site (Table 11). The ASPM score for both sites (B-band) were consistent with a macroinvertebrate community with mild to moderate loss of ecological integrity (Table 11).

The similarity in macroinvertebrate metrics at both of these sites suggest that water abstraction has had little effect on macroinvertebrate community composition in Thomsons Creek in the 2025/26 season.

3.2.5. Chatto Creek Site

The most abundant macroinvertebrate taxa in the lower reaches of Chatto Creek in the March 2026 survey were the mayfly *Deleatidium*, the mudsnail *Potamopyrgus*, and the sand-cased caddis fly *Pycnocentria* (Table 10).

Macroinvertebrate indices

Macroinvertebrate metrics for the lower Chatto Creek site (confluence) in the March 2026 survey were in B-band which indicates that the macroinvertebrate community at this site was mild to moderately impacted (Table 11).

Table 10 Summary of macroinvertebrate community composition at sites on the Lauder, Thomsons and Chatto Creeks in March 2026. Only taxa with >100 individuals at one or more sites are included. Full macroinvertebrate data is presented in Appendix B.

ORDER	TAXON	TV	TV (Greenwood et al. 2015)	Lauder Creek at cattle yards 21/03/2026	Lauder Creek at Rail trail 20/03/2026	Thomson creek at u/s intake 21/03/2026	Thomson Creek at u/s sluice channel 20/03/2026	Chatto Creek at u/s confluence 21/03/2026
CRUSTACEA	*Paracalliope*	5	5		20	20	200	60
COLEOPTERA	Elmidae	6	6	240	200	480	3440	500
DIPTERA	*Austrosimulium*	3	6	20	1		20	
	Orthocladiinae	2	4	700		60		20
	Tanytarsini	3	5	60	1	20		1
EPHEMEROPTERA	*Austroclima*	9	6	40		60		1
	Deleatidium	8	7	560	3500	520	2400	3960
PLECOPTERA	*Zelandobius*	5	7	1		60		
TRICHOPTERA	*Beraeoptera*	8	7	1340		40		
	Hudsonema	6	4	20	1	260	220	
	Hydrobiosis	5	8	100	20	20	80	80
	Hydropsyche (Aoteapsyche)	4	8	80	300	60	200	20
	Olinga	9	9	2220		220		20
	Pycnocentria	7	5	1100	1820	460	560	1860
	Pycnocentrodes	5	6	840	20	3300	260	120
OLIGOCHAETA		1	5	160	160	820	260	120
MOLLUSCA	Potamopyrgus	4	5	2440	160	1500	2300	2180
Number of taxa				**30**	**17**	**25**	**18**	**22**
Number of invertebrates (per sample)				**10129**	**6266**	**8043**	**10102**	**9046**
Number of EPT taxa				**18**	**7**	**14**	**7**	**9**
% EPT taxa				**60**	**41**	**56**	**39**	**41**
% EPT abundance				**63**	**91**	**63**	**38**	**67**
MCI score				**132**	**113**	**124**	**120**	**115**
QMCI score				**6.39**	**6.31**	**5.76**	**5.91**	**5.98**
ASPM				**0.63**	**0.41**	**0.55**	**0.41**	**0.43**

3.2.6. Comparison to target states

The results of long-term macroinvertebrate sampling are summarised in Table 11. As part of preparation of the proposed Land & Water Regional Plan, the baseline state for the four long-term macroinvertebrate monitoring sites in the Manuherekia catchment was determined based on historical MCI scores and these were used to set target attribute states for these sites. Scores for most long-term monitoring sites in the Manuherekia catchment meet the target attribute states, with the exception of the Blackstone site, although the MCI for the community measured in 2026 was at the bottom end of the B-band (Table 11).

Table 11 Summary of macroinvertebrate community index scores for long-term (State of the Environment) monitoring sites in the Manuherekia catchment.

Site	pOLWRP targets MCI	SoE monitoring* 5-y median MCI (2022-2026)	Long-term median MCI	MCI (March 2026)
Manuherekia River at Blackstone*	B	102	101	110
Manuherekia River at Ophir*	C	100	105	106
Manuherekia River at Galloway*	C	105	105	99
Dunstan Creek at Beattie Road*	B	114	117	110

* Metrics calculated using original tolerance values for comparison to pOLWRP targets and historical data

4. Summary & Conclusions

4.1. Periphyton

Mainstem sites

The dominance of Didymo in the Upper Manuherekia and at the Blackstone site (which is the closest site to Falls Dam) is consistent with the observation that it dominates upland sites with low phosphorus concentrations (Bothwell et al. 2014). Cover of mats and filamentous algae at most mainstem sites were within the Biggs (2000) guidelines at all sites, but the cover of benthic cyanobacteria at the Ophir site exceeded the Alert (Orange) level (>20%) for potentially toxic benthic cyanobacteria in recreational water (MfE & MoH 2009) on one occasion (December 2025).

Periphyton biomasses at sites in the mainstem of the Manuherekia River were within the Biggs (2000) guidelines at all sites except at Ophir, which exceeded the guideline for the protection of aquatic biodiversity (50 mg/m^2; Biggs 2000) on one occasion (Table 12).

The results of this survey show that periphyton at all but one of the mainstem sites was within guideline levels during the 2025/26 season. Flows during the 2025/26 season were considerably higher than those observed in the 2024/25 season with flow events during the summer months resulting in shorter accrual times at mainstem sites in the 2025/26 season, and the lower periphyton cover and biomasses observed in the 2025/26 season compared to 2025/26 (Table 13).

Dunstan Creek

Periphyton biomass at the Gorge (reference site), Loop Road and Confluence sites exceeded the guideline for the protection of aquatic biodiversity (50 mg/m^2; Biggs 2000) on one and two occasions in the 2025/26 season, while periphyton biomass at Beattie Road site was within guidelines on all occasions (Table 12).

The cover by mats in Dunstan Creek at the Gorge and Loop Road sites exceeded the Biggs (2000) guideline (60% total cover of medium and thick mats) on at least one occasion during the 2025/2026 surveys (Table 12), with Didymo accounting for most of this cover at both sites on these occasions. Cover of by mats at the Beattie Road and Confluence sites were within the Biggs (2000) guideline on all occasions. Cover by filamentous algae was within the Biggs (2000) guideline (30% cover) at all sites in Dunstan Creek during the 2025/26 season. Cover by benthic cyanobacteria at the confluence site exceeded the Alert (Orange) level (>20%) for potentially toxic benthic cyanobacteria in recreational water (MfE & MoH 2009) during the December 2025 survey (Table 12).

The dominance of Didymo at the Gorge and Loop Road sites is consistent with the observation that it dominates upland sites with low phosphorus concentrations, although it is interesting to note that cover by light brown mats (likely dominated by Didymo) at the Loop Road site during the 2025/26 survey (mean cover: 57%) was substantially higher than observed in the 2024/25 survey (mean cover: 8%). In contrast, cover by black/dark brown mats was substantially lower in the 2025/26 survey (mean cover: <1%, peak cover: <1%) than observed in the 2024/25 survey (mean cover: 5%, peak cover: 16%). Both Didymo and *Microcoleus* proliferate at very low DRP concentrations (Bothwell et al. 2014, Wood & Young 2011, Wood & Young 2012). The differences between cover of these two taxa at the Loop Road site during the 2024/25 and 2025/26 surveys suggests that flow may mediate competition between these two taxa at this site.

Other tributaries

Periphyton biomass and cover at the reference sites in the upper reaches of Lauder Creek and both sites in Thomsons Creek were within the Biggs (2000) biomass and cover guidelines on all occasions (Table 12). Chlorophyll *a* biomass at the Lauder Creek at Rail Trail and Chatto Creek sites exceeded the guideline for the protection of aquatic biodiversity (50 mg/m^2; Biggs 2000) on two occasions in the 2025/26 season (Table 12). Whilst cover by black/dark brown mats in the Chatto Creek site exceeded 20% during the February and March surveys, these mats were dominated by the red alga *Audouinella*, not benthic cyanobacteria, meaning that periphyton cover in the Lauder Creek at Rail Trail and Chatto Creek sites were within cover guidelines on all occasions (Table 12).

Substantial variation in accrual period was observed between sites in the 2025/26 surveys. Rainfall in January affected tributaries in the upper catchment like Dunstan Creek (max. accrual time = 65-72 days) and Lauder Creek (max. accrual time = 74 days) did not affect flows in the Thomsons Creek (max. accrual time = 138-139 days) or Chatto Creek (max. accrual time = 142 days) to the same degree, resulting in much longer accrual times. The pattern of biomass accrual at tributary sites in the 2025/26 season were variable, while periphyton biomass at sites in Lauder and Chatto Creeks generally increased with accrual time, biomass at both sites in Thomsons Creek remained low on all sampling occasions. Biomass at the Lauder Creek at Rail Trail site exceeded 100 mg/m^2 after 41 accrual days (December 2025), while on the next sampling occasion (January 2026), the benthic biomass had declined to 67 mg/m^2. Similarly, periphyton biomass at the Chatto Creek site exceeded 151 mg/m^2 after 75 accrual days (January 2026), was lower on the next sampling occasion (February 2026; 41 mg/m^2), before increasing again before the March survey (141 mg/m^2, 142 accrual days).

Table 12 Comparison of periphyton biomass and cover in the 2025/26 surveys with biomass and cover guidelines of Biggs (2000) and contact recreation guidelines (MfE & MoH 2009).

Waterbody/site	Biggs (2000) Biodiversity	Biggs (2000) Aesthetics/ recreation	Biggs (2000) Trout habitat & angling	Biggs (2000) Diatoms/cyanobacteria cover (60% >0.3 mm thick)	Biggs (2000) Filamentous algae (30% >20 mm long)	MfE & MoH (2009) Red alert >50% cover cyanobacteria
Manuherikia River						
d/s Forks (reference)	✓	✓	✓	✓	✓	✓
Blackstone	✓	✓	✓	✓	✓	✓
Ophir	X	✓	✓	✓	✓	✓
D/s MICSL Take	✓	✓	✓	✓	✓	✓
Galloway	✓	✓	✓	✓	✓	✓
Dunstan Creek						
Gorge (reference)	X	✓	✓	X	✓	✓
Loop Road	X	✓	✓	X	✓	✓
Beattie Road	✓	✓	✓	✓	✓	✓
Confluence	X	✓	✓	✓	✓	✓
Lauder Creek						
Yards (reference)	✓	✓	✓	✓	✓	✓
Rail Trail	X	✓	✓	✓	✓	✓
Thomsons Creek						
Diversion Weir (reference)	✓	✓	✓	✓	✓	✓
U/s sluice channel	✓	✓	✓	✓	✓	✓
Chatto Creek						
Confluence	X	✓	✓	✓	✓	✓

Table 13 Comparison of periphyton biomass (benthic chlorophyll *a*) and accrual time (time since flows of 3x the long-term median flow) at sites in the Manuherekia catchment in the 2024/25 and 2025/26 seasons.

Site	Dec-24	Dec-25	Jan-25	Jan-26	Feb-25	Feb-26	Mar-25	Mar-26
Chlorophyll a (mg per m^2)								
Upper Manuherekia River d/s Forks	2	24	7	36	13	20	23	44
Manuherikia at Blackstone Hill	6	3	2	5	3	1	-	18
Manuherikia at Ophir	60	75	118	7	189		66	6
Manuherekia River d/s MIS Take	13	4	4	6	4	17	5	4
Manuherikia at Galloway	18	7	30	3	35	1	11	33
Dunstan Creek at Gorge	9	54	-	31	55	46	46	84
Dunstan Creek at Loop Road	10	48	37	53	20	22	37	30
Dunstan Creek at Beattie Road	4	4	26	30	25	8	26	-
Dunstan Creek at Confluence	13	34	71	81	81	50	50	24
Lauder Creek at Yards	2	30	11	35	5	11	35	19
Lauder Creek at Rail Trail	27	105	1	67	35	13	7	27
Thomsons Creek at Race	1	3	5	5	3	3	6	9
Thomsons Creek u/s sluice channel	2	2	5	3	57	2	3	5
Chatto Creek at Confluence	5	43	42	151	17	41	9	141
Accrual time (days since flows 3x median flow)								
Upper Manuherekia River d/s Forks	45	41	72	74	97	15	128	52
Manuherikia at Blackstone Hill	32	29	73	64	94	4	122	34
Manuherikia at Ophir	32	33	73	68	94	7	122	37
Manuherekia River d/s MIS Take	30	39	71	71	92	14	120	51
Manuherikia at Galloway	31	31	72	66	93	7	121	37
Dunstan Creek at Gorge	43	38	70	71	95	16	126	53
Dunstan Creek at Loop Road	43	38	70	71	95	16	126	53
Dunstan Creek at Beattie Road		30		65		8		38
Dunstan Creek at Confluence	31	39	72	72	93	16	121	53
Lauder Creek at Yards	44	42	71	74	96	17	127	54
Lauder Creek at Rail Trail	44	41	71	74	96	16	127	53
Thomsons Creek at Race	43	40	70	72	95	101	126	138
Thomsons Creek u/s sluice channel	42	41	69	73	94	102	125	139
Chatto Creek at Confluence	40	44	67	75	92	105	123	142

Comparison to target attribute states for periphyton

Analysis of long-term periphyton biomass at Manuherekia at Blackstone Hill and Galloway indicate that these sites meet the baseline and target attribute states set out in the proposed Land & Water Regional Plan (LWRP). 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 pOLWRP..

4.2. Macroinvertebrates

Macroinvertebrate Community Index (MCI) scores at most sites sampled in March 2026 fell within the A- or B-band, with the exception of the sample collected from Manuherekia at Galloway by ORC as part of SoE monitoring, which fell within the C-band (Table 14). QMCI scores fell within the A- or B-band at most sites, with the exception of Dunstan Creek at Loop Road which fell within the C-band (Table 14). Notably, this site is upstream of most of the water takes in the catchment suggesting that this score likely reflects the proliferation of Didymo at this site in the 2025/26 season. ASPM scores fell within the A- or B-band at all sites during this survey (Table 14).

MCI scores for three of the four long-term sites met the proposed target attribute state, the long-term median MCI score at the Blackstone site (101) fell well below the threshold for B-band (110) (Table 14), likely reflecting the dominance of the periphyton at this site by Didymo and filamentous algae and the .

The MCI score at the Manuherekia at Blackstone site in March 2026 exceeded the target attribute state in the pOLWRP, but the 5-year median did not meet this target (Table 14). In comparison, the MCI scores for the other three long-term monitoring sites met or exceeded the pOLWRP target, as did the 5-year median values for these sites (Table 14). The QMCI and ASPM scores measured in the March 2026 samples and 5-year median scores placed all four sites in the same attribute band as the pOLWRP target (Table 14). These results indicate that macroinvertebrate communities are consistent with the target attribute state in the pOLWRP.

Table 14 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	pLWRP target (MCI)	SoE monitoring* 5-y median (2022-2026)			This survey† 20th/21st March 2026		
		MCI	QMCI	ASPM	MCI	QMCI	ASPM
Upper Manuherekia River d/s forks					A	A	A
Manuherekia River at Blackstone*	B	C (102)	B (6.40)	B (0.52)	B	B	B
Manuherekia River at Blackstone					B	B	B
Manuherekia River at Ophir*	C	C (100)	B (6.35)	B (0.50)	B	B	B
Manuherekia River at Ophir					B	B	B
Manuherekia River d/s MICSL take					A	A	B
Manuherekia River at Galloway*	C	C (105)	A (6.77)	B (0.51)	C	B	B
Manuherekia River at Galloway					B	B	B
Dunstan Creek at Gorge					B	B	B
Dunstan Creek at Loop Road					B	C	B
Dunstan Creek at Beattie Road*	B	B (114)	A (6.91)	A (0.60)	B	B	B
Dunstan Creek at Beattie Road					A	B	B
Dunstan Creek at confluence					A	B	B
Lauder Creek at cattle yards					A	B	A
Lauder Creek at Rail Trail					B	B	C
Thomsons Creek at race					B	B	B
Thomsons Creek u/s sluice channel					B	B	C
Chatto Creek at confluence					B	B	B

* Metrics calculated using original tolerance values for comparison to pOLWRP targets and historical data

† Metrics calculated using updated tolerance values of Greenwood et al. (2015).

4.3. Overall conclusions

The Manuherekia Catchment Group started the phased implementation of the Catchment Management Plan (CMP) in the 2024/25 irrigation season and this continued in the 2025/26 irrigation season. Flows during the 2025/26 irrigation season were high (with high flow events associated with rainfall events, contrasting with conditions in the first year of the phased implementation of the CMP (2024/25), which coincided with hydrological season dominated by dry conditions with long periods of low, stable flows. The contrasting hydrological conditions in these seasons provided an opportunity to compare the ecological outcomes in a season of low, stable flows with one where flows were much higher. Month-by-month comparisons of flows in each of the catchments studied before each of the surveys suggests that flows at sites in the mainstem of the Manuherekia were between two-times and five-times higher in 2025/26 compared with 2024/25 season. Similar comparisons for tributary sites indicate that flows in 2025/26 were 1.8-times to three-times higher compared with flows at corresponding sites in the 2024/25 season, although differences in flows in Chatto Creek were lower (1.4x - 1.6x) and flows in Lauder Creek at Rail Trail were higher (ten-times to fifteen-times higher) (antecedent flows are presented in Tables 3 & 4 of both Olsen 2025 and this report).

Comparison of periphyton biomass and cover with guidelines for the 2024/25 and 2025/26 seasons suggest that despite the contrasting hydrological conditions experienced in the 2024/25 and 2025/26 seasons, the periphyton outcomes at most sites were similar. The much higher peak biomass observed at the Ophir site in the 2024/25 season compared to 2025/26 likely reflects the localised effects of nutrients from the Omakau WWTP and Thomsons Creek combined with the longer accrual time observed in 2024/25 (when peak biomass was observed after 94 accrual days) compared to peak accrual time in 2025/26 (68 days). Periphyton cover at the Ophir site on most occasions in 2025/26 was lower than typically observed at this site. This may reflect slower accrual (e.g. due to greater dilution of nutrients from these point sources), the shorter accrual times observed in this season, or a combination of both.

Macroinvertebrate indices scores for long-term monitoring sites in the Manuherekia met or exceeded the target attribute state for MCI proposed in the proposed Otago Land and Water Plan (pOLWP) in both seasons and scores for the various sites in the 2024/25 and 2025/26 seasons were similar.

Didymo was a dominant part of the periphyton community at in Dunstan Creek at Gorge and Upper Manuherekia downstream of Forks sites in both seasons. Both of these sites were included in these surveys as upstream (reference) sites that are unimpacted by land use and water abstraction. The cover of Didymo observed at the Loop Road site was much higher in the 2025/26 season than was observed in 2024/25, when cover of benthic cyanobacteria was much higher. These observations suggest that flow may mediate competition between these two taxa at this site.

Macroinvertebrate metrics for sites in the lower Dunstan Creek (Beattie Road and Confluence) were generally higher than those for sites in the upper Dunstan Creek (Gorge, Loop Road) in the 2025/26 season. These observations may reflect the effect of Didymo on the macroinvertebrate community at the upper sites.

Differences in macroinvertebrate metrics 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 between the contribution of changes in water quality, habitat and flows to differences in community composition between these two sites. In contrast, the similarity in macroinvertebrate metrics at the two sites in Thomsons Creek sites does not suggest that water abstraction affected macroinvertebrate community composition in the 2025/26 season.

The effects of water abstraction on periphyton composition and biomass and macroinvertebrate communities are often raised by community and stakeholders during consultation on flow management (such as minimum flows, residual flows and water allocation). Typically, such conversations are had prior to flow management measures being implemented. Given the long history of flow abstraction in the Manuherekia catchment, the contrasting hydrological conditions during the 2024/25 and 2025/26 irrigation seasons provided an opportunity to compare ecological outcomes for periphyton and macroinvertebrate communities between a dry year dominated by stable flows (2024/25) and a wet year with higher flows and occurrence of high flow events (2025/26). The results of monthly observations in these two seasons resulted in similar ecological outcomes and the higher flows observed in the 2025/26 season may have contributed to positive (e.g. lower periphyton biomass in the Manuherekia at Ophir) and negative outcomes (e.g. greater cover of Didymo in Dunstan Creek at Loop Road). These findings demonstrate the difficulty in predicting the effect of higher flows on ecological outcomes and raise doubts over the oft-made assumption that higher flows will result in 'better' ecological outcomes.

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Appendix A

Periphyton cover data

Raw periphyton cover data collected at survey sites between December 2025 and March 2026 are presented in Tables 13-17 Raw periphyton cover data for ORC biomonitoring sites December 2025 and April 2026 (courtesy of ORC) are presented in Table 20.

Table 15 Periphyton cover at sites in the upper and mainstem Manuherekia between December 2025 and March 2026.

		Upper Manuherekia at ds Forks				Manuherekia at downstream of MICSL take			
Category	**Thickness**	**12/12/2025**	**14/01/2026**	**11/02/2026**	**20/03/2026**	**12/12/2025**	**13/01/2026**	**11/02/2026**	**20/03/2026**
Thin green film	<0.5mm	0	0	0	0	0	94	85	84
Thin light brown film	<0.5mm	54	0	36	0	61	1	0	0
Thin black/dark brown film	<0.5mm	2	0	0	1	0	0	0	0
Sludge		2	0	0	0	0	0	0	0
Medium green mat	0.5-3mm	0	0	0	7	0	2	3	0
Medium light brown mat	0.5-3mm	1	2	8	0	7	2	0	2
Medium black/dark brown mat	0.5-3mm	4	9	9	10	4	0	1	0
Thick green/light brown mat	>3mm	14	13	0	11	0	0	9	0
Thick black/dark brown mat	>3mm	2	0	0	0	3	0	0	0
Short green filaments	<2cm	0	0	0	0	0	0	0	0
Short brown/reddish filaments	<2cm	0	0	0	0	0	0	3	0
Long green filaments	>2cm	5	3	8	2	0	0	0	0
Long brown/reddish filaments	>2cm	0	0	0	0	0	0	0	0
Bryophytes		0	0	0	0	0	0	0	0
Macrophytes		0	0	0	0	0	0	0	0
Total algal % cover		**82**	**27**	**61**	**30**	**74**	**100**	**100**	**86**

Table 16 Periphyton cover at sites in the Dunstan Creek between December 2025 and March 2026.

		Dunstan Creek at Gorge				Dunstan Creek at Loop Road			
Category	**Thickness**	**12/12/2025**	**14/01/2026**	**11/02/2026**	**20/03/2026**	**12/12/2025**	**14/01/2026**	**11/02/2026**	**20/03/2026**
Thin green film	<0.5mm	0	1	1	3	0	0	39	8
Thin light brown film	<0.5mm	0	0	0	0	0	0	0	0
Thin black/dark brown film	<0.5mm	0	0	0	0	0	9	0	0
Sludge		0	0	0	0	0	0	0	0
Medium green mat	0.5-3mm	0	3	13	1	0	27	21	33
Medium light brown mat	0.5-3mm	2	4	9	1	1	0	0	0
Medium black/dark brown mat	0.5-3mm	2	40	4	56	0	21	35	44
Thick green/light brown mat	>3mm	71	3	1	5	49	0	0	0
Thick black/dark brown mat	>3mm	0	1	2	1	0	0	2	0
Short green filaments	<2cm	0	0	0	0	0	0	0	0
Short brown/reddish filaments	<2cm	0	6	4	0	0	19	2	3
Long green filaments	>2cm	1	0	0	0	19	0	0	0
Long brown/reddish filaments	>2cm	0	0	0	0	0	0	0	0
Bryophytes		0	0	0	0	0	0	0	0
Macrophytes		0	0	29	0	0	0	0	0
Total algal % cover		**76**	**58**	**63**	**67**	**69**	**76**	**100**	**87**

Table 17 Periphyton cover at sites in the Dunstan and Chatto Creek between December 2025 and March 2026.

		Dunstan Creek at confluence				Chatto Creek at confluence			
Category	**Thickness**	**12/12/2025**	**14/01/2026**	**11/02/2026**	**20/03/2026**	**13/12/2025**	**13/01/2026**	**12/02/2026**	**21/03/2026**
Thin green film	<0.5mm	0	70	18	66	0	0	0	0
Thin light brown film	<0.5mm	71	8	0	0	83	43	69	72
Thin black/dark brown film	<0.5mm	0	0	0	0	12	0	2	0
Sludge		0	0	0	0	0	0	0	0
Medium green mat	0.5-3mm	0	2	26	0	0	0	0	0
Medium light brown mat	0.5-3mm	0	12	9	8	5	56	1	1
Medium black/dark brown mat	0.5-3mm	4	0	0	3	0	0	22	28
Thick green/light brown mat	>3mm	1	1	6	12	0	0	0	0
Thick black/dark brown mat	>3mm	24	0	0	0	0	0	0	0
Short green filaments	<2cm	0	0	0	0	0	0	0	0
Short brown/reddish filaments	<2cm	0	1	3	1	0	0	0	0
Long green filaments	>2cm	0	0	0	0	0	0	0	0
Long brown/reddish filaments	>2cm	0	0	0	0	0	0	0	0
Bryophytes		0	0	0	0	0	0	0	0
Macrophytes		0	0	0	0	0	0	0	0
Total algal % cover		**99**	**93**	**61**	**92**	**100**	**100**	**93**	**100**

Table 18 Periphyton cover at sites in the Lauder Creek between December 2025 and March 2026.

		Lauder at Cattleyards				Lauder at Rail Trail			
Category	**Thickness**	**13/12/2025**	**14/01/2026**	**12/02/2026**	**21/03/2026**	**12/12/2025**	**14/01/2026**	**11/02/2026**	**20/03/2026**
Thin green film	<0.5mm	1	61	77	86	0	0	0	0
Thin light brown film	<0.5mm	61	0	0	1	40	41	54	83
Thin black/dark brown film	<0.5mm	0	0	0	0	0	0	1	6
Sludge		0	0	0	0	0	0	0	0
Medium green mat	0.5-3mm	0	0	9	1	0	0	0	0
Medium light brown mat	0.5-3mm	0	3	3	7	41	17	7	0
Medium black/dark brown mat	0.5-3mm	0	27	0	5	2	0	1	5
Thick green/light brown mat	>3mm	34	1	0	1	0	20	6	2
Thick black/dark brown mat	>3mm	2	0	0	0	0	0	1	4
Short green filaments	<2cm	0	0	0	0	0	0	1	0
Short brown/reddish filaments	<2cm	0	0	0	0	2	0	0	0
Long green filaments	>2cm	0	0	0	0	4	19	6	0
Long brown/reddish filaments	>2cm	0	0	0	0	0	0	0	0
Bryophytes		0	0	0	0	0	0	0	0
Macrophytes		0	0	2	0	0	0	0	0
Total algal % cover		**99**	**94**	**97**	**100**	**89**	**97**	**80**	**99**

Table 19 Periphyton cover at sites in the Thomsons Creek between December 2025 and March 2026.

		Thomsons Creek at Race				Thomsons Creek at us Sluice Channel			
Category	**Thickness**	**13/12/2025**	**14/01/2026**	**12/02/2026**	**21/03/2026**	**12/12/2025**	**13/01/2026**	**11/02/2026**	**20/03/2026**
Thin green film	<0.5mm	0	0	0	0	0	0	97	100
Thin light brown film	<0.5mm	97	94	96	89	69	90	0	0
Thin black/dark brown film	<0.5mm	0	3	0	0	0	0	0	0
Sludge		0	0	0	1	0	0	0	0
Medium green mat	0.5-3mm	0	0	0	6	0	0	0	0
Medium light brown mat	0.5-3mm	1	2	1	2	0	0	0	0
Medium black/dark brown mat	0.5-3mm	0	0	1	1	0	0	0	0
Thick green/light brown mat	>3mm	1	0	0	1	0	0	0	0
Thick black/dark brown mat	>3mm	0	0	0	0	0	0	0	0
Short green filaments	<2cm	0	0	0	0	0	0	0	0
Short brown/reddish filaments	<2cm	0	0	0	0	0	0	0	0
Long green filaments	>2cm	0	0	0	0	0	0	0	0
Long brown/reddish filaments	>2cm	0	0	0	0	0	0	0	0
Bryophytes		1	0	0	0	0	0	0	0
Macrophytes		0	1	0	0	0	0	2	0
Total algal % cover		**100**	**100**	**99**	**100**	**69**	**90**	**0**	**0**

Table 20 Periphyton cover at ORC biomonitoring sites in the Manuherekia catchment between December 2025 and April 2026. Data courtesy of ORC.

	Manuherikia at Ophir					Manuherikia at Galloway				
	03/12/2025	**07/01/2026**	**03/02/2026**	**05/03/2026**	**01/04/2026**	**03/12/2025**	**07/01/2026**	**03/02/2026**	**05/03/2026**	**01/04/202**
Thin green film	0	0		0	0	1	0	0	0	
Thin light brown film	38.5	74.5		68	86	79.5	99.75	99.5	95.5	
Thin black/dark brown film	0	0		0	0	0	0	0	0	
Medium green mat	0	0		0	0	0	0	0	0	
Medium light brown mat	4	0		2.5	0.5	2.5	0	0	0	
Medium black/dark brown mat	38	0		0	1	0	0	0	0	
Thick black/dark brown mat	0	1.75		5	0	0	0	0	0	
Thick green/light brown mat	0	0		0	0	0	0	0	0.5	
Short brown/reddish filaments	4	5.5		8	3.5	3.5	0	0	0	
Short green filaments	0	0		0	0	0	0	0	0	
Long brown/reddish filaments	6	0		0	1	1.5	0	0	0	
Long green filaments	2	0		0.5	0	0	0	0	0	
Bryophytes	0	0		0	0	0	0	0	0	
Macrophytes	0	0		0	0	0	0	0	0	
Sludge	0.5	0		0	0	0	0	0	0	
Total algal cover	**92.5**	**81.75**		**84**	**92**	**88**	**99.75**	**99.5**	**96**	

	Manuherikia at Blackstone Hill					Dunstan Creek at Beattie Road				
	03/12/2025	**07/01/2026**	**03/02/2026**	**05/03/2026**	**01/04/2026**	**03/12/2025**	**07/01/2026**	**03/02/2026**	**05/03/2026**	**01/04/202**
Thin green film	0	2	0	1	0	0	1	0		0
Thin light brown film	58.5	65	77	76.5	78.75	78.5	64.25	81		89.75
Thin black/dark brown film	0	0	0	0	0	1	0	0		0
Medium green mat	0	0	0	0	0	0	0	0		0
Medium light brown mat	6	4.5	3	0	0	0.5	1.5	3		0
Medium black/dark brown mat	0	0	0	0	0	0.5	1	0		0
Thick black/dark brown mat	0	0	0	0	0	0	6.5	1.5		5
Thick green/light brown mat	0	1	0	0	0	0	0	0		0
Short brown/reddish filaments	2.5	0	0.5	2	0.75	9.5	0	1.5		3
Short green filaments	0	7	0	0	0	0	0	0		0
Long brown/reddish filaments	9	0	0	0	1	3.5	0	0		0
Long green filaments	0	12.75	0	2.5	6	0	0	0		0
Bryophytes	0	0	0	0	0	0	0	0		0
Macrophytes	0	0	0	0	0	0	0	0		0
Sludge	6	0	0	2	4	0	0	0		0
Total algal cover	**76**	**92.25**	**80.5**	**82**	**86.5**	**93.5**	**74.25**	**87**		**97.75**

Appendix B

Macroinvertebrate data

Raw macroinvertebrate data collected from fourteen sites in the Manuherekia catchment on 20th/21st March 2026 and ORC SoE sites on 4th – 8th March 2026 are presented in Table 21.

Table 21 Macroinvertebrate data for fourteen sites in the Manuherekia Catchment collected as part of monitoring with the phased implementation of the Catchment Management Plan in March 2026.

ORDER	TAXON	TV	TV (Greenwood et al. 2015)	Manuherekia d/s Forks	Manuherekia at Blackstone	Manuherekia at Ophir	Manuherekia d/s MICSC take	Manuherekia at Campground	Dunstan Creek at Gorge	Dunstan Creek at Loop Road	Dunstan Creek at Beatie road	Dunstan Creek at Confluence	Lauder Creek at cattle yards	Lauder Creek at Rail trail	Thomson creek at u/s intake	Thomson Creek at u/s sluice channel	Chatto Creek at u/s confluence	Dunstan Creek at Beattie Road	Manuherikia at Blackstone	Manuherikia at Ophir	Manuherikia at Galloway
				20/03/2026	20/03/2026	20/03/2026	21/03/2026	20/03/2026	20/03/2026	20/03/2026	20/03/2026	20/03/2026	21/03/2026	20/03/2026	21/03/2026	20/03/2026	21/03/2026	05/03/2026	05/03/2026	08/03/2026	04/03/2026
ACARINA	ACARINA	5	3			1												5			
CRUSTACEA	Ostracoda	3	3						20	20					1	20					8
	Paracalliope	5	5			20		1						20	20	200	60				
	Paraleptamphopus	5	7														1			1	1
COLEOPTERA	*Berosus*	5	4					1	1												
	Elmidae	6	6	400	1760	1940	470	3640	240	280	1020	1840	240	200	480	3440	500	1020	520	1110	496
	Hydraenidae	8	8										1		20						
DIPTERA	*Aphrophila*	5	9	40					1				1		20						
	Austrosimulium	3	6	40	1	1		100			1	1	20	1		20		1	10		1
	Ceratopogonidae	3	6									1						35			1
	Chironomus	1	1																		8
	Empididae	3	6						80		1		20								4
	Eriopterini	9	9	1	1						20	1						1	5		
	Maoridiamesa	3	7	1								20	60	1			1				
	Muscidae	3	4	1	1	1	1		20	40	1	1	1	1	20					5	4
	Orthocladiinae	2	4	80	60				700	860	180	820	700		60		20	15		5	4
	Polypedilum	3	2						20								1				
	Stictocladius	9	7							60											
	Tabanidae	3	8	1					1		1	1				1			5		
	Tanypodinae	5	5	1						1											12
	Tanytarsini	3	5	60	1				160	280	20	240	60	1	20		1	20		10	
EPHEMEROPTERA	*Atalophlebioides*	9	6																		1
	Austroclima	9	6	20	20	160	160	1	400	80	1	40	40		60		1		1	45	1
	Coloburiscus	9	9	40					20		1	1	1								
	Deleatidium	8	7	2360	2120	2500	1640	3500	680	300	1660	2100	560	3500	520	2400	3960	330	700	615	236
	Nesameletus	9	8	1	1	1	10				1	1			20			1			1
HEMIPTERA	Saldidae	5	3								1										
	Sigara	5	2																		4
MEGALOPTERA	*Archichauliodes*	7	8	20	20	1	1		20	60	40	20	1		40	20	20	10	1	10	
PLECOPTERA	*Megaleptoperla*	9	7										1								
	Stenoperla	10	9	1					20	1	1		1								
	Zelandobius	5	7	1				20	40	120			1		60			5		1	
	Zelandoperla	10	8	20					20		1		20		1						
TRICHOPTERA	*Beraeoptera*	8	7	40									1340		40						
	Confluens	5	7	20																	
	Costachorema	7	9	1		1	1				1	1	20				1	1		5	
	Helicopsyche	10	9	1																	
	Hudsonema	6	4	20	60	20			20	20	1	40	20	1	260	220		10	45		4
	Hydrobiosidae early instar	5	5						60		20	20									
	Hydrobiosis	5	8	100	20	1	10	40	40	20	100	120	100	20	20	80	80	5	1	1	
	Hydropsyche (Aoteapsyche)	4	8	960	100	380	200	100	220	1	80	200	80	300	60	200	20	20	25	115	4
	Neurochorema	6	6	1					1	60	1	1	20								
	Olinga	9	9	780		80	1		920	240	120	60	2220		220		20	25	10		
	Oxyethira	2	3																1		
	Philorheithrus	8	3										1								
	Plectrocnemia	8	7									40									
	Polyplectropus	8	3												20						
	Psilochorema	8	7	40	1	1	20	1	60	40	1		60	40	1	80	20	5	5	5	1
	Pycnocentria	7	5	20	80	460	30	200	140	200	600	280	1100	1820	460	560	1860	145	20	85	8
	Pycnocentrodes	5	6	80	100	460	330	60	180	180	60	420	840	20	3300	260	120	40	1	150	4

Table 21 Macroinvertebrate data for fourteen sites in the Manuherekia Catchment collected as part of monitoring with the phased implementation of the Catchment Management Plan in March 2026.

ORDER	TAXON	TV	TV (Greenwood et al. 2015)	Manuherekia d/s Forks	Manuherekia at Blackstone	Manuherekia at Ophir	Manuherekia d/s MICSC take	Manuherekia at Campground	Dunstan Creek at Gorge	Dunstan Creek at Loop Road	Dunstan Creek at Beatie road	Dunstan Creek at Confluence	Lauder Creek at cattle yards	Lauder Creek at Rail trail	Thomson creek at u/s intake	Thomson Creek at u/s sluice channel	Chatto Creek at u/s confluence	Dunstan Creek at Beattie Road	Manuherikia at Blackstone	Manuherikia at Ophir	Manuherikia at Galloway
				20/03/2026	20/03/2026	20/03/2026	21/03/2026	20/03/2026	20/03/2026	20/03/2026	20/03/2026	20/03/2026	21/03/2026	20/03/2026	21/03/2026	20/03/2026	21/03/2026	05/03/2026	05/03/2026	08/03/2026	04/03/2026
HIRUDINEA		3	2													1					
NEMATOMORPHA		3	6									1		1							
NEMERTEA		3	2													20	20				
OLIGOCHAETA		1	5	140	280	80	60	80	2360	1240	140	220	160	160	820	260	120	15	40	15	16
PLATYHELMINTHES		3	4				20									20	20				
MOLLUSCA	Potamopyrgus	4	5	1	20	420	60	100	60	240	120	140	2440	160	1500	2300	2180	20	1		1
	Sphaeriidae	3	2											20			20		1		
Number of taxa				**32**	**18**	**19**	**16**	**14**	**28**	**22**	**28**	**27**	**30**	**17**	**25**	**18**	**22**	**21**	**18**	**16**	**22**
Number of invertebrates (per sample)				**5292**	**4646**	**6528**	**3014**	**7844**	**6504**	**4343**	**4194**	**6630**	**10129**	**6266**	**8043**	**10102**	**9046**	**1729**	**1392**	**2178**	**820**
Number of EPT taxa				**19**	**9**	**11**	**10**	**8**	**15**	**12**	**16**	**14**	**18**	**7**	**14**	**7**	**9**	**11**	**9**	**9**	**9**
% EPT taxa				**59**	**50**	**58**	**63**	**57**	**54**	**55**	**57**	**52**	**60**	**41**	**56**	**39**	**41**	**52**	**50**	**56**	**41**
% EPT abundance				**85**	**54**	**62**	**80**	**50**	**43**	**29**	**63**	**50**	**63**	**91**	**63**	**38**	**67**	**34**	**58**	**47**	**32**
MCI score				**138**	**123**	**125**	**131**	**121**	**124**	**122**	**131**	**130**	**132**	**113**	**124**	**120**	**115**	**129**	**124**	**128**	**106**
QMCI score				**7.29**	**6.38**	**6.38**	**6.64**	**6.44**	**5.98**	**5.43**	**6.30**	**6.06**	**6.39**	**6.31**	**5.76**	**5.91**	**5.98**	**6.13**	**6.47**	**6.35**	**6.13**
ASPM				**0.65**	**0.48**	**0.53**	**0.54**	**0.48**	**0.56**	**0.52**	**0.59**	**0.55**	**0.63**	**0.41**	**0.55**	**0.41**	**0.43**	**0.52**	**0.48**	**0.50**	**0.42**

Appendix C

Comparison of macroinvertebrate indices

The Macroinvertebrate Community Index (MCI), semi-quantitative MCI (SQMCI) and quantitative MCI (QMCI) are all calculated using tolerance values for macroinvertebrate taxa present in a sample (or samples) collected from a site. The original tolerance values were given in Stark (1985) and were based on data from sites in Taranaki while some tolerance scores have been assigned based on professional judgement and Stark & Maxted (2007) presented tolerance values for a wide range of taxa. These tolerance values were generated in inconsistent ways between and within regions. To address this, Greenwood et al. (2015) used a national-scale aquatic invertebrate dataset to develop an objective computational process to produce tolerance values for as many macroinvertebrate taxa as possible, at a range of taxonomic levels, for both hard-bottomed and soft-bottomed streams.

Despite the important and much-needed work of Greenwood et al. (2015), adoption of the updated tolerance values has been spotty. In the National Environmental Standard (NEMS) for Macroinvertebrates, it is stated that *"It is recognised that the Macroinvertebrate Community Index (MCI) 'pollution' tolerance values were developed more than 30 years ago and some macroinvertebrate taxa lack a tolerance value. Greenwood et al. (2015) presented a combined set of revised or new MCI tolerance values for 234 taxa found in hard-bottomed streams across New Zealand. However, at the present time, these values are not widely in use. Until such time as an updated national data set is formally introduced, the tolerance values presented in Annex D shall apply under this Standard."* The position stated in the NEMS is flawed. It ignores advancements in knowledge by continuing to use the tolerance values based on analysis conducted in the 1980s using the methods and technology of that time on a dataset collected from a limited geographical area over a limited time period and values based on "expert judgement" rather than tolerance values based on an objective computational analysis of a national dataset using open-source scripts. This position is inconsistent with the requirement for expert witnesses not to "omit material facts" known to them. Failing to acknowledge the shortcomings of the original scores and that there are now robust scores based on a national dataset is arguably both an omission and material to the outcome and conclusions drawn from such analysis. The argument that the Greenwood et al. (2015) scores are not in wide use is self-fulfilling, since regional councils are expected to follow the NEMS. There is no compelling reason why councils have not updated MCI scores based on the updated tolerance values of Greenwood et al. (2015), other than the time and resources required to update the calculations.

Table 22 presents the tolerance values of Stark & Maxted (2007) and the corresponding tolerance value from Greenwood et al. (2015) for all taxa identified from samples collected from sites in the Manuherekia catchment in this survey. A matrix comparing original tolerance values with the updated tolerance value for all taxa identified from samples collected in this survey is presented in Figure 9. It is evident that some of the updated tolerance values of Greenwood et al. (2015) are substantially different from the original tolerance values, with updated tolerance values varying by as much as 5 units (higher and lower) compared with the original tolerance values (Table 22, Figure 9). Consideration of the matrix presented in Figure 9 suggests that taxa with low original tolerance values (<5) tended to have higher updated tolerance values, while taxa with high original tolerance values (>8) tended to have lower updated tolerance values.

Macroinvertebrate Community Index (MCI) values calculated using the revised tolerance values of Greenwood et al. (2015) were consistently higher than those calculated using the original tolerance values (Figure 10). In comparison, QMCI calculated using revised tolerance values was higher than QMCI scores calculated using the original tolerance values for lower values but converging at higher values were similar (Figure 10). Average Score Per Metric (ASPM) values calculated using the revised tolerance values of Greenwood et al. (2015) were similar to those calculated using the original tolerance values (Figure 10).

On the basis of these analyses, the use of the original tolerance values systemically under-estimates MCI scores and under-estimates QMCI scores at lower scores for sites in the Manuherekia catchment. These are not trivial changes, they fundamentally change the interpretation of the "state" of these sites compared to the numeric thresholds in regulatory documents, including the NPSFM and proposed attribute states for the Manuherekia. Given the shortcomings of the approach(es) taken to derive the original tolerance values, indices calculated using the Greenwood et al. (2015) tolerance values were used throughout this report.

Table 22 Comparison of tolerance values of Stark & Maxted (2007) and the corresponding tolerance value from Greenwood et al. (2015) for taxa in samples collected from sites in the Manuherekia catchment in the 2025/2026 survey.

ORDER	TAXON	Original tolerance value	Tolerance value (Greenwood et al. 2015)	ORDER	TAXON	Original tolerance value	Tolerance value (Greenwood et al. 2015)
ACARINA		5	3	MEGALOPTERA	*Archichauliodes*	7	8
COLEOPTERA	*Berosus*	5	4	MOLLUSCA	*Potamopyrgus*	4	5
	Elmidae	6	6		Sphaeriidae	3	2
	Hydraenidae	8	8	NEMATOMORPHA		3	6
CRUSTACEA	Ostracoda	3	3	NEMERTEA		3	2
	Paracalliope	5	5	OLIGOCHAETA		1	5
	Paraleptamphopus	5	7	PLATYHELMINTHES		3	4
DIPTERA	*Aphrophila*	5	9	PLECOPTERA	*Megaleptoperla*	9	7
	Austrosimulium	3	6		*Stenoperla*	10	9
	Ceratopogonidae	3	6		*Zelandobius*	5	7
	Chironomus	1	1		*Zelandoperla*	10	8
	Empididae	3	6	TRICHOPTERA	*Beraeoptera*	8	7
	Eriopterini	9	9		*Confluens*	5	7
	Maoridiamesa	3	7		*Costachorema*	7	9
	Muscidae	3	4		*Helicopsyche*	10	9
	Orthocladiinae	2	4		*Hudsonema*	6	4
	Polypedilum	3	2		Hydrobiosidae early instar	5	5
	Stictocladius	9	7		*Hydrobiosis*	5	8
	Tabanidae	3	8		*Hydropsyche (Aoteapsyche)*	4	8
	Tanypodinae	5	5		*Neurochorema*	6	6
	Tanytarsini	3	5		*Olinga*	9	9
EPHEMEROPTERA	*Atalophlebioides*	9	6		*Oxyethira*	2	3
	Austroclima	9	6		*Philorheithrus*	8	3
	Coloburiscus	9	9		*Plectrocnemia*	8	7
	Deleatidium	8	7		*Polyplectropus*	8	3
	Nesameletus	9	8		*Psilochorema*	8	7
HEMIPTERA	Saldidae	5	3		*Pycnocentria*	7	5
	Sigara	5	2		*Pycnocentrodes*	5	6
HIRUDINEA		3	2				

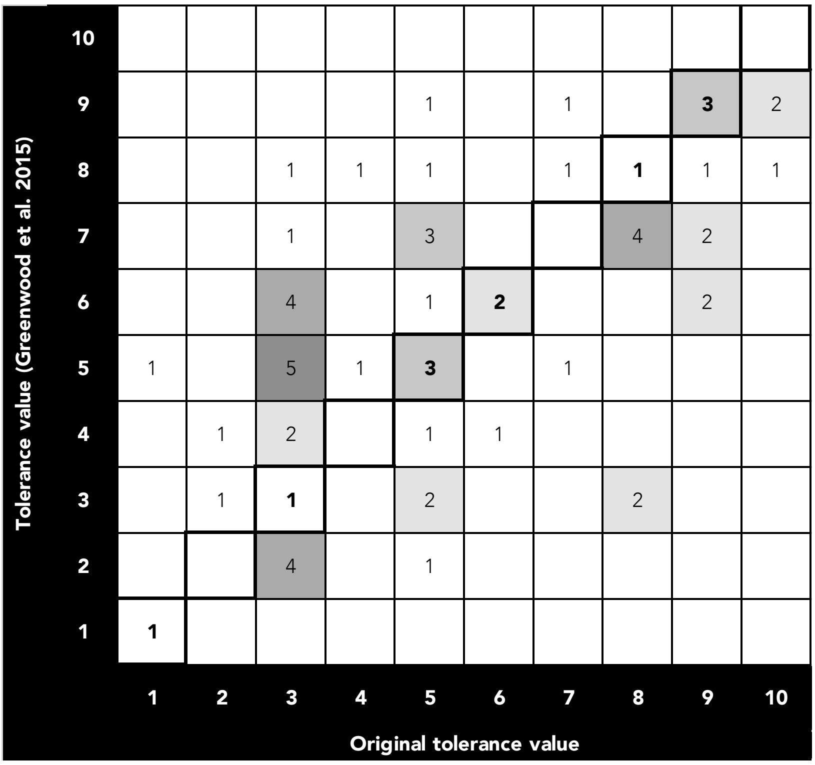

Figure 9 Matrix comparing original tolerance values (Stark & Maxted 2007) and the corresponding tolerance value from Greenwood et al. (2015) for taxa in samples collected from sites in the Manuherekia catchment in the 2025/2026 survey. Numerical values are counts. The diagonal indicates that the original tolerance value and updated tolerance value are the same. Values below the diagonal indicate that the original tolerance value was higher than the updated tolerance value and values above the diagonal indicate that the original tolerance value was lower than the updated tolerance value

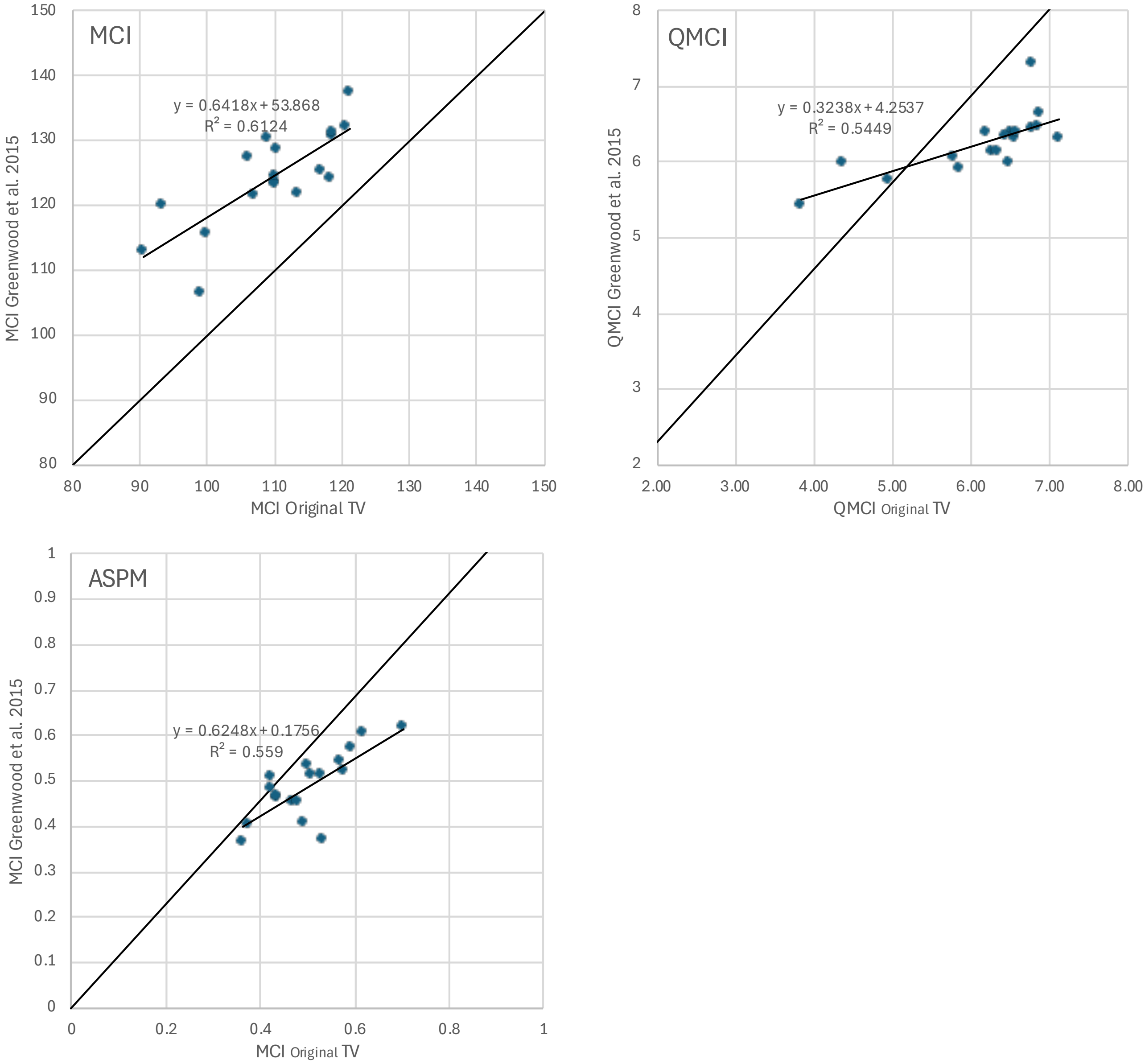

Figure 10 Comparison of MCI, QMCI and ASPM scores for samples collected during the 2025/2026 survey calculated using tolerance values (TV) from Stark & Maxted (2007) (original TV) with scores based on the updated tolerance values of Greenwood et al. (2015).