Current Environmental State and the "Gap" to Draft Freshwater Objectives for Southland

Technical Report

December 2019

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Executive Summary

Background

Environment Southland has embarked on a community-involved process to further develop our approach to managing land and water in the region. Through the People, Water and Land Programme this has included formation of a community-based group called the Regional Forum to help us explore how to achieve the aspirations of communities for freshwater. This will include identifying, amongst other things; community values; freshwater objectives, limits, and both regulatory and non-regulatory methods to achieve them. The Regional Forum was established in early 2019 and has been building knowledge and process through its first phase to September 2019.

Several draft reports were completed in September 2019 that described community values (Wilson et al., 2019) and a suggested starting set of draft numeric freshwater objectives for groundwater, rivers, lakes, estuaries and open coastal areas, that were inferred from previous Southland regional plans (Norton and Wilson 2019). This report follows in sequence and should be read in conjunction with those earlier reports as it relies and builds on them. This report is, in turn, a step in a continuing process and will be brought together with parallel workstreams identifying Ngāi Tahu ki Murihiku values and Iwi objectives, in order to develop a complete set of draft Murihiku Southland freshwater objectives in 2020 (see Figure 1).

Purpose

The three purposes of this report are to:

1. Use Environment Southland monitoring data to assess current environmental state and check whether any of the starting set of draft freshwater objectives were unknowingly drafted at lower than current state, thus necessitating revision upwards to at least a minimum of current state in order to satisfy the need to "maintain or improve" under the National Policy Statement for Freshwater Management 2017 (NPSFM).
2. Compare the current environmental state of groundwater, rivers, lakes and estuaries, with the starting set of draft freshwater objectives for each of these waterbody types, and to thereby assess the nature of any "gap" needing improvement. Understanding this gap is important as the Regional Forum progresses to consider limits and other regulatory and non-regulatory methods for achieving the freshwater objectives.
3. Explore several important topics for management and planning including: i) environmental variability – in space and through time; ii) environmental patterns at different spatial scales; iii) patterns at different time periods; and iv) considerations around implementation of the NPSFM "maintain or improve" requirement.

Method

To assess current environmental state this report uses the same "ABCD" banding system used in the earlier draft freshwater objectives report, where "A" generally means "very good", "B" means "good", "C means "fair" and "D" means "poor". This system simplifies the presentation of results. However the numeric thresholds and other technical details associated with the bands for every attribute are also provided in Appendices 1 to 4 for groundwater, rivers, lakes, and estuaries respectively.

Environment Southland's monitoring site data are used to present summaries of environmental state (A, B, C or D) for three time baselines (2010, 2016 and current 2019) and, wherever possible, state is compared to the relevant draft freshwater objective state (A, B or C band). The size of any gap is indicated by whether one or more bands of improvement is needed to achieve the draft freshwater objective band. Comparisons with freshwater objectives are made for all attributes, where possible at three spatial scales:

- for the region as a whole;
- for each freshwater management unit (FMU) (see map in Figure 5); and,
- for each groundwater, river, lake and estuary class (see Table 5 and Figures 2 to 4).

It was not the purpose of this report to present detailed information for each individual monitoring site. However, the results for every site will be made available on a Geographic Information System (GIS) website so that users can explore that level of detail.

Four groups of attributes have been recognised in this report. All attributes are listed in their groups in Table 1 (rivers), Table 2 (lakes), Table 3 (groundwater) and Table 4 (estuaries and open coast). The four groups are:

1. National compulsory attributes (i.e., currently in the National Objectives Framework[1]);
2. Southland attributes (i.e., those recommended by Norton and Wilson (2019) for use as a starting set of numeric freshwater objectives in Southland, in addition to the national compulsory attributes);
3. Additional proposed national compulsory attributes (i.e., those additional attributes listed in the draft NPSFM released for public consultation in September 2019 as part of Government's Essential Freshwater Package). This group of attributes will need to be reviewed again later in the process when any new NPSFM is finalised;
4. Additional indicators not in the above groups but for which monitoring data is available.

Results and key messages

This is a long report containing many tables and graphs summarising the state of many environmental attributes of groundwater, rivers, lakes and estuaries. For those readers wanting just the key messages these can be found as follows:

For conclusions on the necessary revisions to draft minimum numeric freshwater objectives (FWOs) in order to meet the NPSFM test of "maintain or improve" - see section 9.

For high level conclusions on the size of the "gap" needing improvement to achieve draft minimum FWOs - see section 0. For more detailed discussion specific to waterbody types see:

- Key messages for groundwater (section 5.4);
- Key messages for rivers (sections 6.1, 6.2 and 6.3);
- Key messages for lakes (section 7.1); and
- Key messages for estuaries (section 8.1).

For discussion and conclusions on several important topics for resource management and planning see section 11, and more specifically:

i) Awareness of environmental variability – in space and through time (section 11.1);
ii) Considerations of different spatial scales: site versus class, FMU and region (section 11.2);
iii) Informing decisions on the "baseline" year for management (section 11.3); and
iv) Operating with the NPSFM requirement to "maintain or improve" (section 11.4);

[1] As laid out in the National Policy Statement for Freshwater Management 2017 (NPSFM).

Decision-making – for governance and for plan writing

All of the conclusion topics listed above contain challenges that will require decisions later in the process. Some of these decisions will involve value judgements, by Environment Southland's council and Te Ao Marama board, to set the level for finalised freshwater objectives, and limits and other methods to achieve them. Some will require planning decisions around how to structure a future regional plan change, including on things like how to handle environmental variability, the appropriate spatial scale for various plan provisions, time baselines and mechanisms to implement "maintain or improve". This report offers technical information and some suggestions about how some of these decisions might be approached. This is intended to inform discussion and future policy decisions on these matters, which probably can only be finalised later once the learnings from all the steps in the intended process are known.

Where to from here for developing freshwater objectives?

This report is a step in a continuing process. Key further steps in current progress include:

- Documenting Ngāi Tahu ki Murihiku values and Iwi objectives (planned for early 2020);
- Bringing the draft numeric freshwater objectives together with Iwi values and objectives to enable testing against other NPSFM (2017) and proposed Southland Water and Land Plan (pSWLP) requirements including Ki Uta Ki Tai, Te Mana o Te Wai, and the need to provide for hauora and in so doing acknowledge and protect the mauri of water. This step is intended to establish an agreed position on draft freshwater objectives for the process going forward in 2020.

Notable further steps beyond the above may include reviews following the finalisation of any new NPSFM and decisions on the pSWLP[2]. Further steps will also involve:

- consideration of the limits and methods to achieve the draft freshwater objectives;
- consideration of the implications of those limits and methods including social, cultural and economic implications;
- subsequent deliberations and recommendations by the Regional Forum to Environment Southland's council and Te Ao Marama board; and then,
- decisions to finalise the freshwater objectives, limits and methods in a regional plan change, as well as undertaking non-regulatory actions to achieve objectives.

[2] The pSWLP is currently being heard by Environment Court with decisions anticipated in 2021.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

Environment Southland has, through its People Water and Land Programme, embarked on a community-involved process to further develop its approach to managing land and water in the region. This has included community engagement to support the development of community values and draft freshwater objectives, and the formation of a Regional Forum to help it develop limits and both regulatory and non-regulatory methods to achieve them.

The Regional Forum is a community-based group that will advise Environment Southland's council and Te Ao Marama board members on how to achieve the communities' aspirations for freshwater. Members of the Forum will consider the specific policies and rules as well as on-ground initiatives required to make change and improve Southland's water and land for generations to come.

The Regional Forum was established in early 2019 and spent its first phase to August 2019 building knowledge and process. In its second phase, beginning September 2019, the Forum received several technical reports including one about community values (Wilson et al., 2019) and one containing a starting draft set of freshwater objectives that were inferred from previous Southland regional plans (Norton and Wilson 2019). This report follows on from those two earlier reports in sequence and should be read in conjunction as it relies and builds on them. This report is, in turn, a step in a continuing process.

1.2 Relation of this report to others in the process

This report is one of several reports delivering outputs of the "Values and Objectives" workstream under Environment Southland's People Water and Land Programme (Figure 1). The reports in Figure 1 are numbered and this is report number 7. Reports 8 to 9 were either not started or incomplete at the time this report was first drafted. The diagram in Figure 1 has been completed and inserted later into the final version of this report to provide clarity around the process sequence and the relation of this report to that sequence.

1.3 Relation to community engagement, values and freshwater objectives process

Reports 1 to 3 at the left of Figure 1 show reports describing the background regional planning context (Report 1: Miller 2019), community engagement (Report 2: Henderson 2019) and the confirmation of community values (Report 3: Wilson et al., 2019) respectively. The report on starting draft freshwater objectives (Report 6: Norton and Wilson 2019) followed and built on those earlier reports. This report (Report 7) follows in sequence.

1.4 Relation to tangata whenua values and freshwater objectives process

Reports 4, 5 and 8 in Figure 1 show the parallel process of identifying tangata whenua values (Report 5: Wai – Ngāi Tahu ki Murihiku) and draft Ngāi Tahu ki Murihiku freshwater objectives (Report 8), all of which were in process but not yet available at the time of drafting this report. It is important to recognise that this is one of several reasons why the draft freshwater objectives referred to in this report are only a starting draft. At time of writing this report it was intended that tangata whenua values would be documented in time for the Regional Forum's workshop in November 2019, and that Iwi objectives would be drafted by early in 2020. The intent was to then bring the starting draft freshwater objectives assessed in this report together with Iwi values and objectives in a subsequent step of the process in 2020, as illustrated by the coming together of diagrammatic 'river braids' (at Report 9) in Figure 1.

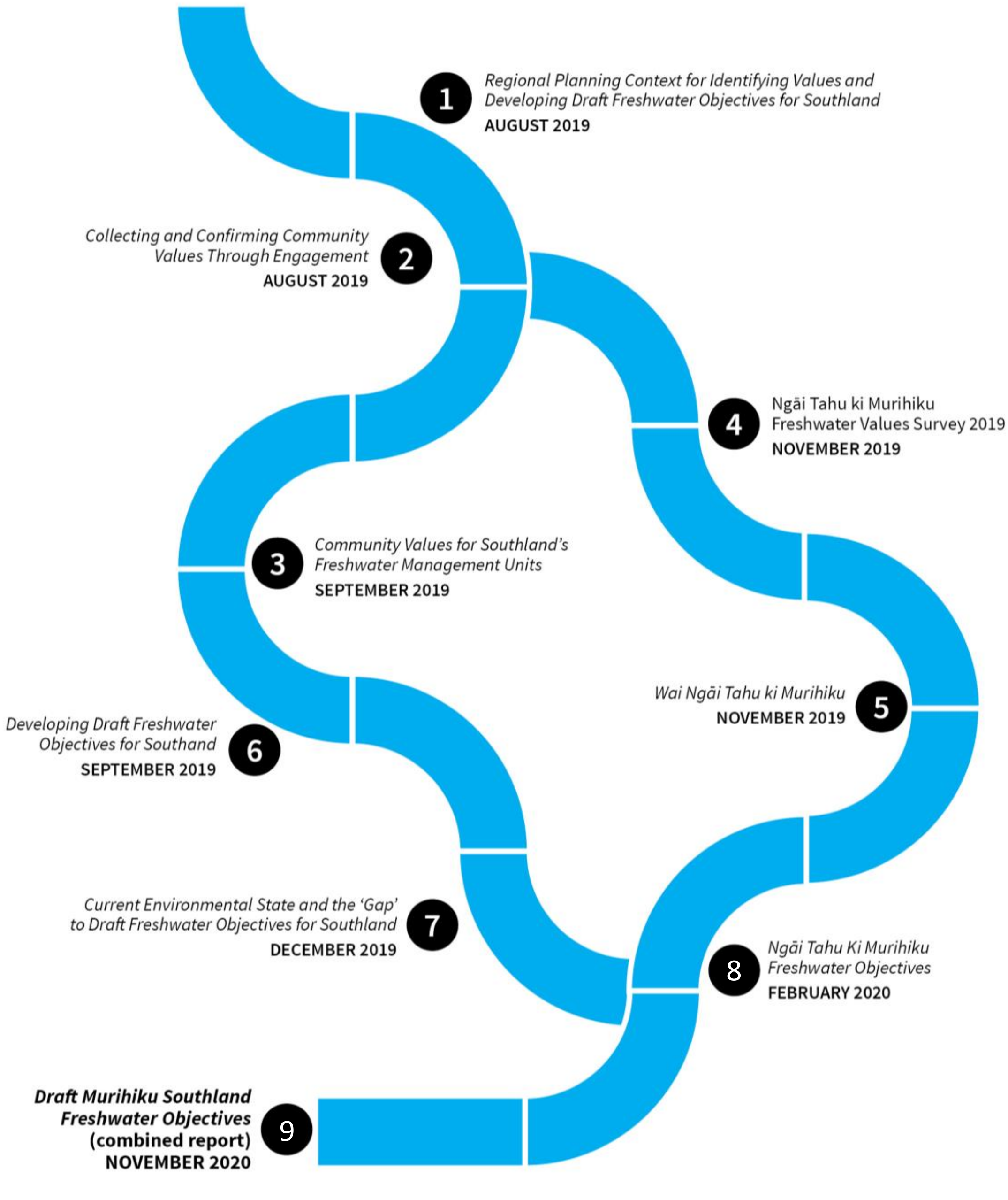

Figure 1: The sequence of reports written for the Values and Objectives workstream – this report is number 7.

2 Purpose and overview

2.1 Purpose

The three purposes of this report are to:

1. Use Environment Southland monitoring data to assess current environmental state and check whether any of the starting set of draft freshwater objectives (in Norton and Wilson 2019) were unknowingly drafted at lower than current state, thus necessitating revision upwards to at least a minimum of current state in order to satisfy the need to "maintain or improve" under the National Policy Statement for Freshwater Management 2017 (NPSFM).
2. Compare the current environmental state of groundwater, rivers, lakes and estuaries, with the starting set of draft freshwater objectives for each of these waterbody types, and to thereby assess the nature of any "gap" needing improvement. Understanding this gap is important as the Regional Forum progresses to consider limits and other regulatory and non-regulatory methods for achieving the freshwater objectives.
3. Explore several important topics for management and planning including: i) environmental variability – in space and through time; ii) environmental patterns at different spatial scales; iii) patterns at different time periods; and iv) considerations around implementation of the NPSFM "maintain or improve" requirement.

2.2 Overview of approach

The report addresses these purposes by assessing available monitoring data for numerous attributes (i.e., measurable characteristics of waterbodies), the locations where those attributes either exceed or do not currently meet the starting draft freshwater objectives, and the size of the gap to be improved in the latter case.

The report uses the same "ABCD" banding system as used in the earlier draft freshwater objectives report (Norton and Wilson 2019) to describe environmental state where "A" generally means "very good", "B" means "good", "C means "fair" and "D" means "poor". The environmental state (A, B, C or D) is presented for three time baselines (2010, 2016 and current 2019) and in each case, wherever possible, is compared to the relevant draft freshwater objective state (A, B or C band). The size of any gap is indicated by whether one or more bands of improvement is needed.

The use of the "ABCD" band system is useful in that it allows comparisons and conversations to be made in ABCD terms without the added complexity of the different numbers, scientific units of measurement and compliance statistics that necessarily define the thresholds between the bands, and which are different for every attribute. A brief narrative description of each attribute, along with the numbers and other technical details, are provided with all of the "attribute state option" tables in Appendices 1 to 4 for groundwater, rivers, lakes, and estuaries respectively.

This report uses available data from individual monitoring sites to present summaries of environmental state and comparisons with freshwater objectives for all attributes where possible at three spatial scales:

- for the region as a whole;
- for each freshwater management unit (FMU) (see map in Figure 5); and
- for each groundwater, river, lake and estuary class (see Table 5 and Figures 2 to 4);

It was not the purpose of this report to present detailed information for each individual monitoring site. However, the environmental state results for every site will be made available on a Geographic Information System (GIS) website so that users can explore that level of detail.

Four groups of attributes have been recognised in this report as described further in section 3.2 below. All attributes are listed in their groups in Table 1 (rivers), Table 2 (lakes), Table 3 (groundwater) and Table 4 (estuaries and open coast). The four groups of attributes are:

1. National compulsory attributes (i.e., currently in the National Objectives Framework[3]);
2. Southland attributes (i.e., those recommended by Norton and Wilson (2019) for use as freshwater objectives in Southland in addition to the national compulsory attributes);
3. Additional proposed national compulsory attributes (i.e., those additional attributes listed in the draft NPSFM released for public consultation in September 2019 as part of Government's Essential Freshwater Package);
4. Additional indicators not in the above groups but for which monitoring data is available.

[3] As laid out in the National Policy Statement for Freshwater Management 2017 (NPSFM).

3 Method

3.1 Data

Generally the monitoring data were assembled from Environment Southand's state of environment (SOE) monitoring database along with other datasets (e.g., national, investigations and consents compliance monitoring) where available in some instances as described later.

3.2 Attributes

It is notable that the choice of attributes to use for setting freshwater objectives in regional plans is a subject of nation-wide discussion at present and there has been contentious debate around some attributes. This discussion and debate seems likely to continue for the foreseeable future. For transparency around this we have recognised four groups of attributes in this report as listed in the previous section 3.1. The rationale for this is:

- All current national compulsory attributes (NPSFM 2017) are recognised as such;
- Attributes suggested by Norton and Wilson (2019) for use in setting draft freshwater objectives, in addition to the national compulsory attributes, are recognised as "Southland attributes";
- Additional proposed national compulsory attributes listed in the draft NPSFM released for public consultation in September 2019 as part of Government's Essential Freshwater Package, if not already suggested for use as "Southland attributes" by Norton and Wilson (2019), are recognised as "Additional proposed national compulsory attributes". It is noted that two of these (dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP)) were suggested by Norton and Wilson (2019) as being of importance for setting "limits" rather than freshwater objectives and that remains our recommendation at this time. Whether any of this group of additional proposed national compulsory attributes are included as freshwater objectives for Southland will need to be reviewed when any new NPSFM is gazetted.
- Some additional attributes were also assessed even though they are not nationally compulsory, nationally proposed, or recommended by Norton and Wilson (2019) for use as freshwater objectives at this time; for example data were available for riverbed suspendible sediment (Quorer method) and these were included for interest alongside other attributes for sediment.

All attributes are listed below in their groups in Table 1 (rivers), Table 2 (lakes), Table 3 (groundwater) and Table 4 (estuaries and open coast).

Table 1: Attributes proposed for rivers.

Group	Attributes	Units	Assessed in this report
National compulsory attributes	Periphyton	Chl-a mg/m^2	Yes
	Nitrate toxicity	mg/L	Yes
	Ammonia toxicity	mg/L	Yes
	Dissolved oxygen (below point sources)	mg/L	Yes
	E. coli	*E. coli*/100 mL	Yes
	Cyanobacteria (planktonic)	biovolume mm^3/L	No
Southland attributes	Macroinvertebrates (wadeable rivers only)	MCI	Yes
	Temperature - summer	°C	Yes
	Temperature - winter	°C	Yes
	E. coli at popular bathing sites	*E. coli*/100 mL	Yes
	Clarity (visible distance)	m	Yes
	Cyanobacteria (benthic)	% cover	Yes
	Filamentous algae	% cover	Yes
	Diatoms and cyanobacteria	% cover	Yes
	Deposited fine sediment[1]	% cover	Yes[1]
	Suspendend fine sediment (turbidity) [1]	FNU	Yes[1]
Additional proposed national compulsory attributes	Dissolved inorganic nitrogen (DIN)	mg/L	Yes
	Macroinvertebrates (wadeable rivers only)	MCI and QMCI	No QMCI
	Macroinvertebrates (wadeable rivers only)	ASPM	No
	Fish	IBI	Yes
	Dissolved oxygen (all rivers)	mg/L	No
	Ecosystem metabolism	$gO_2m^{-2}d^{-1}$	No
	Dissolved Reactive Phosphorus (DRP)	mg/L	Yes
Additional indicators used in this report	Suspendible sediment (Quorer) [2]	g/m^2	Yes[2]
	Deposited fine sediment[2]	% cover	Yes[2]

Table footnotes:

1: Deposited fine sediment (% cover) and suspended fine sediment (turbidity) have both been assessed according to the method and attribute state bands laid out in the draft NPSFM released for public consultation in September 2019 as part of Government's Essential Freshwater Package. These are both recommended for use as Southland attributes at this time but will be reviewed to bring into line with the new NPSFM (2020) attributes for deposited fine sediment (% cover) and suspended fine sediment (clarity) in due course.

2: Suspendible sediment (Quorer method) and deposited fine sediment (% cover) have both been assessed in this report against the guideline criteria of Clapcott et al., 2011 (see relevant tables in Appendix 2 for detail). These results are included for completeness despite not being recommended at this time for use as Southland attributes due to the draft NPSFM (2019) deposited fine sediment and suspended sediment attributes being recommended at this time, as described in footnote 1 above.

Table 2: Attributes proposed for lakes.

Group	Attributes	Units	Assessed in this report
National compulsory attributes	Phytoplankton	Chl-*a* mg/m^3	Yes
	Total phosphorus	mg/m^3	Yes
	Total nitrogen	mg/m^3	Yes
	Ammonia toxicity	mg/L	Yes
	E. coli	*E. coli*/100 mL	Yes
	Cyanobacteria (planktonic)	biovolume mm^3/L	Yes
Southland attributes	*E. coli* at popular bathing sites	*E. coli*/100 mL	No[1]
	Trophic state (TLI)	Trophic Level Index	Yes
	Macrophytes	% cover	Yes
	Trophic state (LakeSPI)	LakeSPI Overall Index; LakeSPI Native Condition Index; LakeSPI Invasive Impact Index	Yes
	Nitrate toxicity	mg/L	Yes
Additional proposed national compulsory attributes	Submerged plants (natives)	LakeSPI (native condition index)	Yes
	Submerged plants (invasive species)	LakeSPI (invasive impact index)	Yes
	Dissolved oxygen (mid-hypolimnetic)	mg/L	No
	Dissolved oxygen (lake bottom)	mg/L	Yes
Additional indicators used in this report	None	-	-

Table footnotes:

1: There are currently no bathing sites monitored in lakes and no lake sites are identified as bathing sites in Appendix G of the proposed SWLP.

Table 3: Attributes proposed for groundwater.

Group	Attributes	Units	Assessed in this report
National compulsory attributes	None	-	-
Southland attributes	*E. coli*	MPN/100 mL	Yes
	Nitrate - human health	mg/L	Yes
	Nitrate - ecological toxicity	NO3-N mg/L	Yes
	Other DWSNZ contaminants*	various	No
Additional proposed national compulsory attributes	None	-	-
Additional indicators used in this report	None	-	-

* Based on DWSNZ = Drinking Water Standards New Zealand (Ministry of Health 2008)

Table 4: Attributes proposed for estuaries and open coast.

Group	Attributes	Units	Assessed in this report
National compulsory attributes	None		-
Southland attributes	Phytoplankton	Chl-*a* mg/m^3	Yes
	Sediment oxygen levels	aRDP mm	Yes
	Gross eutrophic zone	% intertidal area	Yes
	Mud content	% mud at site	Yes
	Sedimentation rate	mm/year	Yes
	Macroalgae	EQR	Yes
	E. coli	*E. coli*/100 mL	Yes
	E. coli at popular bathing sites	*E.coli*/100 mL	Yes
	Enterococci	Enterococci/100 mL	Yes
	Enterococci at popular bathing sites	Enterococci/100 mL	Yes
	Total arsenic in sediment	mg/kg	Yes
	Total cadmium in sediment	mg/kg	Yes
	Total chromium in sediment	mg/kg	Yes
	Total lead in sediment	mg/kg	Yes
	Total mercury in sediment	mg/kg	Yes
	Total nickel in sediment	mg/kg	Yes
	Total zinc in sediment	mg/kg	Yes
	Total copper in sediment	mg/kg	Yes
Additional proposed national compulsory attributes	None	-	-
Additional indicators used in this report	Mud extent (of area with > 25% mud content)	% of area at earliest monitoring	Yes

Table footnotes:

1: There is an estuary and open coast bathing monitoring program whose data have been used in this report. No bathing sites are currently identified in the Regional Coastal Plan for Southland 2013 for esutaries and open coast.

3.3 Attribute state option tables

The environmental state for each attribute was assessed according to the "attribute state option" tables in Appendices 1 to 4 for groundwater, rivers, lakes, and estuaries[4] respectively. These tables are almost the same as those provided in the September 2019 draft report of Norton and Wilson (2019) except that several errors have been corrected and some technical revisions have been made, particularly to several of the attribute state option tables for estuary attributes. Also the attribute tables have been arranged under sub-headings according to their respective four groupings as defined in section 3.2 above. It is anticipated these same revisions will be made to the final version of the Norton and Wilson (2019) report.

In most cases environmental state is described in the attribute state option tables using the "ABCD" system but a few attributes have been described as a two-tiered "pass/fail" system. Pass/fail has been used where there was insufficient technical justification to describe an ABCD gradient or where technical guidelines use a binary assessment system. Where a guideline

[4] Open coast attribute state option tables have been included with the relevant estuary tables for convenience.

"pass/fail" system has been used the technical source of this is indicated as a footnote to the relevant table.

3.4 Baseline years (2010, 2016, 2019) and associated time periods

The state of an attribute at a site for a given baseline year (2010, 2016 and 2019) was generally assessed using data from the preceding five[5] water years[6] (hereafter referred to as years). Accordingly, the 2010, 2016 and 2019 baseline periods generally encompassed the 2005 to 2009, 2011 to 2015 and 2014 to 2018 water years respectively.

The 2010 and 2016 baseline years were selected because they are of interest as the baseline dates for previous regional plans. The Regional Water Plan for Southland became operative in 2010. The proposed Southland Water and Land Plan uses 1 June 2016 as the baseline date for 'maintain and improve' water quality; however this is currently under appeal to Environment Court and this is why 2010 has also been assessed[7]. The current year (2019) has been included to provide context for whether the attribute state is changing over time.

In some cases there was insufficient data available to satisfy the minimum technical requirement of the five year period and/or the relevant sampling requirement indicated in the attribute state options tables. In some of these cases a technical decision was made to still present the assessment but to note the data weakness and associated greater uncertainty with that result.

In some cases, for the assessment years 2010 and 2016, data have been drawn from existing earlier state of environment reports rather than being re-analysed from raw data. In those cases the data period used was that in the earlier report and may not exactly match the ideal five year pre-requisite requirement; however, using earlier state of environment reports was considered a reasonable approach in the time available. The overall intent of this approach was to generate reasonable, and at least indicative, estimates of environmental state for the relevant time period without unnecessarily wasting data due to small failures of the minimum data requirements. The uncertainty associated with estimating environmental state from relatively small datasets is acknowledged in the conclusions.

3.5 Classes and freshwater management units (FMUs)

The classes used to group data for groundwater, rivers, lakes, estuaries and the open coast were the same as those used to provide draft freshwater objectives as described in Norton and Wilson (2019): see Table 5 below. Maps showing the distribution of river, lake and estuary classes across the region are shown in Figure 2, Figure 3 and Figure 4 respectively.

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[5] Some attributes have specific analysis requirements for the number of samples and/or years of data as indicated in the relevant attribute state option tables in the appendices. These parameters are identified and discussed in the following sections.

[6] A water year is defined as 1 July to 30 June.

[7] We note that in the Interim Decision of the Environment Court dated December 2019, the Court has indicated it is currently "*not attracted to any time-bound benchmarking of water quality at 2010*" (paragraph 124), however, this may be revisited if Ngā Rūnanga decides to pursue this matter.

The freshwater management units (FMUs) are the same five spatial units already adopted by Environment Southland and used in Norton and Wilson (2019). A map of the five FMUs is shown in Figure 5[8].

Table 5: Classes for rivers, lakes, estuaries, open coast and groundwater, as suggested in Norton and Wilson (2019).

Rivers	Lowland soft bed Lowland hard bed Hill Mountain Lake fed Spring fed Natural state waters
Lakes	Lowland shallow lakes Upland shallow lakes Deep lakes Brackish lakes & lagoons Natural state waters
Estuaries	Tidal lagoon estuaries (SIDE) Tidal river estuaries (SSRTRE) Fiords and bays (DSDE) Natural state waters
Open coast	Open coast
Groundwater	Potable groundwater (assumed can occur anywhere) Non-potable groundwater (not mapped) Groundwater drinking supply protection zone

3.6 Summarising results at the level of sites, classes, FMUs and the region

The state of all possible attributes at all possible sites was determined and assembled into a GIS so that users of the GIS can explore the results at individual sites of particular interest to them. However, the large number of sites and attributes (e.g. more than 100 sites and 13 attributes across 3 time periods for rivers alone) means that presenting all the individual site results is impractical for a written report (i.e., it would require hundreds of pages) and is not necessary to achieve the purpose of this report.

The draft freshwater objectives provided by Norton and Wilson (2019) are for each waterbody class rather than for each individual waterbody or site. These class-level freshwater objectives could ultimately be further grouped or subdivided based on the broader level of each FMU or the region as a whole if desired. While it would also be possible to set individual freshwater objectives at a finer spatial scale for some particularly important individual waterbodies or sites where justified, this is not currently envisaged to be a practical approach across all waterbodies and/or sites, for the reasons described in Norton and Wilson (2019). For the purpose of this report it was

[8] The Environment Court Interim Decision (December 2019) indicates there will be six FMUs in future, with Waituna Lagoon to be separated from the Mataura FMU. The new FMU will be refered to as 'Waituna' (paragraph 343).

therefore useful to group the results and present summaries of environmental state wherever possible at the following spatial scales:

- for the region as a whole;
- for each freshwater management unit (FMU); and
- for each groundwater, river, lake and estuary class.

The variability in environmental state amongst sites within each of these spatial groupings has been illustrated using statistical and graphical techniques (e.g., 'box & whisker' plots), as described further in the next section.

Notwithstanding above, this report does present results for individual sites for lakes and estuaries. This is because there are fewer monitored sites on lakes and estuaries, and showing individual site results was considered the best way of illustrating the variability of environmental state in these cases.

3.7 Additional method detail

Some further detail of the methods used for assembling and analysing data is provided in Appendix 5. This is particularly to record details specific to the individual assessments for groundwater, rivers, lakes and estuaries, and to record exceptions to the general method described above where necessary. The detail in Appendix 5 is unlikely to affect the interpretation of the results presented below for most readers but may be of interest to techncial readers.

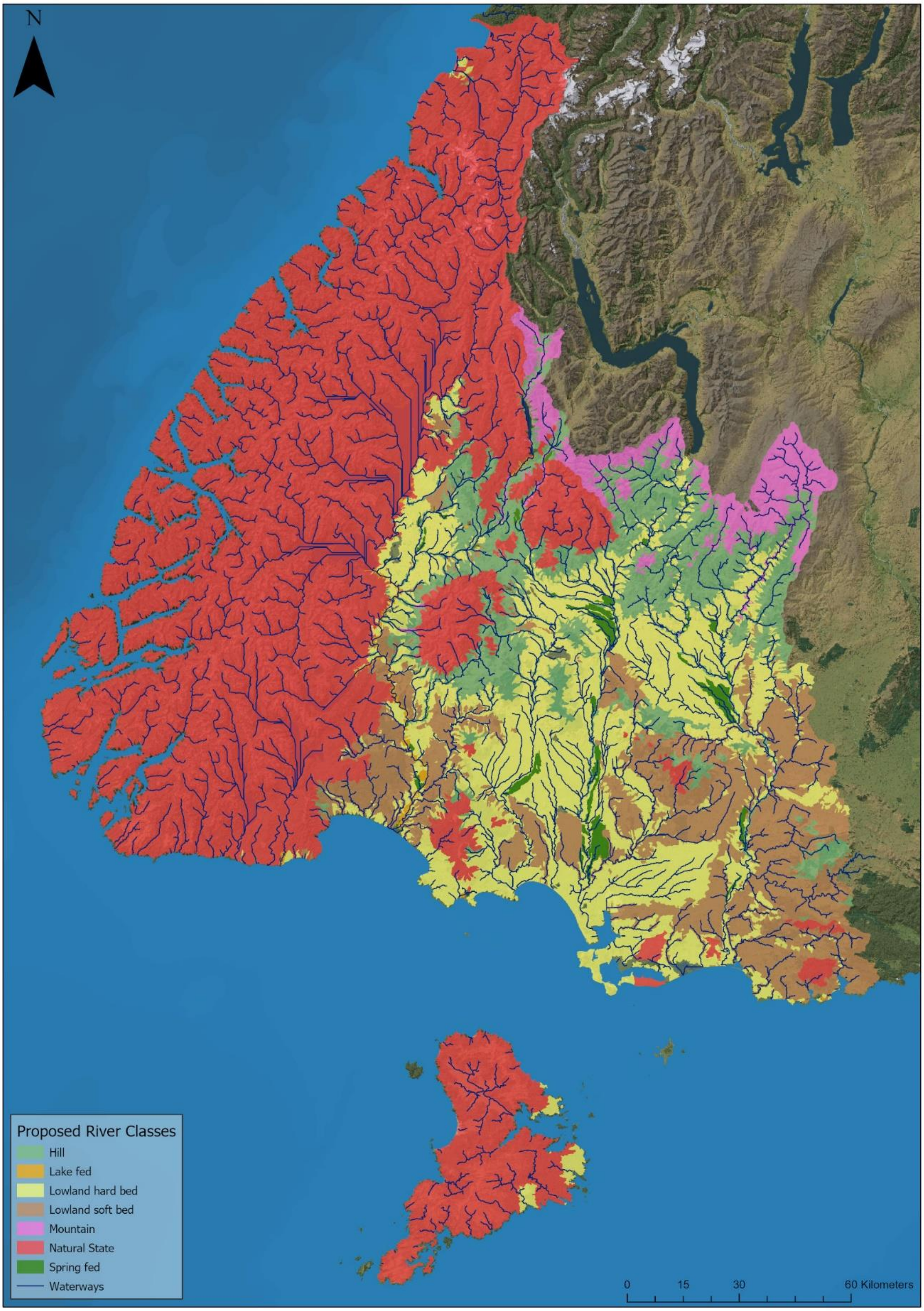


Figure 2: Map of river water quality classes for Southland

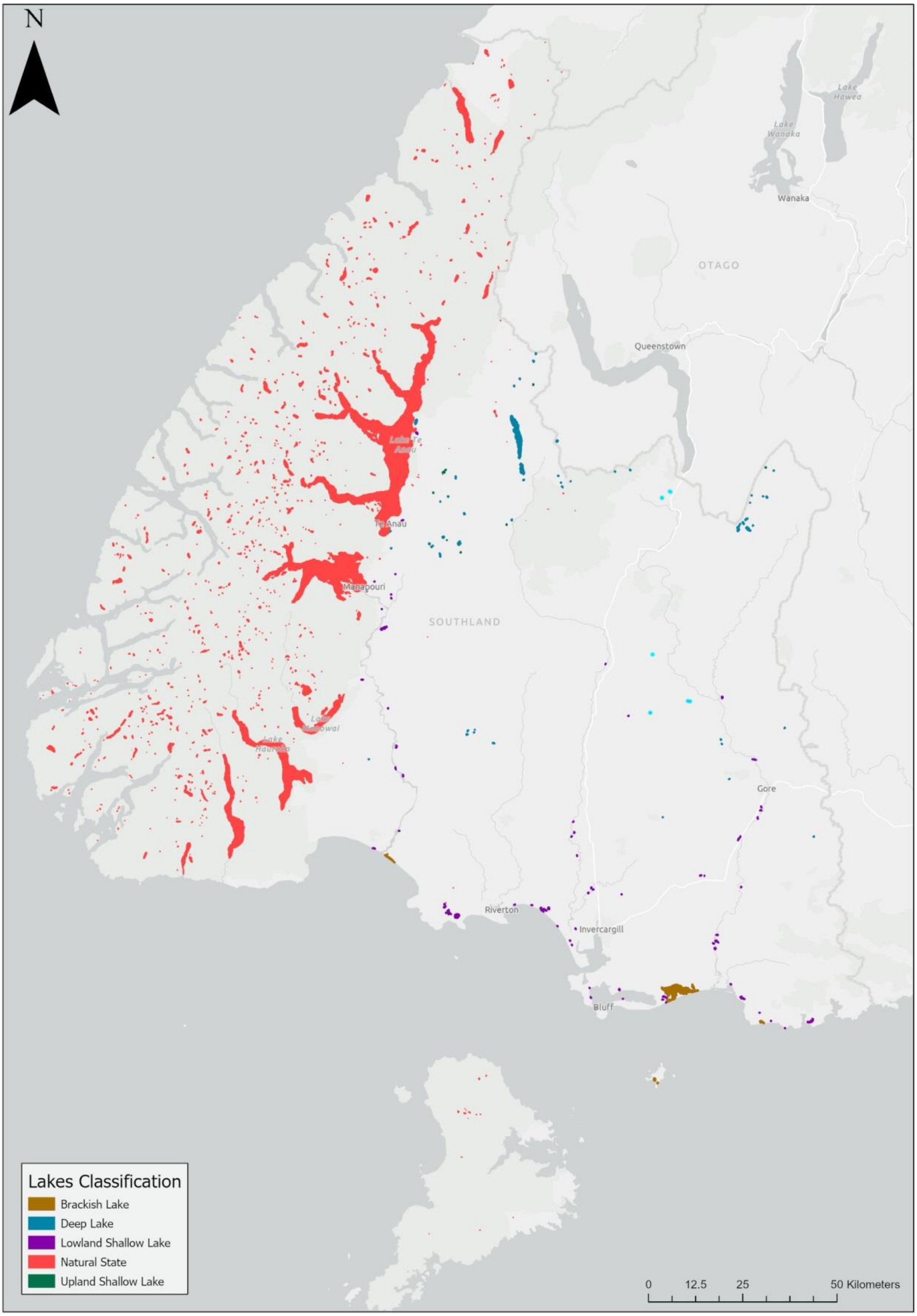


Figure 3: Map of lake classes for Southland

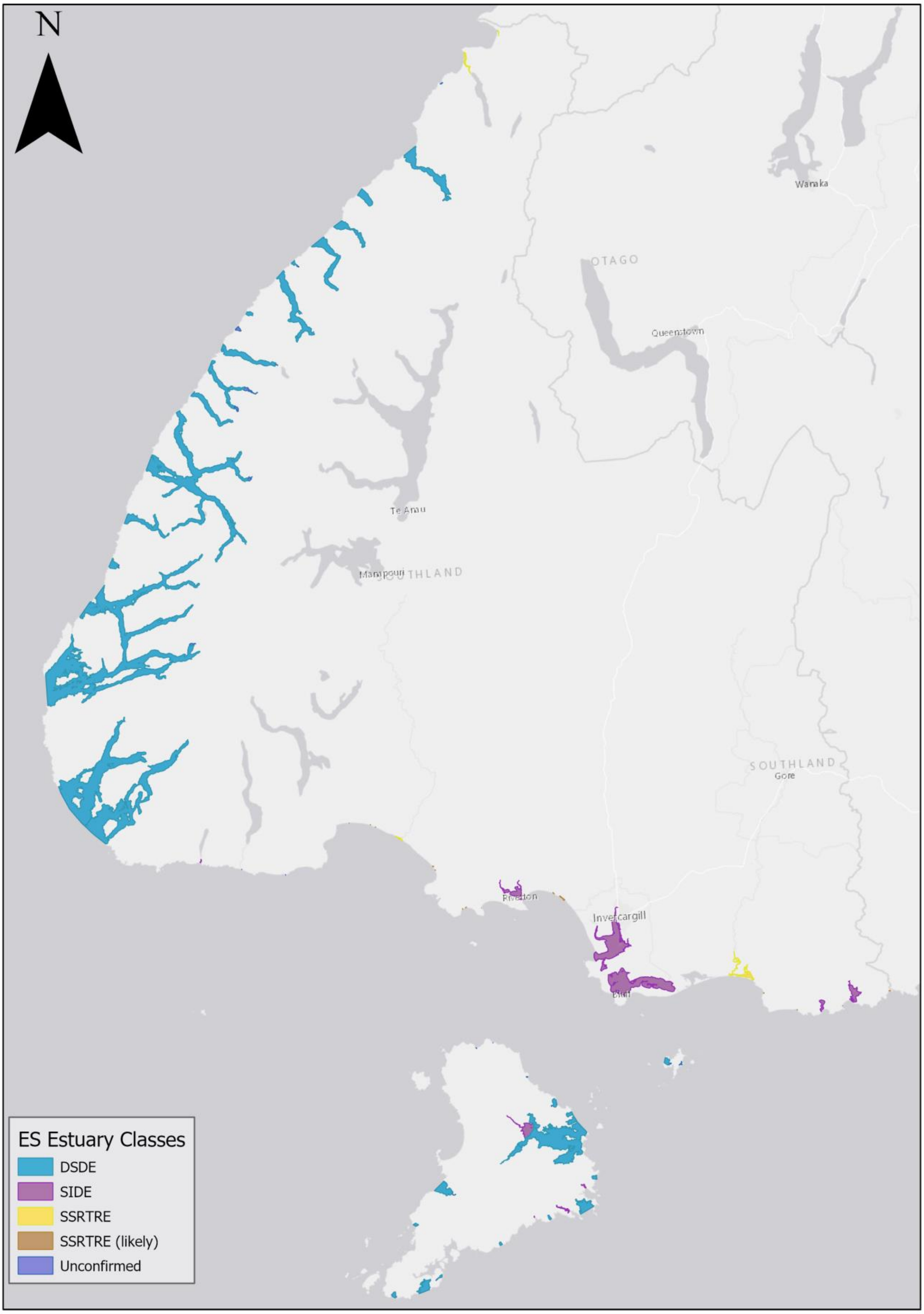


Figure 4: Map of estuary classes for Southland

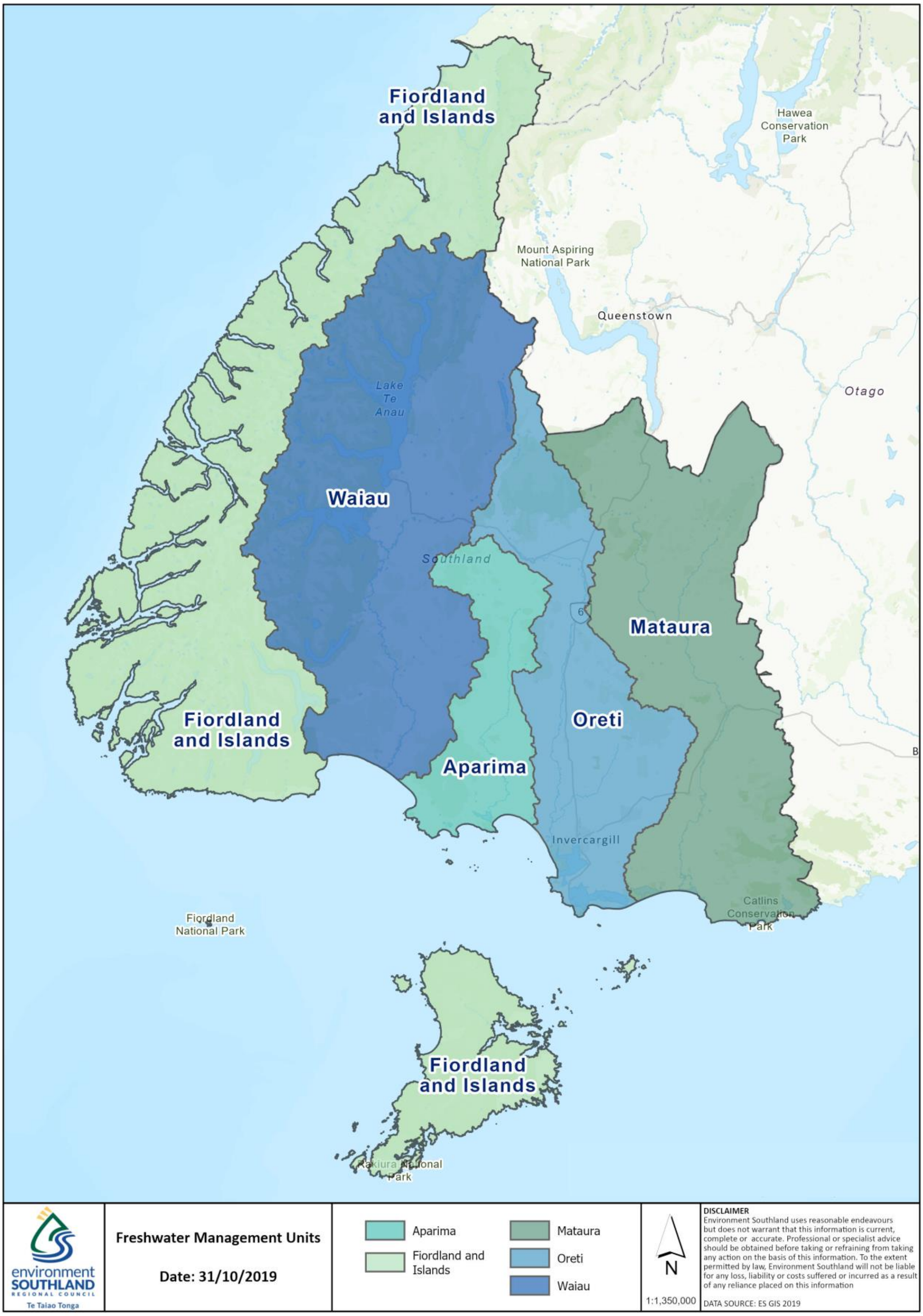


Figure 5: Map of freshwater management units (FMUs)

4 How to read the results in this report

As already described, this report mostly uses an "ABCD" banding system to describe environmental state where "A" generally means "very good", "B" means "good", "C means "fair" and "D" means "poor". In a few cases attributes have been described as a two-tiered "pass/fail" system; usually where there was insufficient technical justification to describe an ABCD gradient.

The environmental state (A, B, C or D) is presented for three time baselines (2010, 2016 and current 2019) and in each case, wherever possible, is compared to the relevant draft freshwater objective state (A, B or C band). The size of any gap is indicated by whether one or more bands of improvement is needed.

As a cross-reference aid to the "ABCD" band system there are narrative descriptions of each attribute, along with the threshold numbers and other technical details, provided as "attribute state option" tables in Appendices 1 to 4 for groundwater, rivers, lakes, and estuaries respectively.

4.1 Results at different spatial scales

Summaries are presented at three spatial scales, where possible:

- for the region as a whole;
- for each freshwater management unit (FMU); and
- for each groundwater, river, lake and estuary class;

The reason for this is that the draft freshwater objectives provided in Norton and Wilson (2019) were identified for each class of rivers, lakes, estuaries and groundwater, and these sit within the context of the Southland region and the five identified FMUs for the region.

Different things can be learned at each of these spatial levels of analysis:

- ***Region scale*** analysis illustrates what the key problems are; such as the key contaminants nitrogen, phosphorus, sediment and faecal microorganisms, which directly and indirectly contribute to numerous failures to meet draft freshwater objectives across the region. However analysis at regional scale dosn't tell us clearly where the problems are occurring.
- ***FMU scale*** analysis displays the clear distinction between the largely pristine state of the Fiordland and Islands FMU compared to the other four FMUs with more developed land uses (Waiau, Aparima, Ōreti and Mataura).
- ***Class scale*** analysis shows up clear patterns of difference between the classes, particularly for rivers and lakes.
- ***Individual waterbody scale*** analysis (where available) illustrates how variable the environment can be, even for waterbodies within the same class and sites within the same waterbody.

4.2 "Box and whisker" diagrams

To illustrate variability between sites and the spread of site data within river classes we have used "box and whisker" diagrams, as illustrated and explained in
Figure 6. Generally these show the median, quartiles, 5th and 95th percentiles of data from all sites within a class, or within an FMU or within the region as a whole.

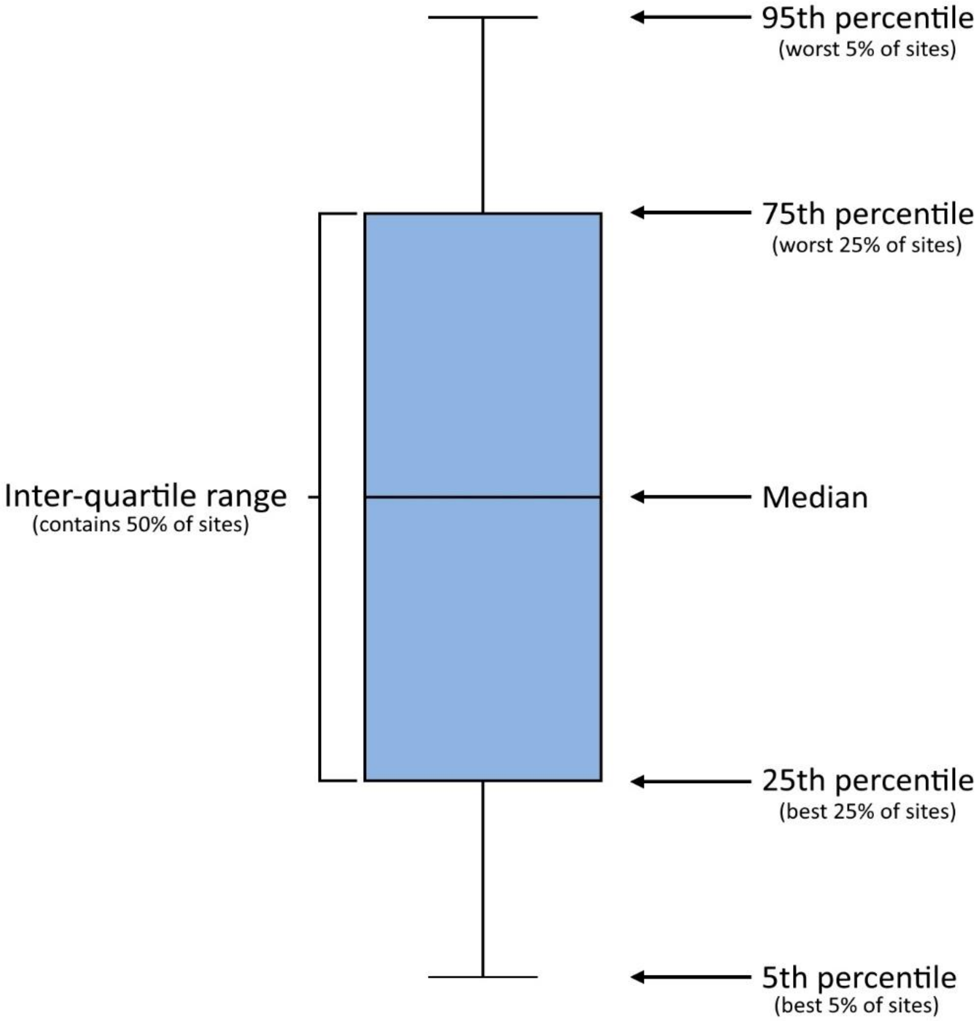


Figure 6: Generic diagram showing how to interpret a box and whisker plot.

5 Groundwater results

Four types of attributes were used as draft FWOs for groundwater as provided in Norton and Wilson (2019). These were:

- *E. coli* - in relation to the value of water supply (human health);
- Nitrate – in relation to the value of water supply (human health);
- Nitrate – in relation to groundwater ecosystem health (toxicity); and
- All other DWSNZ[9] contaminants - in relation to the value of water supply (human health).

Of these, the state of the first three have been assessed below. There is insufficient data available to assess other DWSNZ contaminants across the region.

5.1 Region scale analysis

5.1.1 E. coli

The proportion of groundwater sites meeting the draft FWO (A band) and failing (D band) across the region at different time periods is shown in Table 6 and in Figure 7 below. These results show approximately one third of sites fail the draft FWO for water supply (human health).

Table 6: Percentage of sites that pass and fail with respect to *E. coli* for the Southland region for each of the assessment years.

	2010			2016			2019		
	Num	Pass	Fail	Num	Pass	Fail	Num	Pass	Fail
Southland	236	69.1%	30.9%	301	72.1%	27.9%	309	64.4%	35.6%

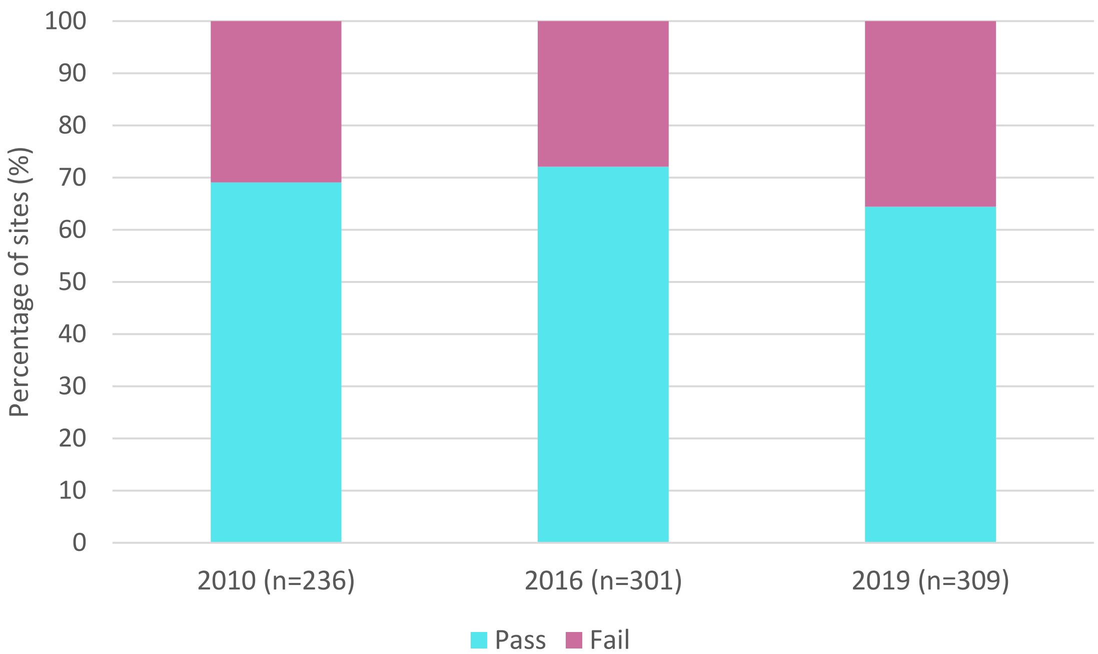


Figure 7: Proportion of sites in pass or fail bands with respect to *E. coli* for the three assessment years (whole of Southland region).

[9] Drinking Water Standards New Zealand 2005 (revised 2018) (Ministry of Health 2018)

5.1.2 Nitrate – water supply (human health)

The proportion of groundwater sites meeting the draft FWO (pass band) and failing (fail band) across the region at different time periods is shown in Table 7: Percentage of sites classes that pass and fail with respect to nitrate nitrogen for the Southland region for each of the assessment years. and in Figure 8**Figure 8: Proportion of sites in pass or fail bands with respect to nitrate nitrogen for the three assessment periods (whole of Southland region). N/A represents bores that are naturally unpotable.** below. Note that a small percentage of sites were classified as having "non-potable groundwater" (due to high naturally occurring concentrations of manganese and arsenic exceeding the DWSNZ) and so the draft FWO of pass band does not apply to those sites and they are depicted as "NA" (not applicable) in Table 7 and in Figure 8. These results suggest there has been some deterioration since 2010 and approximately one third of sites currently (in 2019) fail the draft FWO for nitrate for water supply (human health).

Table 7: Percentage of sites classes that pass and fail with respect to nitrate nitrogen for the Southland region for each of the assessment years.

	2010				2016				2019			
	Num	Pass	Fail	NA	Num	Pass	Fail	NA	Num	Pass	Fail	NA
Southland	110	80.9%	15.5%	3.6%	214	66.4%	31.8%	1.9%	176	68.2%	31.3%	0.5%

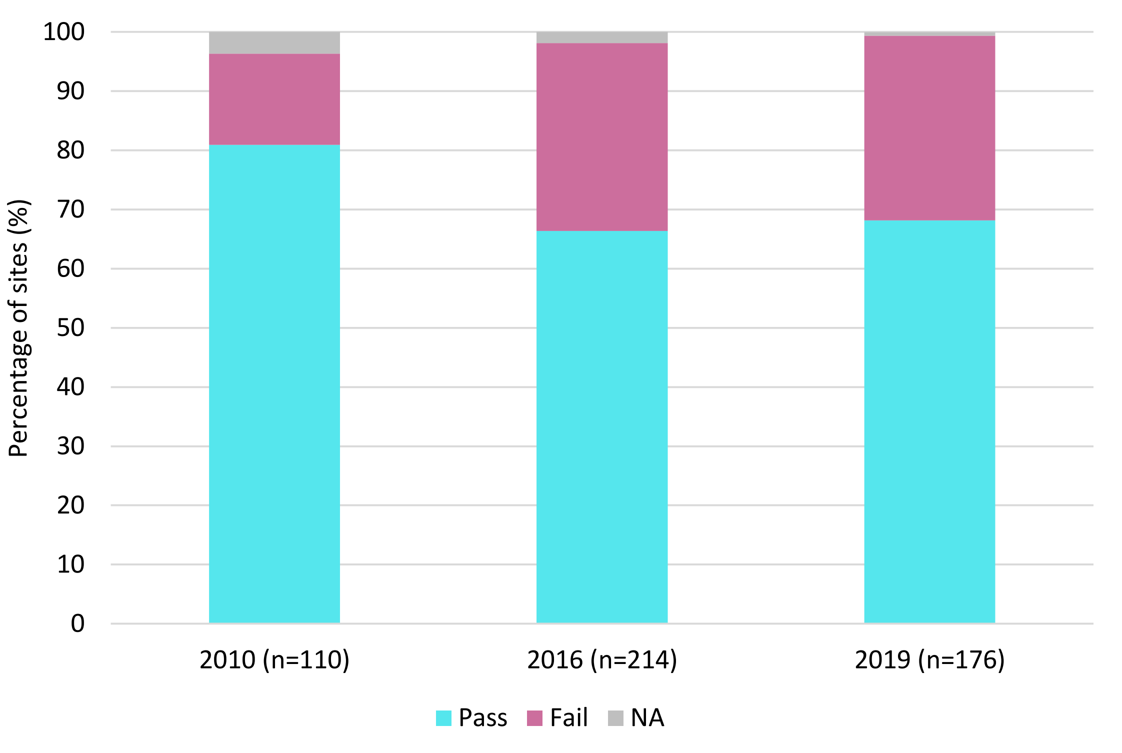


Figure 8: Proportion of sites in pass or fail bands with respect to nitrate nitrogen for the three assessment periods (whole of Southland region). N/A represents bores that are naturally unpotable.

5.1.3 Nitrate – groundwater ecosystem health (toxicity)

The average groundwater nitrate nitrogen concentration was calculated across all suitable sites in the region for the three time periods. A summary presenting the assigned band for each assessment period for the whole Southland region is presented below in Table 8. A graphical 'box and whisker' representation of this data is also presented in Figure 9 and this shows the distribution of site concentrations around the mean. This shows that while some sites are in B band (green) and a few are in A band (blue), most sites are in C band (yellow) and a few are in D band (red) that will require improvement to achieve at least C band. The band level to set freshwater objectives for groundwater ecosystem health has not yet been set and remains a choice from A to C band. These results show considerable improvement would be needed to achieve an objective better than C band across the region.

Table 8: Calculated five-year mean concentrations and associated assigned bands for the Southland region for each of the assessment periods.

	2010			2016			2019		
	Num	5 Year Mean (mg/L)	Band	Num	5 Year Mean (mg/L)	Band	Num	5 Year Mean (mg/L)	Band
Southland	110	4.51	C	214	5.71	C	176	5.75	C

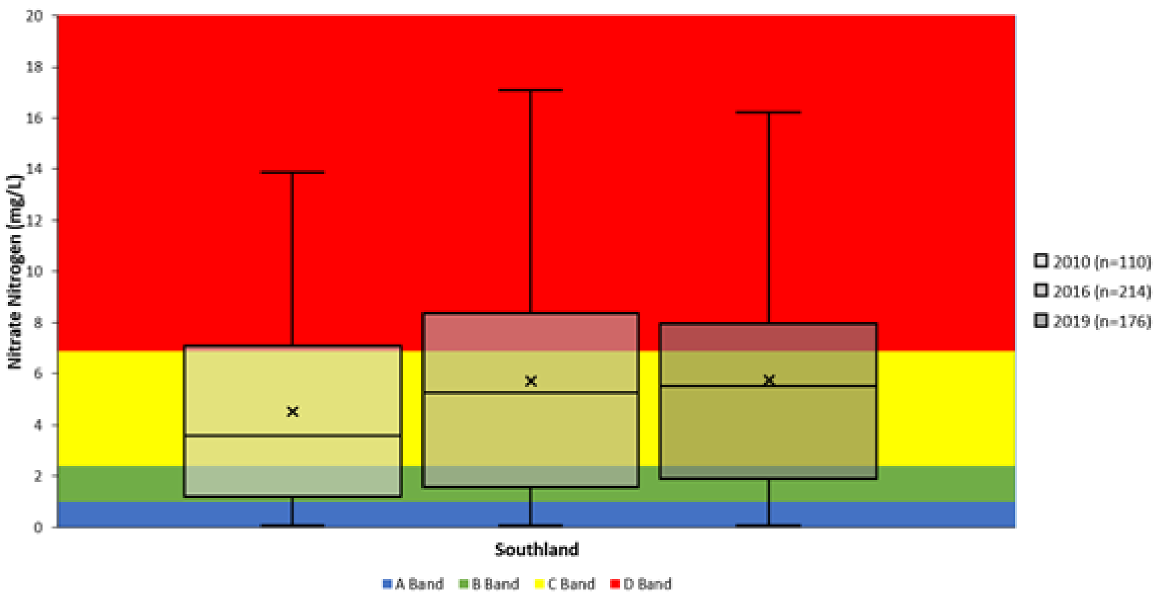


Figure 9: Box and whisker plots showing the distribution of site medians that are used to calculate the regional five-year mean for each assessment period. On each box the middle horizontal line indicates the five-year median, the cross indicates the five-year mean and the upper and lower quartiles are indicated by the extent of the box. The whiskers indicate the max and min values that are not considered outliers (1.5 times the interquartile range above or below the upper and lower quartiles).

5.2 FMU scale analysis

Groundwater sites were grouped into their respective FMUs and a similar analysis was then undertaken as presented below.

5.2.1 *E. coli*

The proportion of groundwater sites meeting the draft FWO (pass band) and failing (fail band) in each FMU at different time periods is shown in Table 9 and in Figure 10 below. These results show relatively small differences between FMUs with slightly fewer sites currently (in 2019) failing the draft FWO for *E. coli* for water supply (human health) in the Waiau FMU (20% fail) and slightly more failing in the Aparima FMU (44%).

Table 9: Percentage of sites classes that pass and fail with respect to *E. coli* for each FMU for each of the assessment years. There is insufficient data to make an assessment for the Fiordland and Islands FMU.

	2010			2016			2019		
FMU	Num	Pass	Fail	Num	Pass	Fail	Num	Pass	Fail
Mataura	87	80.5%	19.5%	123	76.4%	23.6%	117	67.5%	32.5%
Ōreti	86	60.5%	39.5%	111	69.4%	30.6%	106	63.2%	36.8%
Aparima	45	60%	40%	50	64%	36%	66	56.1%	43.9%
Waiau	16	75%	25%	17	82.4%	17.6%	20	80%	20%
Fiordland and Islands	2	Insufficent data							

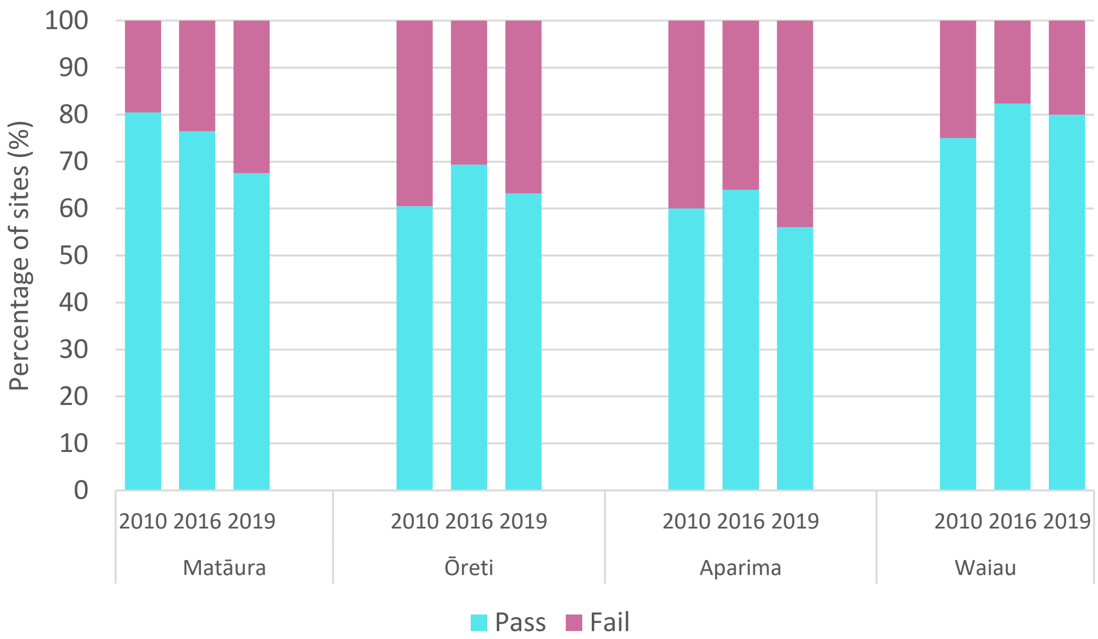


Figure 10: Proportion of sites in pass and fail bands with respect to *E. coli* for the three assessment years by FMU. Insufficient data available to make an assessment for the Fiordland and Islands FMU.

5.2.2 Nitrate – water supply (human health)

The proportion of groundwater sites meeting the draft FWO (A band) and failing (D band) in each FMU at different time periods is shown in Table 10 and in Figure 11. Note again that the small percentage of sites classified as having "non-potable groundwater" are depicted as "NA" (not applicable). These results show relatively small differences between FMUs with 25 to 37% of sites currently (in 2019) failing the draft FWO for nitrate for water supply (human health).

Table 10: Percentage of sites classes that pass and fail with respect to nitrate nitrogen for each FMU for each of the assessment periods. There is insufficient data to make an assessment for the Fiordland and Islands FMU.

	2010				2016				2019			
FMU	Num	Pass	Fail	NA	Num	Pass	Fail	NA	Num	Pass	Fail	NA
Mataura	43	76.7%	23.3%	0%	85	61.2%	37.6%	1.2%	70	62.9%	37.1%	0%
Ōreti	40	80%	15%	5%	76	68.4%	29.0%	2.6%	57	73.7%	24.6%	1.7%
Aparima	21	90.5%	4.8%	4.7%	42	73.8%	23.8%	2.4%	40	70%	30%	0%
Waiau	6	83.3%	0%	16.7%	11	63.6%	36.4%	0%	9	66.7%	33.3%	0%
Fiordland and Islands	Insufficent data											

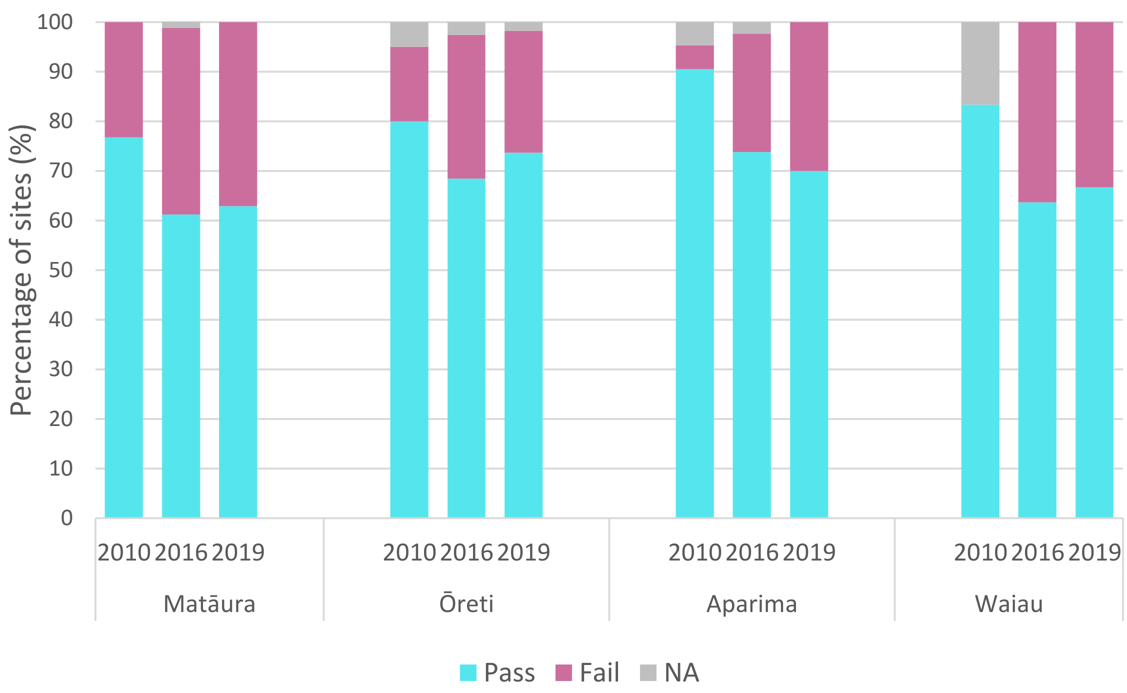


Figure 11: Proportion of sites in pass and fail bands with respect to nitrate nitrogen for each assessment periods by FMU. There is insufficient data to make an assessment for the Fiordland and Islands FMU.

5.2.3 Nitrate – groundwater ecosystem health (toxicity)

The average groundwater nitrate nitrogen concentration was calculated across all suitable sites in each FMU for the three time periods. A summary presenting the assigned band for each FMU and assessment period is presented below in Table 11. A graphical 'box and whisker' representation of this data is also presented in Figure 12 and this shows the distribution of site concentrations around the median for each FMU.

These results suggest there has been some deterioration in median state between 2010 and 2019 particularly in the Ōreti and Waiau FMUs and to a lesser extent in the Aparima FMU, with negligible difference in median state between 2010 and 2019 in the Mataura FMU. The results show that while some sites are in B band (green) and a few are in A band (blue), most sites are in C band (yellow) and a significant number have been in D band (red) since 2016 and these will require improvement to achieve at least C band. The band level to set freshwater objectives for groundwater ecosystem health has not yet been set and remains a choice from A to C band. These results show considerable improvement would be needed to achieve an objective better than C band in all FMUS except the Fiordland and Islands; it is assumed this latter FMU is already currently in A band although there is insufficient data to substantiate this (Table 11).

Table 11: Calculated five-year means and associated assigned bands for each FMU for each of the assessment periods. There is insufficient data to make an assessment for the Fiordland and Islands FMU.

	2010			2016			2019		
FMU	Num	5 Year Mean (mg/L)	Band	Num	5 Year Mean (mg/L)	Band	Num	5 Year Mean (mg/L)	Band
Mataura	43	6.46	C	85	6.79	C	70	6.64	C
Ōreti	40	3.55	C	76	4.79	C	57	5.05	C
Aparima	21	2.88	C	42	5.17	C	40	5.09	C
Waiau	6	2.64	C	11	5.80	C	9	6.11	C
Fiordland and the Islands*	0	NA	NA (A)	0	NA	NA (A)	0	NA	NA (A)

* Fiordland and Islands do not have data for this assessment but it is assumed these are classed in the A Band.

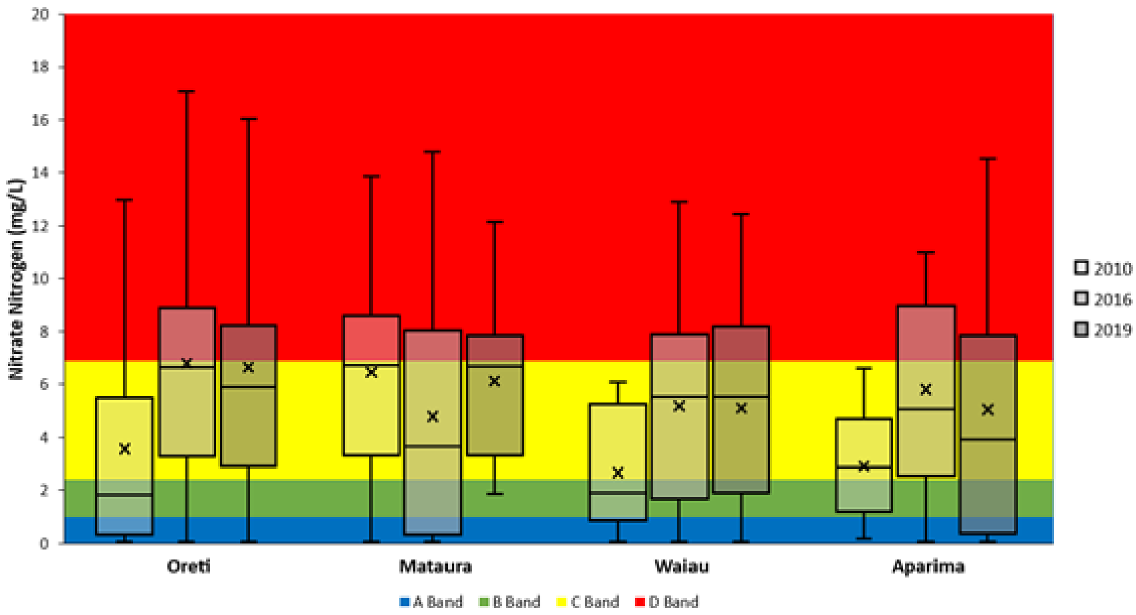


Figure 12: Box and whisker plots showing the distribution of site medians that are used to calculate the regional five-year means for each FMU for each assessment period. On each box the middle horizontal line indicates the five-year median, the cross indicates the five-year mean and the upper and lower quartiles are indicated by the extent of the box. The whiskers indicate the max and min values that are not considered outliers (1.5 times the interquartile range above or below the upper and lower quartiles).

5.3 Groundwater Management Zone (GMZ) scale analysis

This scale of analysis was only carried out for the nitrate nitrogen attribute in relation to toxicity for groundwater ecosystem health.

5.3.1 Nitrate – groundwater ecosystem health (toxicity)

Groundwater sites were grouped into their respective GMZs and the mean groundwater nitrate nitrogen concentration was calculated across all suitable sites in each GMZ for the three time periods. A summary presenting the assigned band for each GMZ is presented below in Table 12. Graphical 'box and whisker' representations of this data are also presented in Figure 13 (for 2010), Figure 15 (for 2016) and Figure 17 (for 2019). These figures show the distribution of site concentrations around the median for each GMZ. Maps depicting these results spatially are shown in Figure 14 (for 2010), Figure 16 (for 2016) and Figure 18 (for 2019).

These results suggest there has been some deterioration in mean state between 2010 and 2019, particularly in the Blackmount, Castlerock, Makarewa, Ōreti, Te Anau, Waimatuku, and Waimea Plains GMZs. The results show that while some sites are currently in B band (green) and a few are in A band (blue), most sites are in C band (yellow) and a significant number are in D band (red) and these will require improvement to achieve at least C band. The band level to set freshwater objectives for groundwater ecosystem health has not yet been set and remains a choice from A to C band. These results show considerable improvement would be needed to achieve an objective better than C band in most GMZs.

Table 12: Calculated five-year mean groundwater nitrate nitrogen and associated assigned bands for each GMZ for each of the assessment periods.

	2010			2016			2019		
Groundwater Zone	Num	5 year mean (mg/L)	Band	Num	5 year mean (mg/L)	Band	Num	5 year mean (mg/L)	Band
Awarua	3	1.10	B	7	0.94	A	1	0.00	A
Blackmount	1	0.01	A	3	8.93	D	3	8.93	D
Castlerock	1	3.40	C	4	11.94	D	4	12.45	D
Central Plains	16	5.33	C	25	5.30	C	22	5.16	C
Croydon	2	3.55	C	5	7.28	D	5	6.44	C
Dipton	2	0.03	A	1	0.02	A	2	0.09	A
Edendale	9	7.28	D	18	7.71	D	14	7.33	D
Five Rivers	4	3.47	C	8	3.95	C	8	3.42	C
Knapdale	3	8.25	D	9	7.62	D	9	8.43	D
Lower Aparima	6	3.16	C	12	3.55	C	12	3.47	C
Lower Mataura	6	5.98	C	15	7.10	D	14	5.55	C
Lower Ōreti	8	2.00	B	13	2.02	B	10	4.20	C
Makarewa	3	0.14	A	7	6.27	C	1	2.00	B
Ōreti	2	4.50	C	2	7.50	D	2	7.95	D
Riversdale	7	4.35	C	12	5.42	C	9	3.90	C
Te Anau	2	1.85	B	2	3.78	C	2	3.65	C
Te Waewae	1	4.95	C	4	6.98	D	3	6.37	C
Upper Aparima	11	2.95	C	19	5.67	C	18	5.70	C
Waihopai	5	4.25	C	17	4.90	C	8	5.42	C
Waimatuku	4	2.24	B	9	6.12	C	8	5.95	C
Waimea Plains	6	9.26	D	5	14.45	D	5	14.48	D
Waipounamu	1	3.30	C	1	3.65	C	1	3.90	C
Wendonside	5	8.88	D	4	11.30	D	5	9.05	D
Cattle Flat	NA	NA	NA	1	1.38	B	1	1.43	B
Longridge	NA	NA	NA	2	2.46	C	2	2.90	C
Orepuki	NA	NA	NA	1	5.90	C	1	5.40	C
Wendon	NA	NA	NA	3	4.42	C	2	3.15	C

*GMZ’s with no representative sites are not displayed.

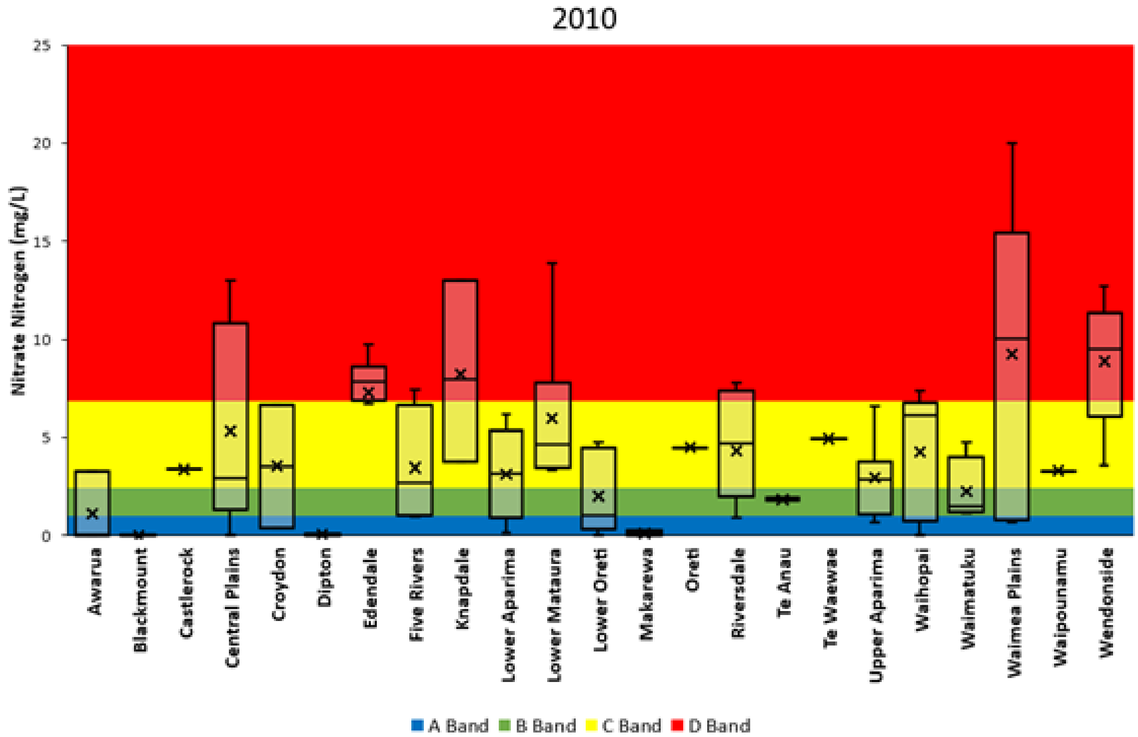


Figure 13: Box and whisker plots showing the distribution of site medians that are used to calculate the regional five-year means for each FMU for the 2010 assessment period. On each box the middle horizontal line indicates the five-year median, the cross indicates the five-year mean and the upper and lower quartiles are indicated by the extent of the box. The whiskers indicate the max and min values that are not considered outliers (1.5 times the interquartile range above or below the upper and lower quartiles).

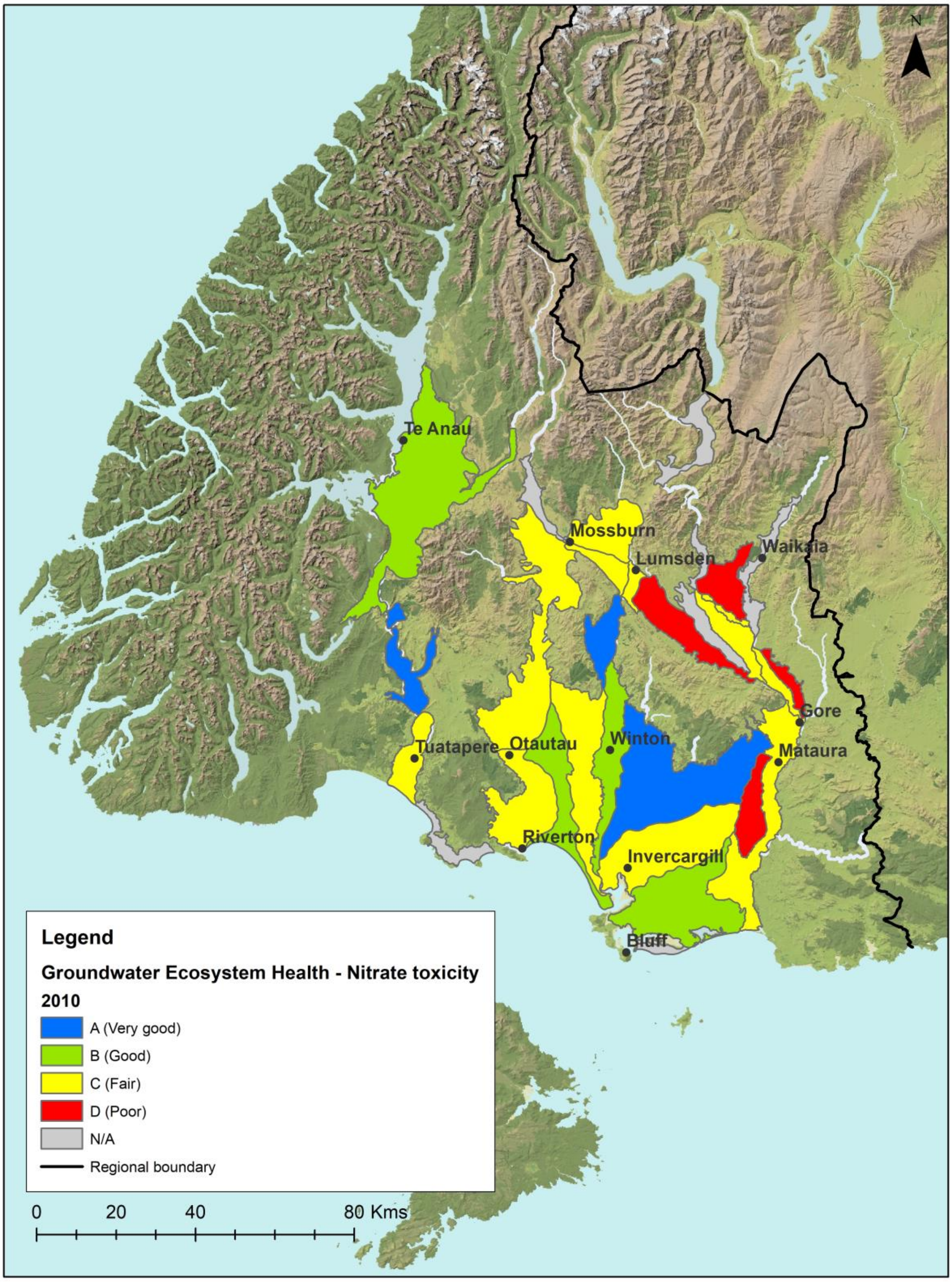


Figure 14: Map showing the assigned band for each GMZ for the 2010 assessment period.

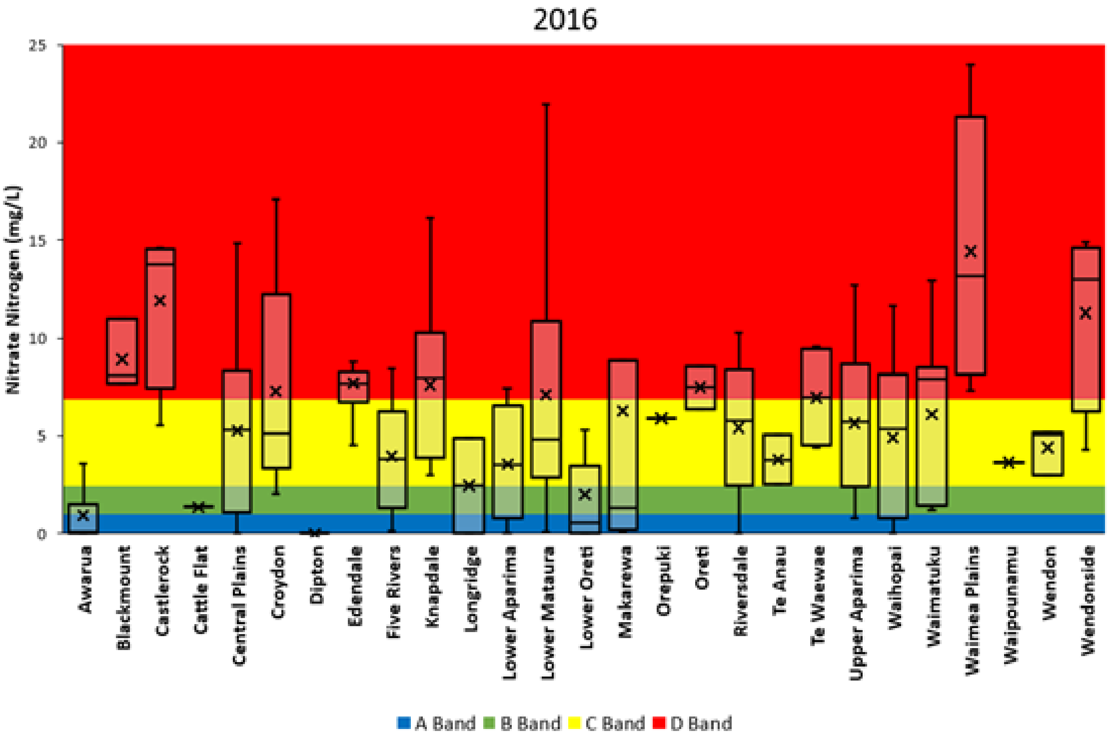


Figure 15: Box and whisker plots showing the distribution of site medians that are used to calculate the regional five-year means for each FMU for the 2016 assessment period. On each box the middle horizontal line indicates the five-year median, the cross indicates the five-year mean and the upper and lower quartiles are indicated by the extent of the box. The whiskers indicate the max and min values that are not considered outliers (1.5 times the interquartile range above or below the upper and lower quartiles).

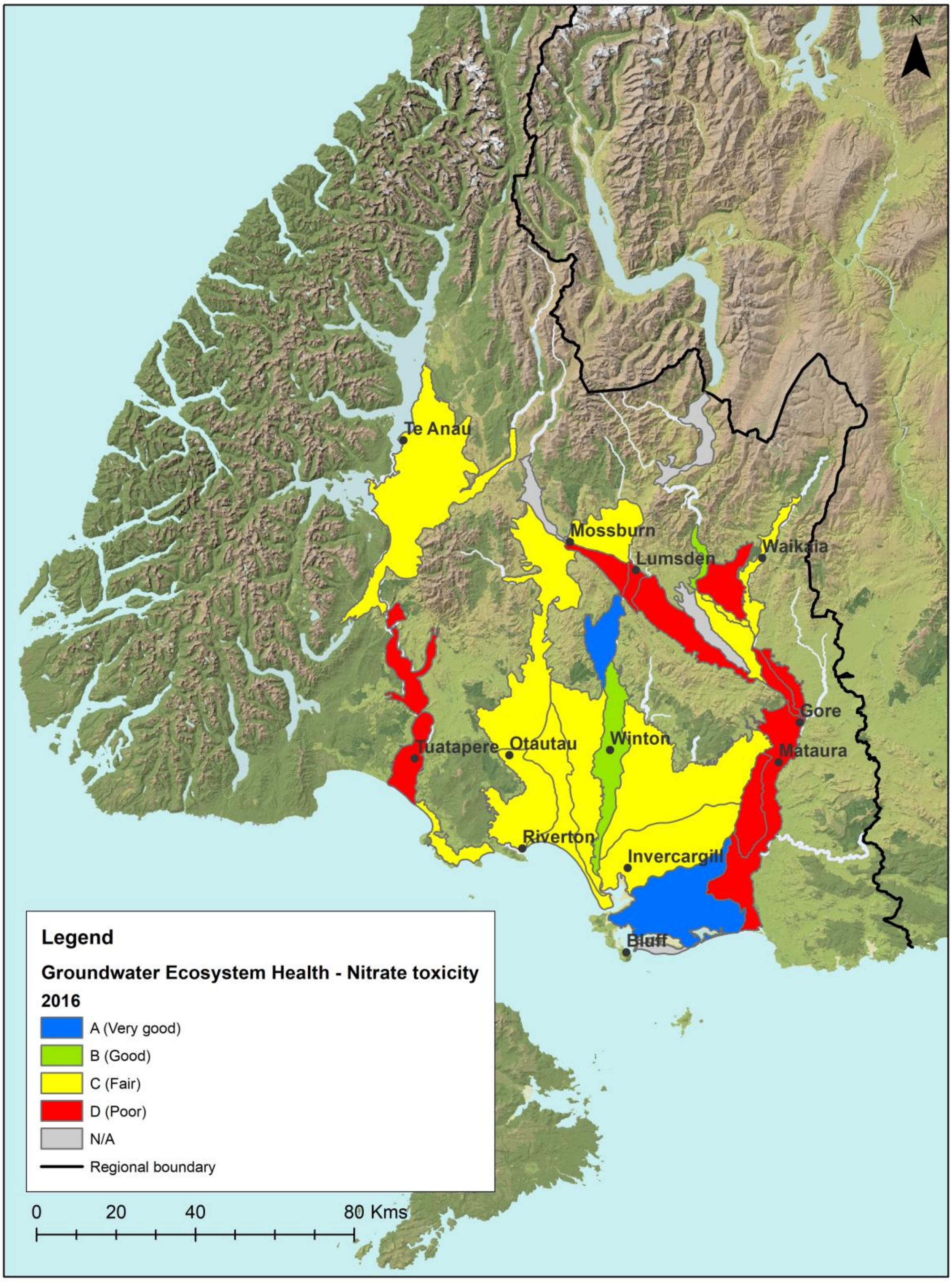


Figure 16: Map showing the assigned band for each GMZ for the 2016 assessment period.

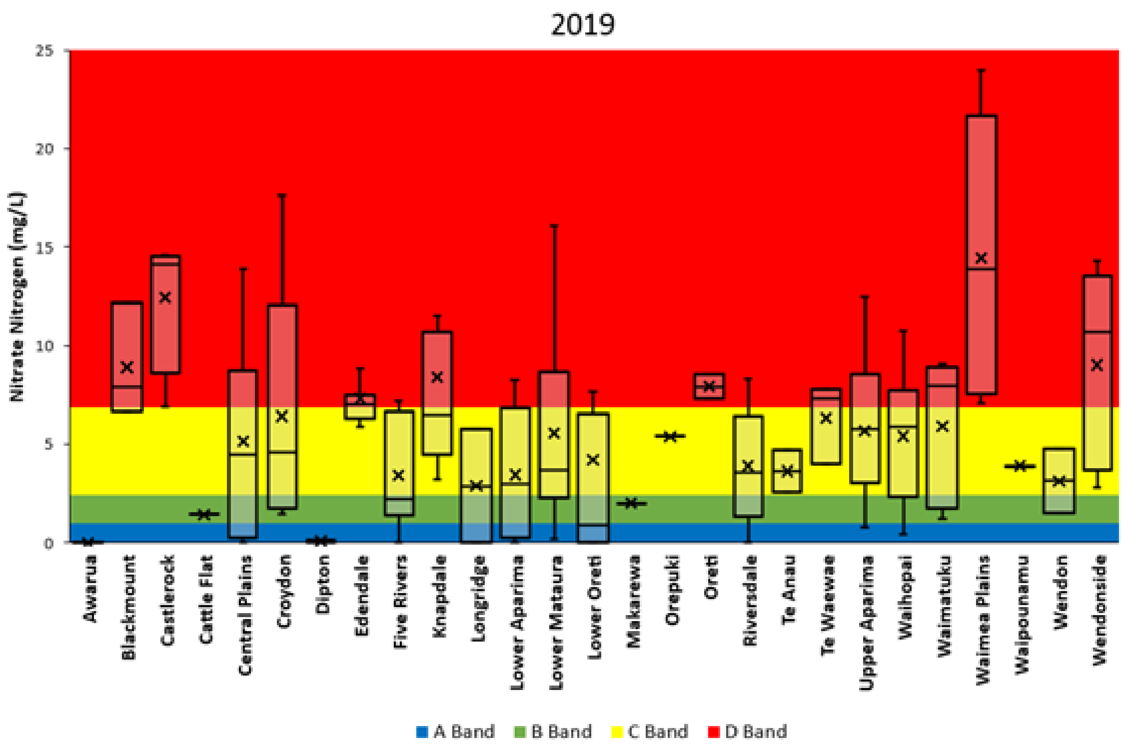


Figure 17: Box and whisker plots showing the distribution of site medians that are used to calculate the regional five-year means for each FMU for the 2019 assessment period. On each box the middle horizontal line indicates the five-year median, the cross indicates the five-year mean and the upper and lower quartiles are indicated by the extent of the box. The whiskers indicate the max and min values that are not considered outliers (1.5 times the interquartile range above or below the upper and lower quartiles).

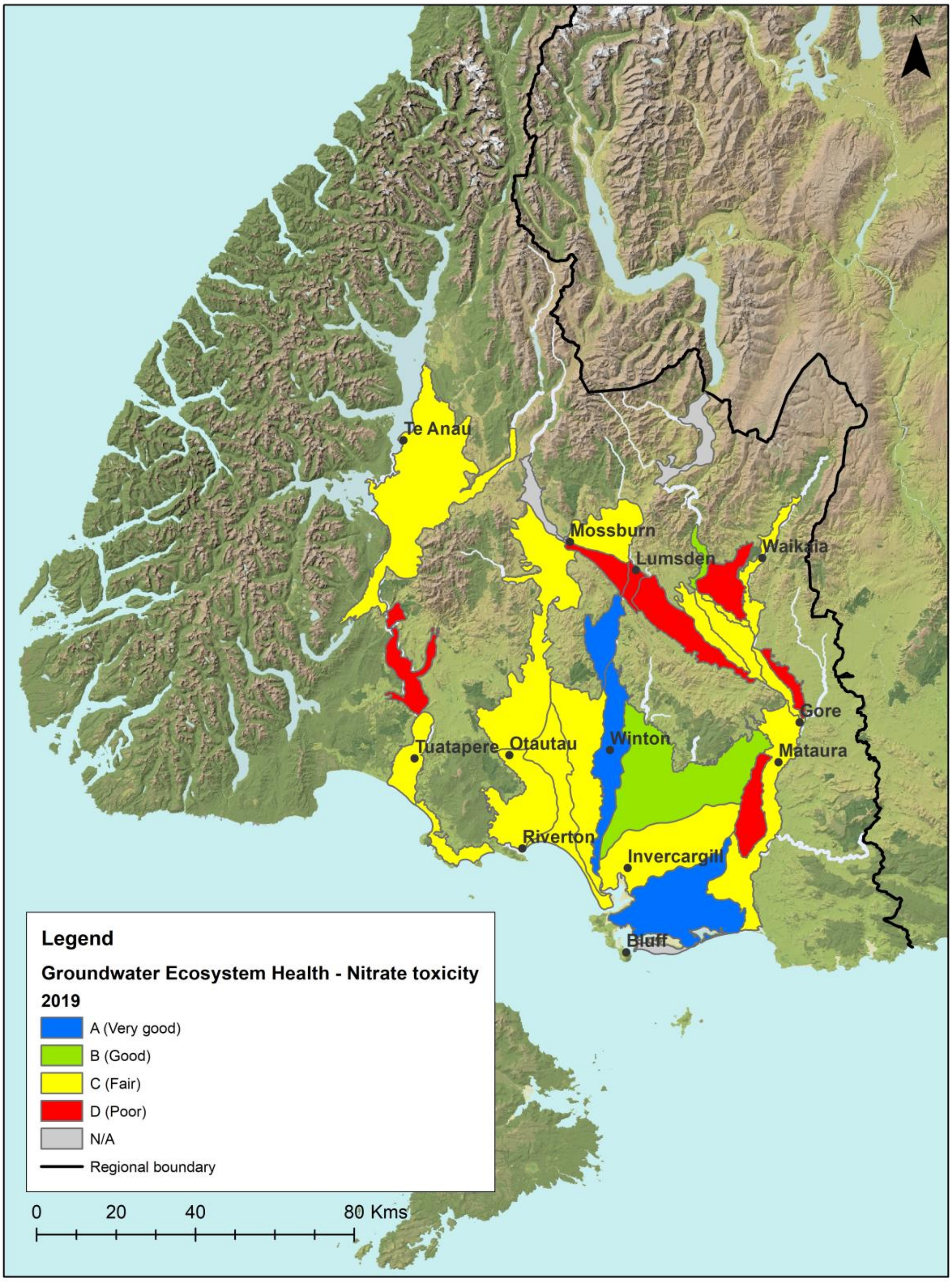


Figure 18: Map showing the assigned band for each GMZ for the 2019 assessment period.

5.4 Key message for groundwater

5.4.1 Human health for drinking

- At a regional scale approximately one third of groundwater bore monitoring sites fail the draft *E. coli* FWO for drinking water supply (human health). The failing sites are spread acoss the four developed FMUs (Waiau, Aparima, Ōreti and Mataura). Few sites are monitored in the Fiordland and Islands FMU but groundwater in that FMU is assumed to be good.

- At a regional scale, approximately one third of sites currently fail the draft FWO for nitrate for drinking water supply (human health). This is approximately twice the percentage of sites that failed in 2010 indicating some deterioration has occured.

- Substantial improvement in both *E. coli* and nitrate contamination would be needed in some locations to meet the relevant draft FWOs for groundwater being safe for drinking across the region.

5.4.2 Groundwater ecosystem health

- The draft freshwater objective for potential effects of nitrate toxicity on groundwater ecosystem health has not yet been set and remains a choice from A to C band, while needing to at least maintain current state.

- The nitrate nitrogen concentration results organised by Groundwater Management Zone (GMZ) show that while currently four zones are in A (blue) or B band (green), most zones are in C band (yellow) and a significant number are in D band (red) (16 and 7 zones respectively) (Table 12).

- Considerable improvement in some locations would be needed to achieve an objective better than C band for nitrate toxicity in groundwater across the region.

6 Rivers results

6.1 Region scale analysis

Results for all attributes across the whole region are shown in Table 13 to Table 17. The distribution of results across sites is shown by the box and whisker plots in the top part of each table. The number (and percentage) of sites meeting the draft FWOs is shown in the middle rows of each table. The number (and percentage) of sites needing to improve by one, two or three bands to achieve the draft FWOs is shown in the bottom rows of each table.

Key messages from the region scale analysis are as follows:

6.1.1 General messages

- There is generally large variability in environmental state between sites, as illustrated by the mostly tall (i.e., spread out) box and whisker plots.
- We cannot see from the regional results whether this environmental variability is associated with differences between FMUs or river classes. To address this question finer scaled analyses at FMU and river class scales are presented in sections 6.2 and 6.3.
- What we can see from the region scale analysis is which attributes are the biggest problem in terms of failing to meet the draft FWOs; these are described below.

6.1.2 Nutrients

- The dissolved nutrient DIN exhibits wide variability across sites, with approximately a third of sites in A band, one third in D band and one third in between. Substantial reduction in DIN concentrations would be needed to achieve at least C band at all river sites in the region (Table 13); however see third bullet below.
- For the dissolved nutrient DRP there appears to have been improvement since 2010 although a quarter of sites are currently (2019) in D band (Table 13).
- Both DIN and DRP are attributes in the group of "Additional proposed national compulsory attributes" and are currently recommended by Norton and Wilson (2019) for use as limits rather than as FWOs (see section 3.2). The ABCD band thresholds used for DIN and DRP in this report are from the proposed new draft NPSFM (September 2019) and were derived nationally. It is anticipated that regional-scale modelling work in Phase Three of the Regional Forum process will help more robustly estimate the percentage reductions in DIN and DRP needed in different catchments to meet river periphyton, lake phytoplankton and estuary macroalgae objectives. In the meantime the reductions in DIN to meet at least C band shown in this report can be considered indicative of what may be needed.

6.1.3 Toxicants, dissolved oxygen and temperature

- Nitrate and ammonia toxicity are not a key problem at most sites (Table 13).
- For dissolved oxygen (DO) there is wide variability between sites and a substantial proportion (67%) fail to meet the draft FWO of A band in all river classes (Table 13).

- For temperature in summer (Cox-Rutherford Index - CRI) there appears to have been some deterioration (temperature increase) since 2010 and currently (2019) approximately one third of sites fail to meet the draft FWO (Table 13).

- For temperature in winter almost all sites fail to meet the draft FWO (a maximum of 11 °C for trout spawning) (Table 13), suggesting this is a very difficult objective to achieve even naturally as there are not obvious resource use causes (e.g., heated water discharges, lake of shade or large abstractions) contributing to warm water temperatures in winter in Southland.

6.1.4 E. coli

- For *E. coli* at all sites not designated as bathing sites, around 10% of sites currently achieve the draft FWO but 90% require substantial improvement (Table 14).

- For *E. coli* at identified bathing sites (Table 14) all seven monitored popular bathing sites (i.e., 100% of sites) are in D band and would require substantial improvement by 3 bands to achieve the draft FWO of A band.

6.1.5 Sediment and clarity

- For water clarity (black disc) approximately half the sites met the draft FWO. Of the 50% of sites that failed, about 30% would need to improve by one band and the other 20% by two bands (Table 15).

- For deposited fine sediment (% cover) 100% of sites achieved A band when assessed against the new proposed draft NPSFM deposited fine sediment bands (released for public consultation September 2019) (Table 15). There is currently no draft FWO band set for deposited fine sediment but from these results it may be reasonable to set the draft FWO at A band for all river types. Note that when deposited fine sediment (% cover) was assessed against the Clapcott et al., (2011) guideline almost all sites (97%) achieved the guideline and 3% of sites failed (Table 16).

- For suspended sediment (measured as turbidity) the results suggest some improvement between 2010 and 2019, with approximately 37% of sites achieving A band, 3% B band, 22% C band and 38% D band, when assessed against the new proposed draft NPSFM suspended sediment bands (released for public consultation September 2019) (Table 15). There is currently no draft FWO band set for suspended sediment.

- For suspendible sediment (Quorer suspended inorganic sediment (SIS) method), which is not nationally compulsory or proposed but is included in this report as an additional attribute for interest because data are available (see section 3.2), around 80% of sites failed the assessed guideline (Clapcott et al., 2011) in 2019 and 60% failed in 2016 (Table 16).

6.1.6 Periphyton, macroinvertebrates and native fish

- For periphyton biomass (chlorophyll *a*) approximately 90% of sites met the draft FWO while 7% would need to improve by one band and 3% improve by two bands (Table 15).

- For benthic cyanobacteria cover around 73% of sites met the draft FWO. Of those that failed 12% would need to improve by one band, 12% by two bands and 3% by three bands (Table 15).

- For filamentous periphyton cover about half the sites achieved and half failed the draft FWO (Table 16).

- For mat periphyton cover (diatoms and cyanobacteria) about 85% achieved and 15% failed the draft FWO (Table 16).

- For macroinvertebrates (MCI) approximately two-thirds of sites achieved the draft FWO while the other third needs to improve by one band (Table 17).

- For native fish (IBI) at 2019 27% of sites achieved A band, 45% B band, 18% C band and 9% D band (Table 17). No numeric FWO is currently proposed for native fish IBI. However IBI is one of the additional proposed national compulsory attributes in the new proposed draft NPSFM released for public consultation in September 2019 and so its inclusion will need to be reviewed when any new NPSFM is finalised.

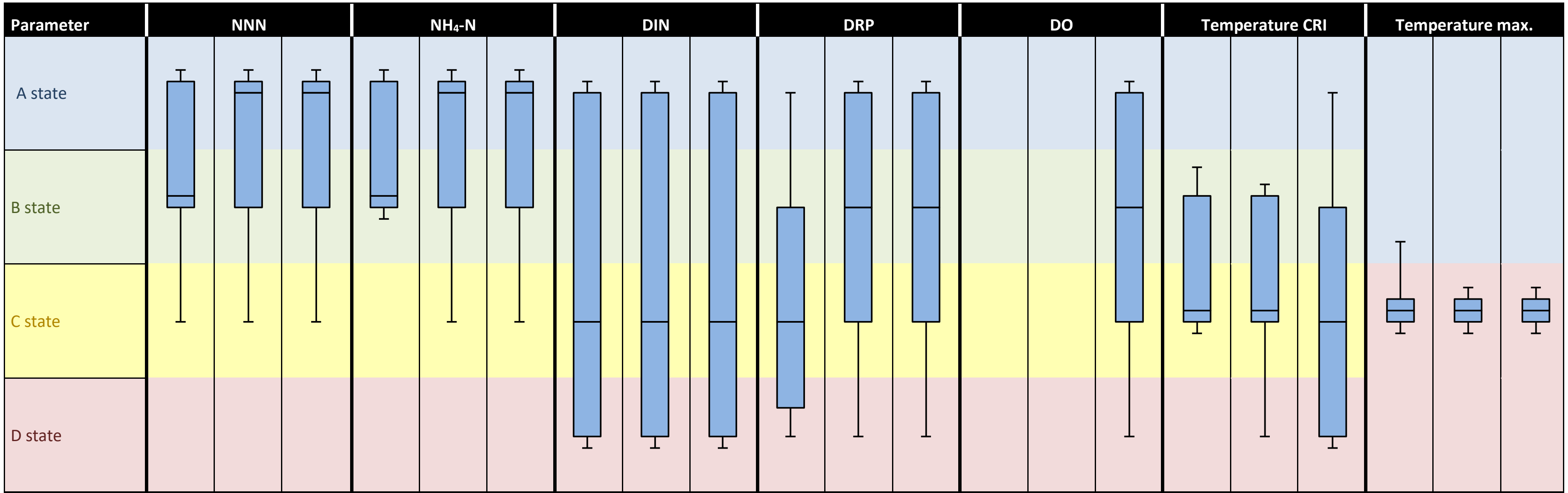
6.1.7 Summary messages

- Nutrients (DIN and DRP) and sediment are the key contaminants that contribute to many of the failures to meet draft FWOs listed above, along with known riparian and in-stream habitat and flow regime issues in places, and potentially also climate effects, despite these latter non-contaminant related effects not having been assessed quantitatively in this report. Most notably the failed draft FWOs include failures to meet key ecosystem health attributes for periphyton and macroinvertebrates at a significant proportion of sites across the region.

- *E. coli* is a key contaminant affecting the value of human health for recreation and the draft FWO for this attribute was failed at a significant majority of sites across the region and at all monitored designated bathing sites.

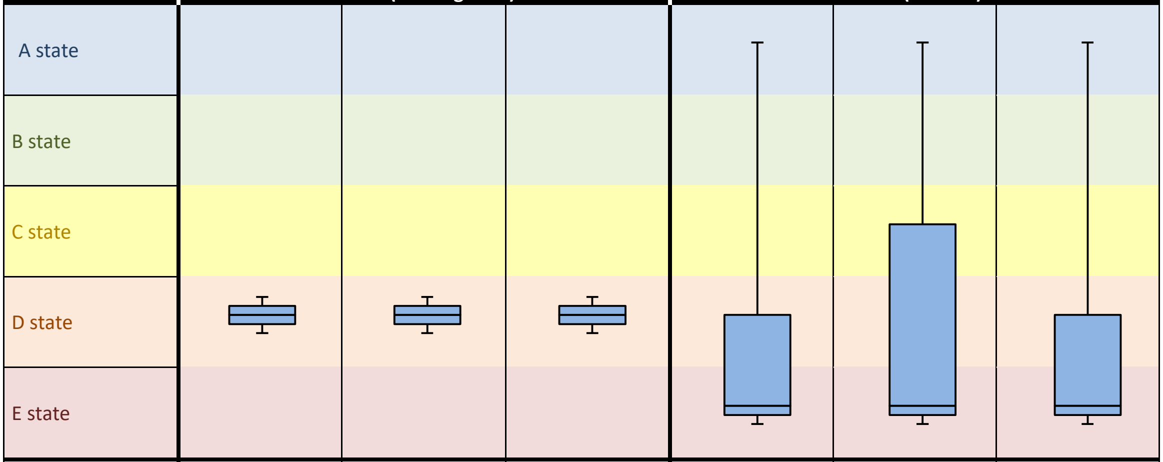
- Finally, to explore patterns around "where" in the region the above problems occur requires analysis at finer spatial scales (FMU and river class level) as presented in the following sections.

Table 13: Distribution of attribute states of the monitored rivers across the region by water quality attribute, and a breakdown of the improvement required to meet the FWOs (NNN = nitrate-nitrite nitrogen)



Parameter	NNN			NH_4-N			DIN			DRP			DO			Temperature CRI			Temperature max.		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	30 45%	40 53%	32 53%	32 48%	46 61%	34 57%	22 31%	21 28%	17 28%	10 15%	23 32%	20 34%	-	-	10 36%	1 6%	1 5%	5 12%	1 6%	0 0%	0 0%
Sites in B state	23 34%	23 30%	20 33%	32 48%	25 33%	22 37%	5 7%	4 5%	3 5%	19 29%	14 19%	12 21%	-	-	6 21%	4 25%	5 24%	11 26%		N/A	
Sites in C state	13 19%	13 17%	8 13%	3 4%	5 7%	4 7%	19 27%	24 32%	20 33%	20 30%	18 25%	13 22%	-	-	9 32%	11 69%	11 52%	14 33%			
Sites in D state	1 1%	0 0%	0 0%	0 0%	0 0%	0 0%	25 35%	27 36%	20 33%	17 26%	18 25%	13 22%	-	-	3 11%	0 0%	4 19%	12 29%	15 94%	18 100%	21 100%
Maintain	64 98%	74 100%	58 100%	65 100%	74 100%	58 100%		N/A			N/A		-	-	9 33%	14 88%	17 81%	27 66%	1 7%	0 0%	0 0%
Improve 1 state	1 2%	0 0%	0 0%	0 0%	0 0%	0 0%							-	-	6 22%	2 13%	4 19%	13 32%	13 93%	16 100%	16 100%
Improve 2 states	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%							-	-	9 33%	0 0%	0 0%	1 2%		N/A	
Improve 3 states	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%							-	-	3 11%	0 0%	0 0%	0 0%			

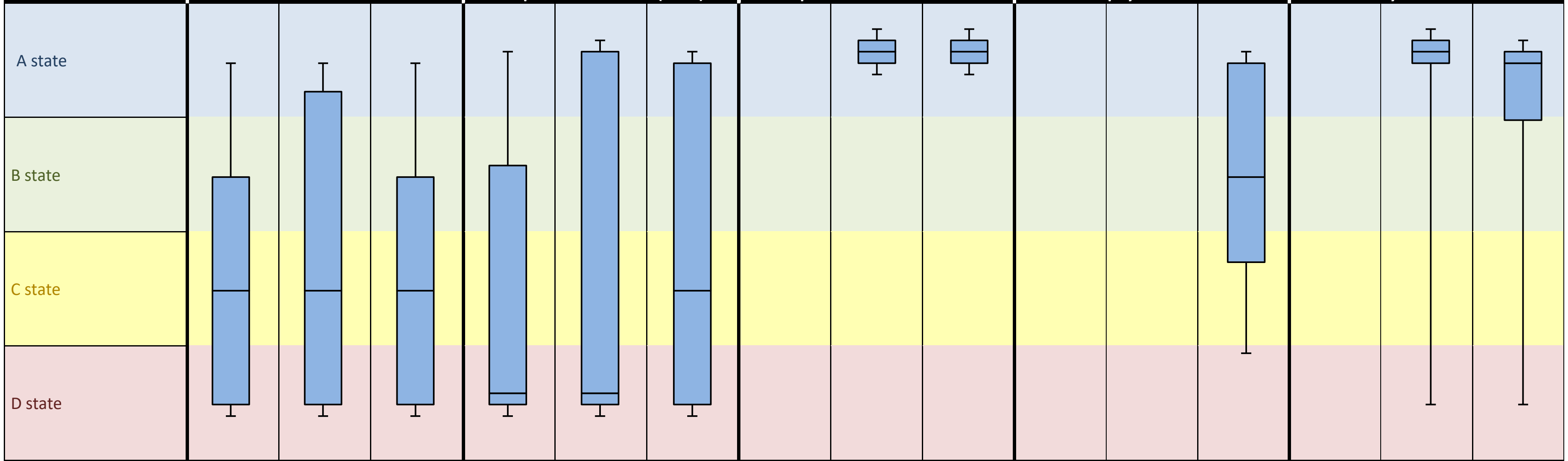
Table 14: Distribution of attribute states of the monitored rivers across the region by *E. coli* attribute, and a breakdown of the improvement required to meet the FWOs.



FMU	*E. coli* (bathing sites)			*E. coli* (all sites)		
Baseline year	2010	2016	2019	2010	2016	2019
Sites in A state	0 0%	0 0%	0 0%	6 9%	12 16%	6 10%
Sites in B state	0 0%	0 0%	0 0%	8 11%	6 8%	2 3%
Sites in C state	0 0%	0 0%	0 0%	2 3%	2 3%	1 2%
Sites in D state	5 100%	5 100%	7 100%	12 17%	15 20%	20 33%
Sites in E state	N/A			42 60%	41 54%	31 52%
Maintain	0 0%	0 0%	0 0%	10 15%	16 22%	5 9%
Improve 1 state	0 0%	0 0%	0 0%	4 6%	2 3%	2 3%
Improve 2 states	0 0%	0 0%	0 0%	11 16%	14 19%	19 33%
Improve 3 states	5 100%	5 100%	7 100%	43 63%	42 57%	32 55%
Improve 4 states	N/A			0 0%	0 0%	0 0%

Table 15: Distribution of attribute states of the monitored rivers across the region by water quality, sediment and aquatic plant attribute, and a breakdown of the improvement required to meet the FWOs.

Parameter	Black disc			Suspended sediment (turb.)			Deposited sediment cover			Periphyton biomass			Benthic cyanobacteria cover		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	15 22%	19 26%	14 24%	14 20%	24 32%	22 37%	-	30 100%	35 100%	-	-	10 33%	-	24 80%	26 74%
Sites in B state	9 13%	13 18%	10 17%	5 7%	5 7%	2 3%	-	0 0%	0 0%	-	-	12 40%	-	1 3%	1 3%
Sites in C state	12 18%	13 18%	11 19%	9 13%	7 9%	13 22%	-	0 0%	0 0%	-	-	6 20%	-	1 3%	3 9%
Sites in D state	32 47%	29 39%	23 40%	42 60%	40 53%	23 38%	-	0 0%	0 0%	-	-	2 7%	-	4 13%	5 14%
Maintain	25 37%	36 49%	28 49%	28 40%	36 47%	37 62%	-	0 100%	0 100%	-	-	26 90%	-	23 79%	24 73%
Improve 1 state	22 33%	20 27%	18 32%	42 60%	40 53%	23 38%	-	0 0%	0 0%	-	-	2 7%	-	2 7%	4 12%
Improve 2 states	20 30%	17 23%	11 19%	-	-	-	-	0 0%	0 0%	-	-	1 3%	-	3 10%	4 12%
Improve 3 states	0 0%	0 0%	0 0%	-	-	-	-	0 0%	0 0%	-	-	0 0%	-	1 3%	1 3%

Table 16: Distribution of compliance with the FWOs for periphyton cover and the Clapcott *et al.* (2011) deposited sediment and suspendible inorganic sediment (SIS) (by Quorer method) guidelines, and a breakdown of the improvement required to meet the FWOs/guidelines.

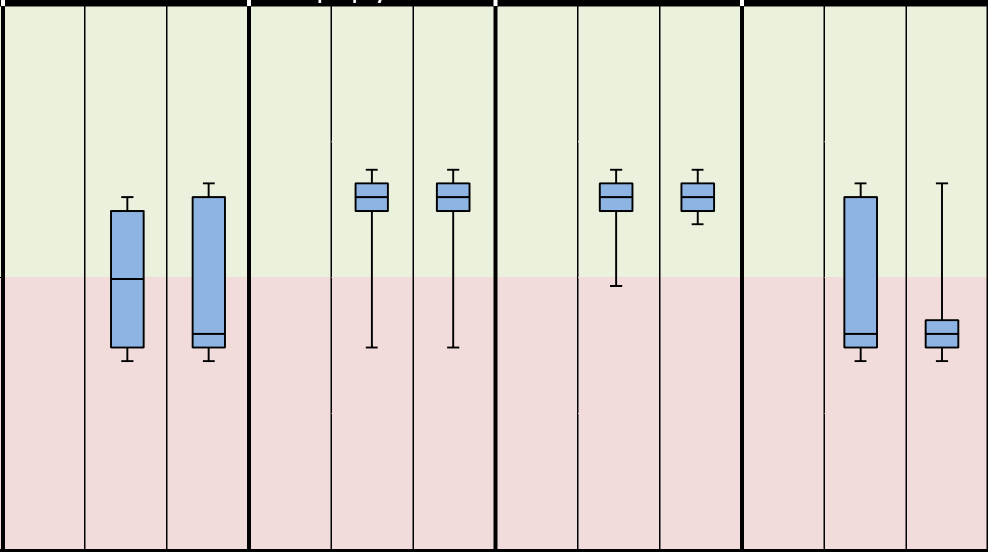
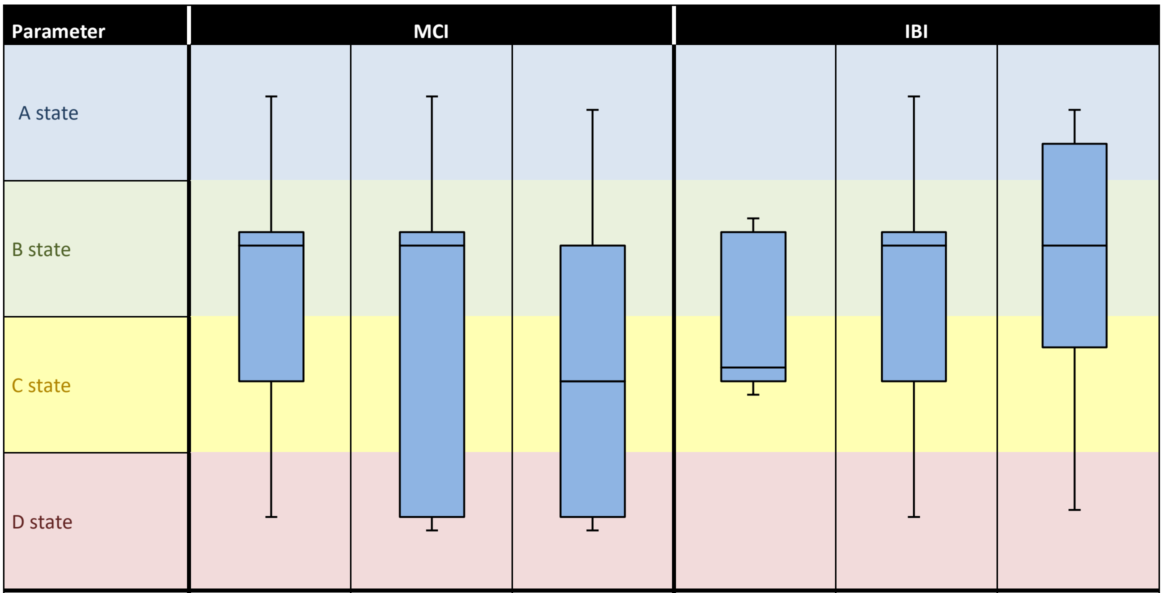
Parameter	Filamentous periphyton cover			Mat periphyton cover			Deposited sediment cover			SIS		
Pass state (meeting objective/guide-line) Fail state (failing objective/guide-line)												
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites meeting	-	15 50%	13 37%	-	26 87%	29 83%	-	28 93%	34 97%	-	31 40%	18 18%
Sites failing	-	15 50%	22 63%	-	4 13%	6 17%	-	2 7%	1 3%	-	46 60%	84 82%
Maintain	-	15 50%	13 37%	-	26 87%	29 83%	-	28 93%	34 97%	-	31 40%	18 18%
Improve	-	15 50%	22 63%	-	4 13%	6 17%	-	2 7%	1 3%	-	46 60%	84 82%

Table 17: Distribution of attribute states of the monitored rivers across the region by macroinvertebrate and fish attribute, and a breakdown of the improvement required to meet the FWOs.



Parameter	MCI			IBI		
Baseline year	2010	2016	2019	2010	2016	2019
Sites in A state	16 20%	17 16%	12 11%	0 0%	10 19%	6 27%
Sites in B state	35 44%	38 37%	39 37%	4 36%	25 48%	10 45%
Sites in C state	12 15%	21 20%	22 21%	7 64%	12 23%	4 18%
Sites in D state	17 21%	28 27%	32 30%	0 0%	5 5%	2 4%
Maintain	55 74%	69 70%	65 66%	N/A		
Improve 1 state	19 26%	30 30%	34 34%			
Improve 2 states	0 0%	0 0%	0 0%			
Improve 3 states	0 0%	0 0%	0 0%			

6.2 FMU scale analysis

Results for all attributes and sites grouped into their parent FMUs are shown in Table 18 to Table 36. The distribution of results in each FMU is shown by the box and whisker plots in the top part of each table. The number (and percentage) of sites meeting the draft FWOs in each FMU is shown in the middle rows of each table. The number (and percentage) of sites needing to improve by one, two or three bands to achieve the draft FWOs is shown in the bottom rows of each table.

Key messages from the FMU scale analysis are as follows:

6.2.1 Fiordland and islands FMU

- For the 'Fiordland and islands' FMU there is limited data for any attributes and it is assumed that streams and rivers in this FMU are in a high quality, largely natural state compared to the other four more developed FMUs.

6.2.2 Nutrients

- For the dissolved nutrient DIN the Waiau FMU is in a significantly better state than the other three FMUs, with more than half Waiau FMU sites in A band and none in D band. There is negligible difference between the other three developed FMUs and they are in poorer state with 45%, 44% and 26% of sites in D band for the Ōreti, Aparima and Mataura FMUs respectively (Table 20). However see third bullet below.

- For the dissolved nutrient DRP the pattern is similar to DIN, with the Waiau in a significantly better state (88% of sites in A band) than the others. There is negligible difference between the other three developed FMUs and they are in poorer state with 33%, 30% and 17% of sites in D band for the Aparima, Mataura and Ōreti FMUs respectively (Table 21).

- Both DIN and DRP are attributes in the group of "Additional proposed national compulsory attributes" and are currently recommended by Norton and Wilson (2019) for use as limits rather than as FWOs (see section 3.2). The ABCD band thresholds used for DIN and DRP in this report are from the proposed new draft NPSFM (September 2019) and were derived nationally. It is anticipated that regional-scale modelling work in Phase Three of the Regional Forum process will help more robustly estimate the percentage reductions in DIN and DRP needed in different catchments to meet river periphyton, lake phytoplankton and estuary macroalgae objectives. In the meantime the reductions in DIN to meet at least C band shown in this report can be considered indicative of what may be needed.

6.2.3 Toxicants, dissolved oxygen and temperature

- For nitrate and ammonia toxicity there is negligible difference between the FMUs. The Waiau FMU has a greater proportion of sites in A band (almost 100%) than the other three developed FMUS, but all FMUs are almost 100% compliant with the draft FWOs for nitrate and ammonia toxicity (Table 18 and Table 19).

- For dissolved oxygen (DO) there is wide variability between sites, with the state possibly a little worse in the Aparima FMU (median state C band) compared to the Waiau and Mataura FMUs (median state B band) and Ōreti FMU (median state upper B band) (Table 22).

- For temperature in summer (CRI) the deterioration (temperature increase) since 2010 is evident in all four developed FMUs, suggesting that potentially climate may be a factor. There is no clear difference between these four FMUs, with median current (2019) state in B band (Aparima and Waiau) or C band (Mataura and Ōreti) (Table 23).

- For temperature in winter there is no difference between FMUs, with all four developed FMUs failing to meet the draft FWO (a maximum of 11 ^{o}C for trout spawning) in almost all sites, reinforcing that this is a very difficult objective to achieve (Table 24). There are no obvious resource use causes (e.g., heated water discharges or large abstractions) contributing to warm water temperatures in winter in Southland.

6.2.4 E. coli

- For *E. coli* at all monitored sites not designated as bathing sites the Waiau FMU was again in better condition than the other FMUs, although deterioration since 2010 means the Waiau FMU still currently (2019) fails to meet the draft FWOs in 90% of sites, with most of those (60%) needing to improve by two bands or more. The other three developed FMUs are in poorer state with little difference between them, and with more than 90% of sites failing and the majority needing to improve by three bands to achieve the draft FWO (Table 25).

- As noted previously for *E. coli* at identified bathing sites (Table 14) all seven monitored popular bathing sites (i.e., 100% of sites) are in D band and would require substantial improvement by 3 bands to achieve the draft FWO of A band.

6.2.5 Sediment and clarity

- For water clarity (black disc) the Waiau FMU was again in significantly better state than the other three developed FMUs, with 100% of sites meeting the draft FWOs compared to 56%, 35% and 38% of sites meeting the draft FWOs in the Aparima, Mataura and Ōreti FMUs respectively (Table 26).

- For deposited fine sediment (% cover) there was little difference between FMUs and 100% of sites achieved A band when assessed against the new proposed draft NPSFM deposited fine sediment bands (released for public consultation September 2019) (Table 28). There is currently no draft FWO band set for deposited fine sediment but from these results it seems it may be reasonable to set the draft FWO at A band for all river types. Note that when deposited fine sediment (% cover) was assessed against the Clapcott et al., (2011) guideline almost all sites achieved the guideline with 100% of sites achieving the guideline in the Aparima, Mataura and Oreti FMUs and 91% of sites in the Waiau FMU (Table 29).

- For suspended sediment (measured as turbidity) the results suggest some improvement between 2010 and 2019 across all FMUs. The Waiau was again in significantly better state than the other three developed FMUs with 80% of sites in A band and one site in D band (in 2019) when assessed against the new proposed draft NPSFM suspended sediment bands released for public consultation September 2019 (Table 27). The Mataura was the worst FMU for suspended sediment with 61% of sites in D band in 2019. The Aparima and Ōreti were similar with 33% and 28% of sites in D band in 2019 respectively. There is currently no draft FWO band set for suspended sediment.

- For suspendible sediment (Quorer SIS method), which is not nationally compulsory or proposed but is included in this report as an additional attribute for interest because data are available (see section 3.2), the majority of sites failed the assessed guideline (Clapcott et al., 2011) in all FMUs, with 74%, 96%, 89% and 62% of sites failing in the Aparima, Mataura, Ōreti and Waiau FMUs respectively (Table 30).

6.2.6 Periphyton, macroinvertebrates and native fish

- For periphyton biomass (chlorophyll *a*) the FMUS were similar with 75%, 100%, 86% and 86% of sites currently (2019) meeting the draft FWOs in the, Aparima, Mataura, Ōreti and Waiau FMUs respectively (Table 31).

- For benthic cyanobacteria cover the Waiau FMU was slightly worse with 60% of sites currently (2019) meeting the draft FWOs in the Waiau compared to 75%, 75% and 86%, of sites in the Aparima, Mataura and Ōreti FMUs respectively (Table 34).

- For filamentous periphyton cover the Aparima FMU was worst with no sites currently (2019) meeting the draft FWO. For the remaining FMUs, 33%, 38% and 55% of sites meet the draft FWOs in the Mataura, Ōreti and Waiau FMUs respectively (Table 32).

- For mat periphyton cover (diatoms and cyanobacteria) the Waiau FMU was again slightly worse, with 64%, 100%, 92% and 88% of sites currently (2019) meeting the draft FWOs in the Waiau, Aparima, Mataura and Ōreti FMUs respectively (Table 33).

- For macroinvertebrates (MCI) the Waiau FMU was in a better state than the others, with 100% of Waiau FMU sites achieving the draft FWOs compared to 76%, 57% and 48% in the Aparima, Mataura and Ōreti FMUs respectively (Table 35).

- For native fish (IBI) there wasn't a notable difference between the four developed FMUs, with the majority of sites in A to C bands for all FMUs and only a few sites in D band in some years for all FMUs (Table 36). No numeric FWO was proposed for native fish (IBI) by Norton and Wilson (2019). However IBI is one of the additional proposed national compulsory attributes in the new proposed draft NPSFM released for public consultation in September 2019 and so its inclusion will need to be reviewed when any new NPSFM is finalised.

6.2.7 Summary messages

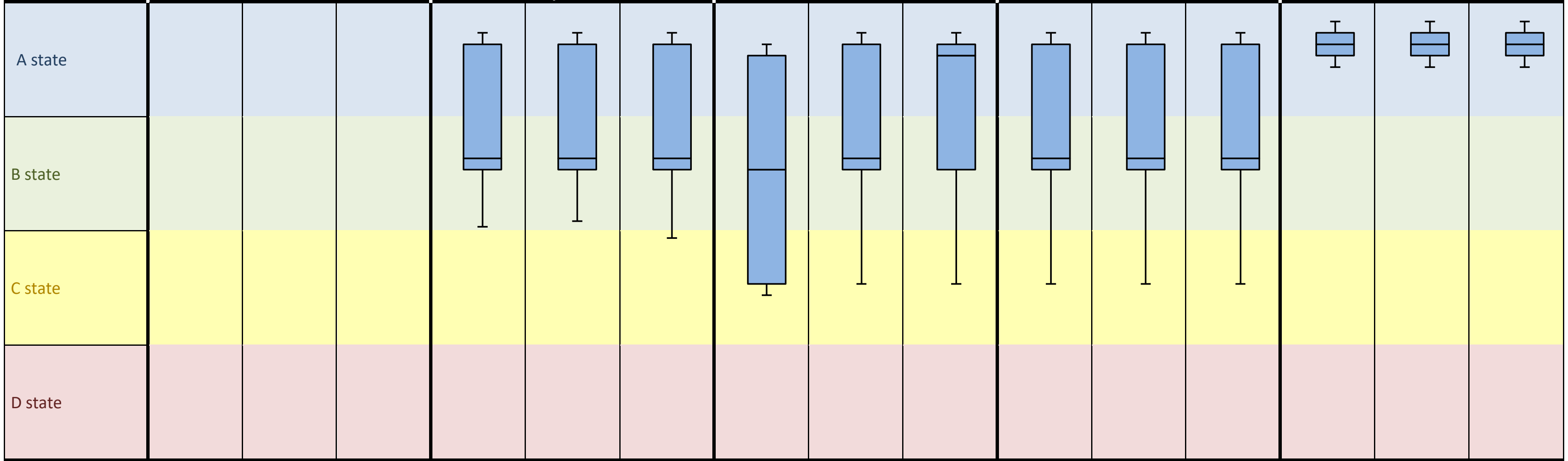
- The FMU scale analysis suggests that both the 'Fiordland and islands' FMU and the Waiau FMU exhibit distinct patterns of compliance with the draft FWOs compared to the other three developed FMUs (Aparima, Mataura and Ōreti) which are all similar to eachother in terms of FWO compliance.

- The 'Fiordland and islands' FMU is distinct for being in a high quality, largely natural state although we have few data to show this.

- The Waiau FMU is distinct for being in generally better condition than the other developed FMUs for many attributes (DIN, DRP, *E. coli*, water clarity, suspended sediment, filamentous periphyton and macroinvertebrate MCI) although in distinctly worse condition for a few key attributes (mat cover and benthic cyanobacteria).

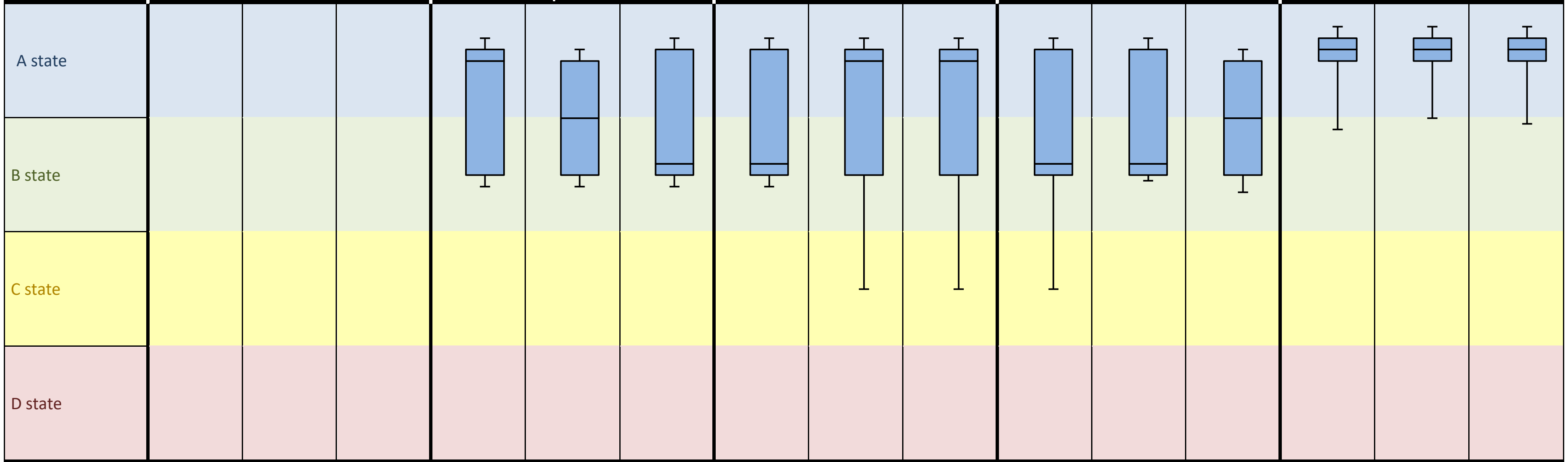
- The FMU scale analysis reinforces that nutrients (DIN and DRP), sediment and *E. coli* are key contaminants that contribute to observed failures to meet draft FWOs in all of the developed FMUs, along with potentially in places with known riparian and in-stream habitat and flow regime issues, and potentially also climate effects, despite these latter non-contaminant related effects not having been assessed quantitatively in this report.

Table 18: Distribution of the NNN toxicity attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	5 45%	5 42%	3 33%	9 30%	16 48%	12 52%	7 41%	8 40%	7 39%	9 100%	11 100%	10 100%
Sites in B state	-	-	-	5 45%	6 50%	5 56%	12 40%	9 27%	7 30%	6 35%	8 40%	8 44%	0 0%	0 0%	0 0%
Sites in C state	-	-	-	1 9%	1 8%	1 11%	8 27%	8 24%	4 17%	4 24%	4 20%	3 17%	0 0%	0 0%	0 0%
Sites in D state	-	-	-	0 0%	0 0%	0 0%	1 3%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Maintain	-	-	-	11 100%	12 100%	9 100%	29 97%	33 100%	23 100%	15 100%	18 100%	16 100%	9 100%	11 100%	10 100%
Improve 1 state	-	-	-	0 0%	0 0%	0 0%	1 3%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Improve 2 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Improve 3 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%

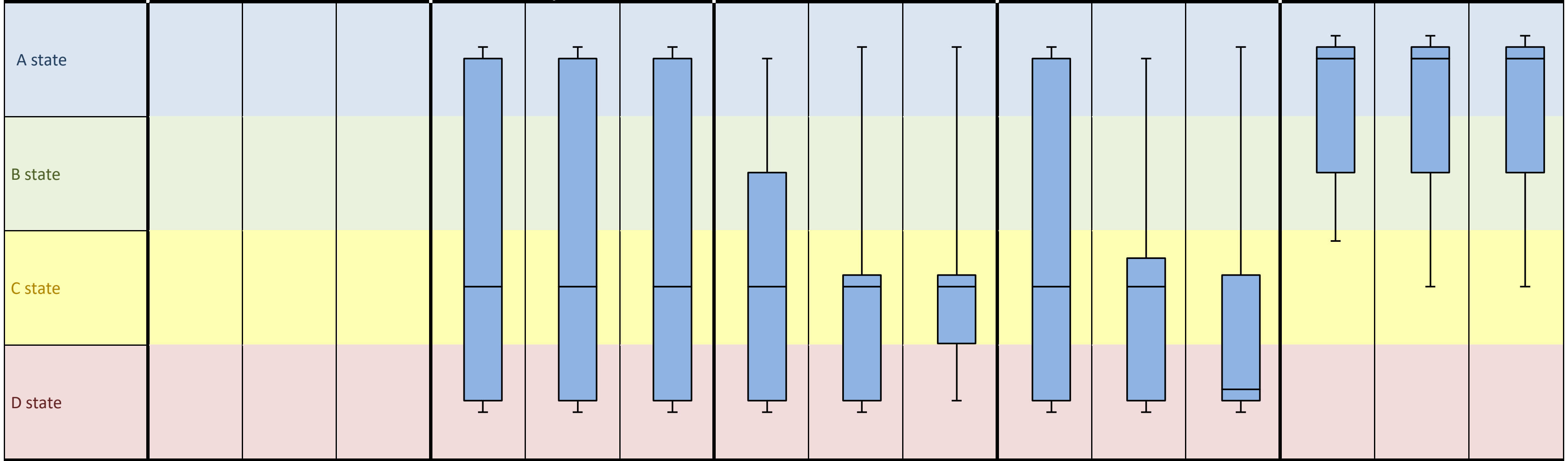
Table 19: Distribution of the NH_4-N toxicity attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	6 55%	6 50%	4 44%	10 33%	22 67%	12 52%	8 47%	8 40%	9 50%	8 89%	10 91%	9 90%
Sites in B state	-	-	-	5 45%	6 50%	5 56%	20 67%	7 21%	8 35%	6 35%	11 55%	8 44%	1 11%	1 9%	1 10%
Sites in C state	-	-	-	0 0%	0 0%	0 0%	0 0%	4 12%	3 13%	3 18%	1 5%	1 6%	0 0%	0 0%	0 0%
Sites in D state	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Maintain	-	-	-	11 100%	12 100%	9 100%	30 100%	33 100%	23 100%	15 100%	18 100%	16 100%	9 100%	11 100%	10 100%
Improve 1 state	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Improve 2 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Improve 3 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%

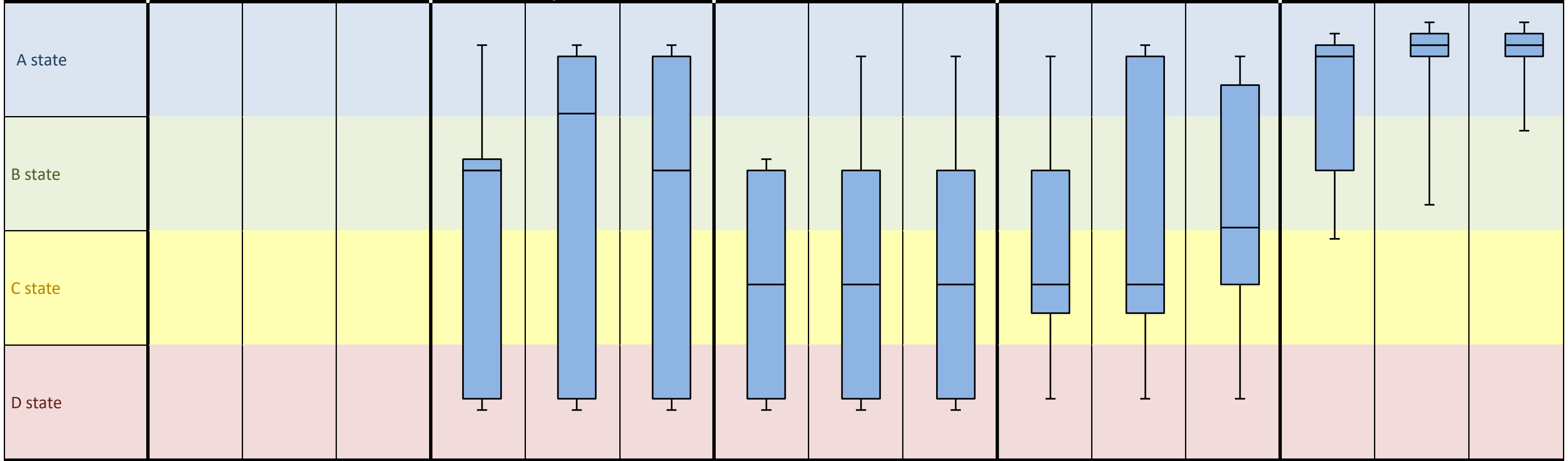
Table 20: Distribution of the DIN attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.

FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		



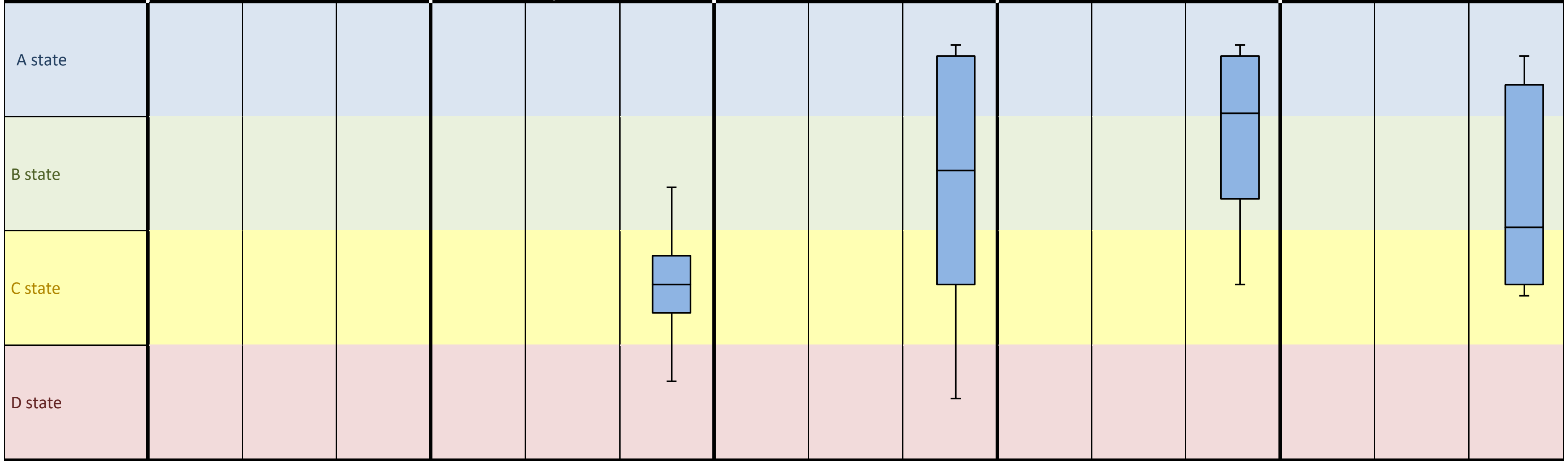
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	4 36%	4 33%	3 33%	7 21%	6 18%	4 17%	6 33%	4 20%	4 22%	5 56%	7 64%	6 60%
Sites in B state	-	-	-	0 0%	0 0%	0 0%	2 6%	1 3%	1 4%	0 0%	1 5%	0 0%	3 33%	2 18%	2 20%
Sites in C state	-	-	-	2 18%	3 25%	2 22%	12 36%	13 39%	12 52%	4 22%	6 30%	4 22%	1 11%	2 18%	2 20%
Sites in D state	-	-	-	5 45%	5 42%	4 44%	12 36%	13 39%	6 26%	8 44%	9 45%	10 56%	0 0%	0 0%	0 0%
Maintain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Improve 1 state	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Improve 2 states	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Improve 3 states	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 21: Distribution of the DRP attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	2 18%	6 50%	4 44%	1 3%	4 12%	4 17%	2 13%	6 30%	5 28%	5 56%	7 88%	7 88%
Sites in B state	-	-	-	4 36%	1 8%	2 22%	8 27%	10 30%	5 22%	4 25%	3 15%	4 22%	3 33%	0 0%	1 13%
Sites in C state	-	-	-	1 9%	1 8%	0 0%	12 40%	10 30%	7 30%	6 38%	6 30%	6 33%	1 11%	1 13%	0 0%
Sites in D state	-	-	-	4 36%	4 33%	3 33%	9 30%	9 27%	7 30%	4 25%	5 25%	3 17%	0 0%	0 0%	0 0%
Maintain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Improve 1 state	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Improve 2 states	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Improve 3 states	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

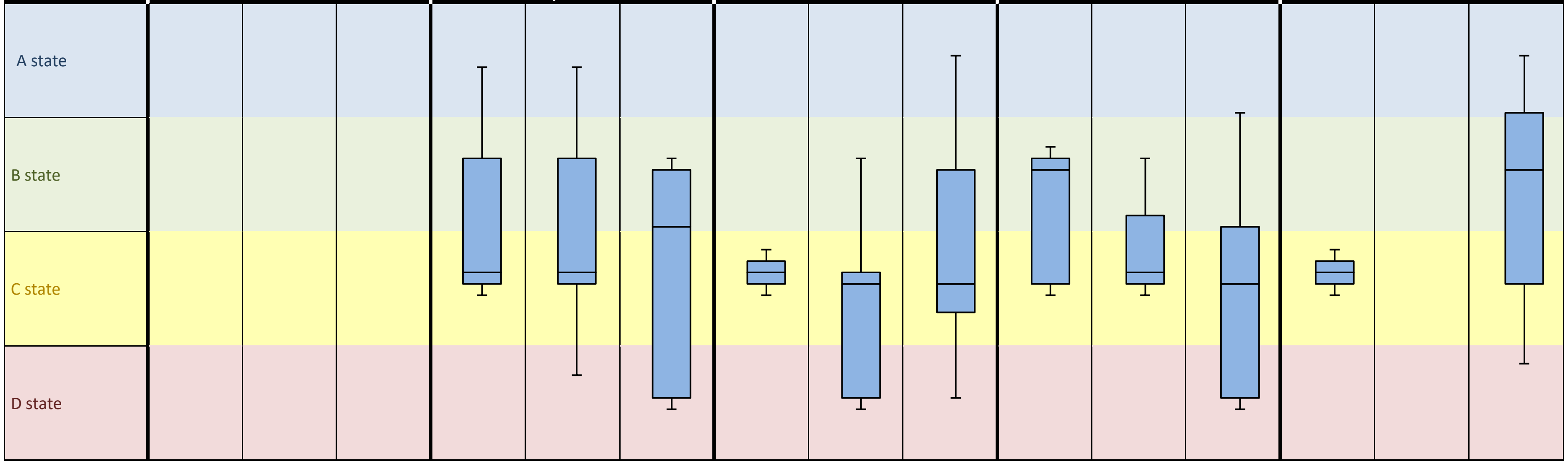
Table 22: Distribution of the DO attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	-	-	0 0%	-	-	4 40%	-	-	4 50%	-	-	2 33%
Sites in B state	-	-	-	-	-	1 25%	-	-	2 20%	-	-	2 25%	-	-	1 17%
Sites in C state	-	-	-	-	-	2 50%	-	-	2 20%	-	-	2 25%	-	-	3 50%
Sites in D state	-	-	-	-	-	1 25%	-	-	2 20%	-	-	0 0%	-	-	0 0%
Maintain	-	-	-	-	-	0 0%	-	-	4 40%	-	-	3 43%	-	-	2 33%
Improve 1 state	-	-	-	-	-	1 25%	-	-	2 20%	-	-	2 29%	-	-	1 17%
Improve 2 states	-	-	-	-	-	2 50%	-	-	2 20%	-	-	2 29%	-	-	3 50%
Improve 3 states	-	-	-	-	-	1 25%	-	-	2 20%	-	-	0 0%	-	-	0 0%

Table 23: Distribution of the temperature CRI attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.

FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	1 33%	1 20%	0 0%	0 0%	0 0%	2 13%	0 0%	0 0%	1 9%	0 0%	-	2 29%
Sites in B state	-	-	-	0 0%	1 20%	4 50%	0 0%	2 22%	3 19%	4 57%	2 29%	2 18%	0 0%	-	2 29%
Sites in C state	-	-	-	2 67%	2 40%	1 13%	5 100%	4 44%	7 44%	3 43%	5 71%	4 36%	1 100%	-	2 29%
Sites in D state	-	-	-	0 0%	1 20%	3 38%	0 0%	3 33%	4 25%	0 0%	0 0%	4 36%	0 0%	-	1 14%
Maintain	-	-	-	3 100%	4 80%	5 63%	4 80%	6 67%	11 69%	7 100%	7 100%	6 60%	0 0%	-	5 71%
Improve 1 state	-	-	-	0 0%	1 20%	3 38%	1 20%	3 33%	5 31%	0 0%	0 0%	4 40%	1 100%	-	1 14%
Improve 2 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	1 14%
Improve 3 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	0 0%

Table 24: Distribution of the max. winter temperature attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.

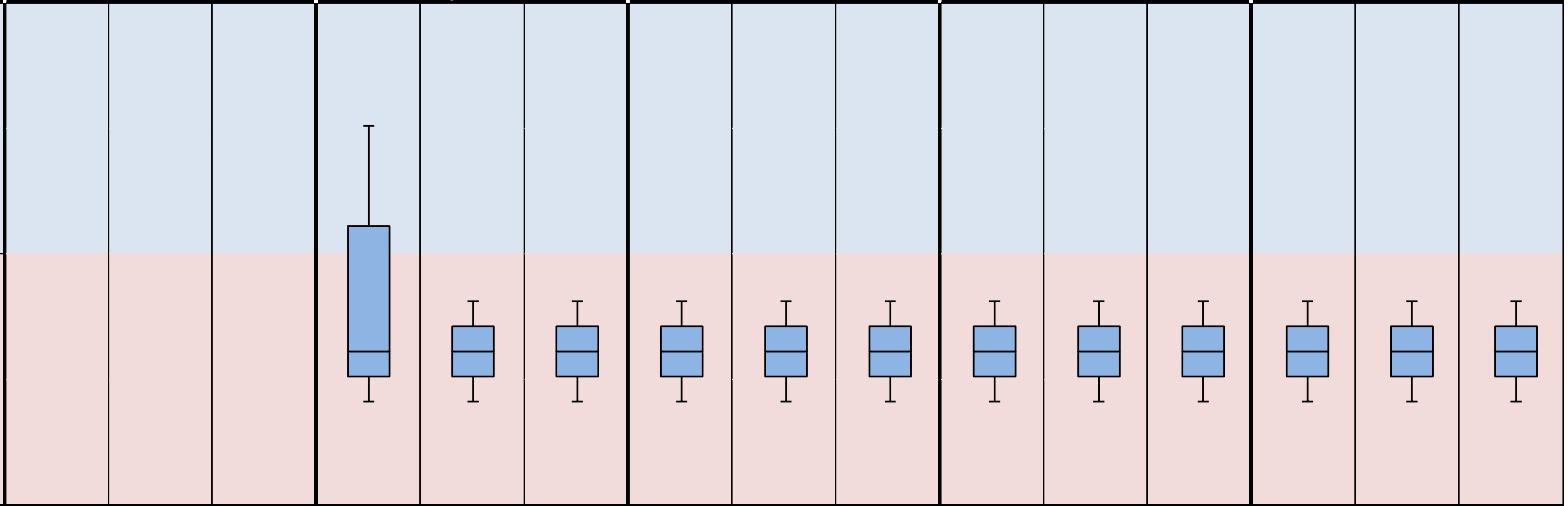
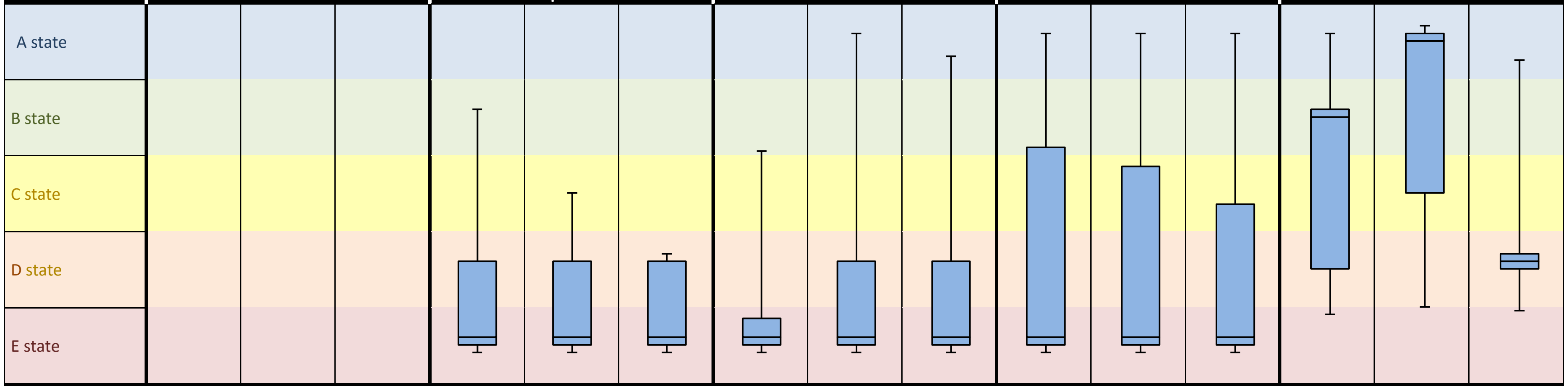
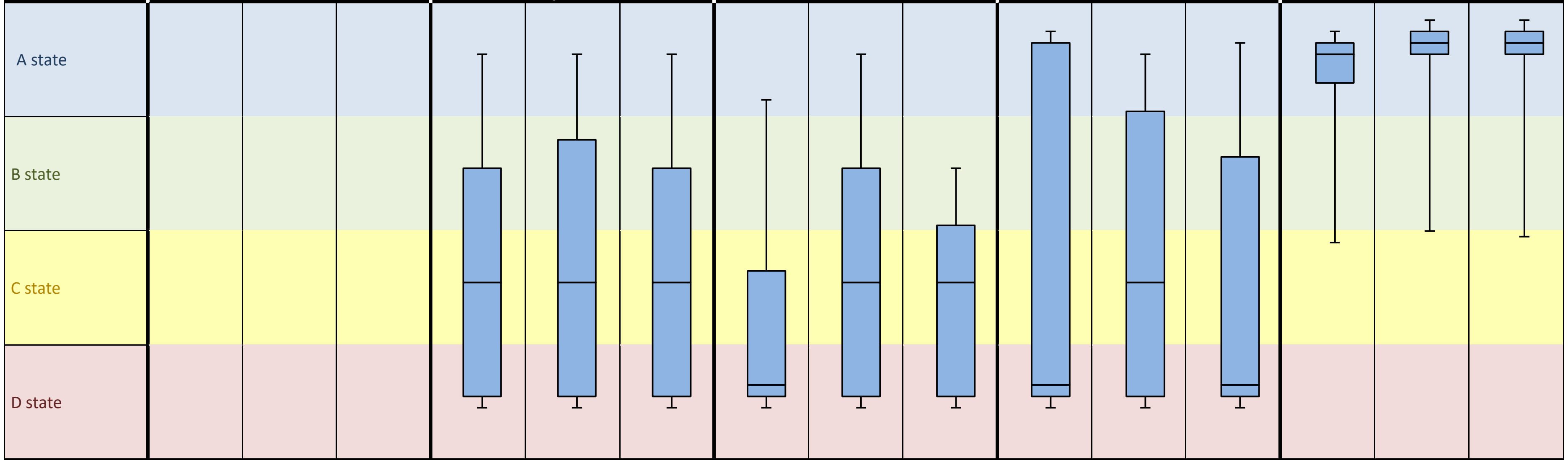
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Pass state Fail state															
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in Pass state	-	-	-	1 33%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Sites in Fail state	-	-	-	2 67%	4 100%	5 100%	5 100%	6 100%	9 100%	7 100%	7 100%	6 100%	1 100%	1 100%	1 100%
Maintain	-	-	-	1 33%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Improve	-	-	-	2 67%	4 100%	5 100%	4 100%	5 100%	5 100%	6 100%	6 100%	5 100%	1 100%	1 100%	1 100%

Table 25: Distribution of the *E. coli* attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



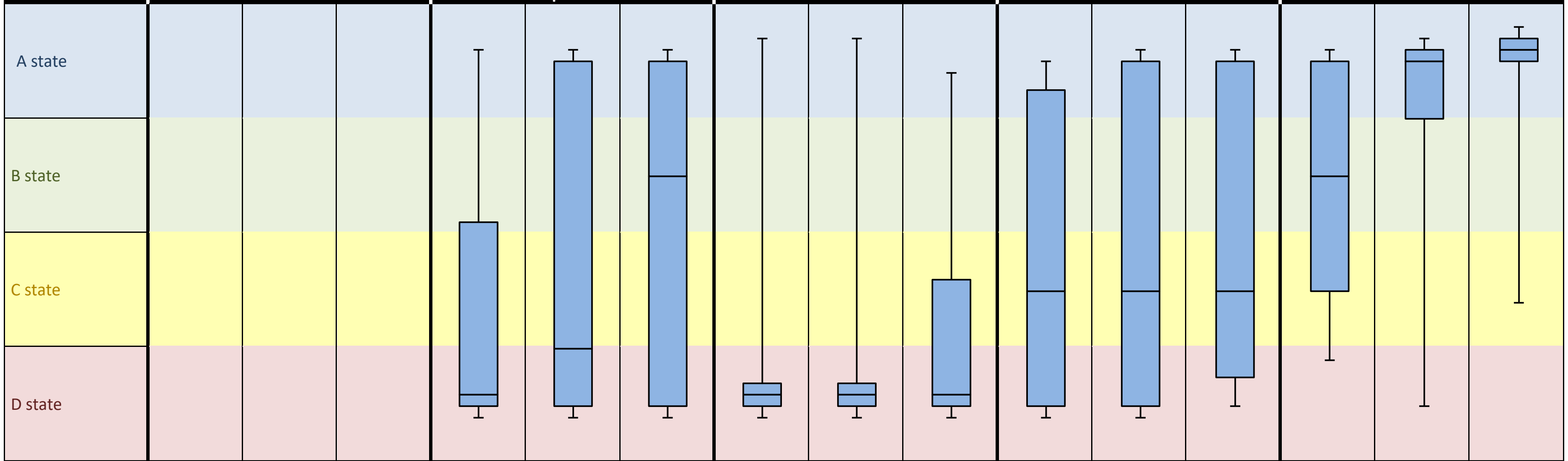
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	0 0%	0 0%	0 0%	1 3%	3 9%	2 9%	3 17%	3 15%	3 17%	2 22%	6 55%	1 10%
Sites in B state	-	-	-	2 18%	1 8%	0 0%	1 3%	1 3%	0 0%	2 11%	2 10%	1 6%	3 33%	2 18%	1 10%
Sites in C state	-	-	-	0 0%	0 0%	0 0%	1 3%	1 3%	0 0%	0 0%	1 5%	1 6%	1 11%	0 0%	0 0%
Sites in D state	-	-	-	2 18%	4 33%	4 44%	5 16%	7 21%	7 30%	3 17%	2 10%	2 11%	2 22%	2 18%	7 70%
Sites in E state	-	-	-	7 64%	7 58%	5 56%	24 75%	21 64%	14 61%	10 56%	12 60%	11 61%	1 11%	1 9%	1 10%
Maintain	-	-	-	2 18%	1 8%	0 0%	1 3%	4 12%	2 9%	3 19%	3 17%	2 13%	4 44%	8 73%	1 10%
Improve 1 state	-	-	-	0 0%	0 0%	0 0%	2 6%	1 3%	0 0%	0 0%	1 6%	1 6%	2 22%	0 0%	1 10%
Improve 2 states	-	-	-	2 18%	4 33%	4 44%	5 16%	7 21%	7 30%	3 19%	2 11%	2 13%	1 11%	1 9%	6 60%
Improve 3 states	-	-	-	7 64%	7 58%	5 56%	24 75%	21 64%	14 61%	10 63%	12 67%	11 69%	2 22%	2 18%	2 20%
Improve 4 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%

Table 26: Distribution of the visual clarity attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	2 18%	3 25%	2 22%	2 6%	3 9%	1 4%	5 29%	5 26%	4 24%	6 75%	8 80%	7 78%
Sites in B state	-	-	-	2 18%	3 25%	2 22%	5 16%	7 21%	5 22%	1 6%	2 11%	2 12%	1 13%	1 10%	1 11%
Sites in C state	-	-	-	2 18%	0 0%	2 22%	7 22%	9 27%	6 26%	2 12%	3 16%	2 12%	1 13%	1 10%	1 11%
Sites in D state	-	-	-	5 45%	6 50%	3 33%	18 56%	14 42%	11 48%	9 53%	9 47%	9 53%	0 0%	0 0%	0 0%
Maintain	-	-	-	5 45%	6 50%	5 56%	8 25%	13 39%	8 35%	5 31%	7 39%	6 38%	7 88%	10 100%	9 100%
Improve 1 state	-	-	-	1 9%	1 8%	1 11%	14 44%	13 39%	11 48%	6 38%	6 33%	6 38%	1 13%	0 0%	0 0%
Improve 2 states	-	-	-	5 45%	5 42%	3 33%	10 31%	7 21%	4 17%	5 31%	5 28%	4 25%	0 0%	0 0%	0 0%
Improve 3 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%

Table 27: Distribution of compliance with the proposed draft NPSFM (September 2019) suspended sediment (turbidity) bands in the monitored rivers within each FMU.



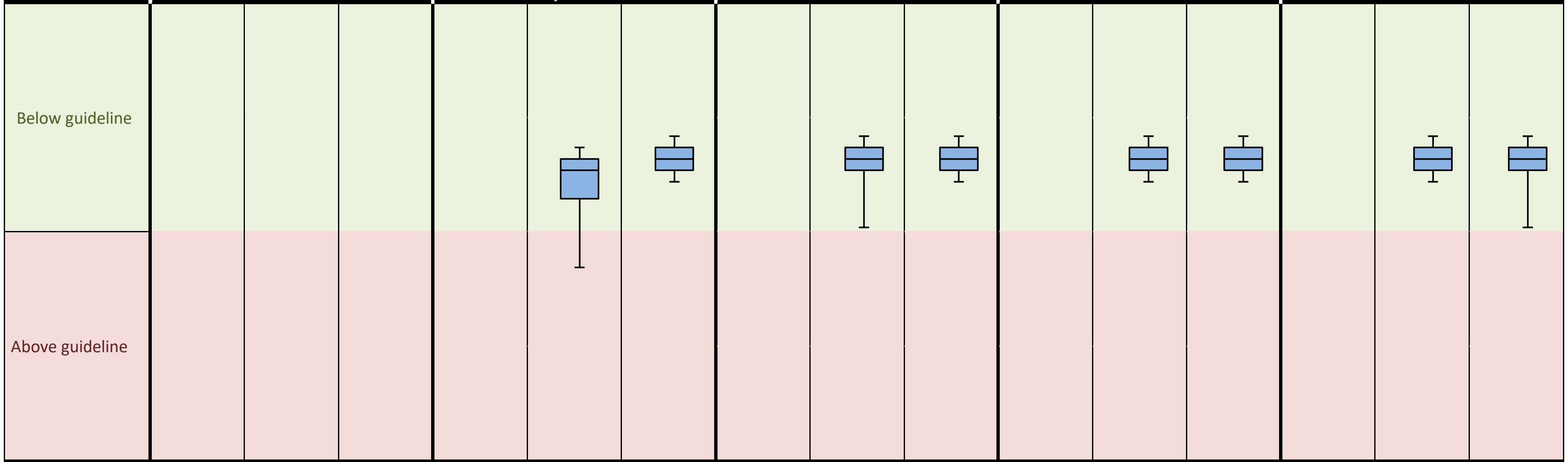
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	2 18%	5 42%	4 44%	3 9%	5 15%	2 9%	5 28%	6 30%	8 44%	4 44%	8 73%	8 80%
Sites in B state	-	-	-	1 9%	0 0%	1 11%	1 3%	1 3%	0 0%	2 11%	3 15%	0 0%	1 11%	1 9%	1 10%
Sites in C state	-	-	-	1 9%	1 8%	1 11%	2 6%	2 6%	7 30%	3 17%	4 20%	5 28%	3 33%	0 0%	0 0%
Sites in D state	-	-	-	7 64%	6 50%	3 33%	26 81%	25 76%	14 61%	8 44%	7 35%	5 28%	1 11%	2 18%	1 10%
Maintain	N/A														
Improve 1 state															
Improve 2 states															
Improve 3 states															

Table 28: Distribution of compliance with the proposed draft NPSFM (September 2019) deposited fine sediment cover bands in the monitored rivers within each FMU.

FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
A state															
B state															
C state															
D state															
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	-	4 100%	4 100%	-	11 100%	12 100%	-	8 100%	8 100%	-	7 100%	11 100%
Sites in B state	-	-	-	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%
Sites in C state	-	-	-	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%
Sites in D state	-	-	-	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%
Maintain	N/A														
Improve 1 state															
Improve 2 states															
Improve 3 states															

Table 29: Distribution of compliance with the Clapcott et al. (2011) fine sediment cover guideline in the monitored rivers within each FMU, and a breakdown of the improvement required to meet the guideline.

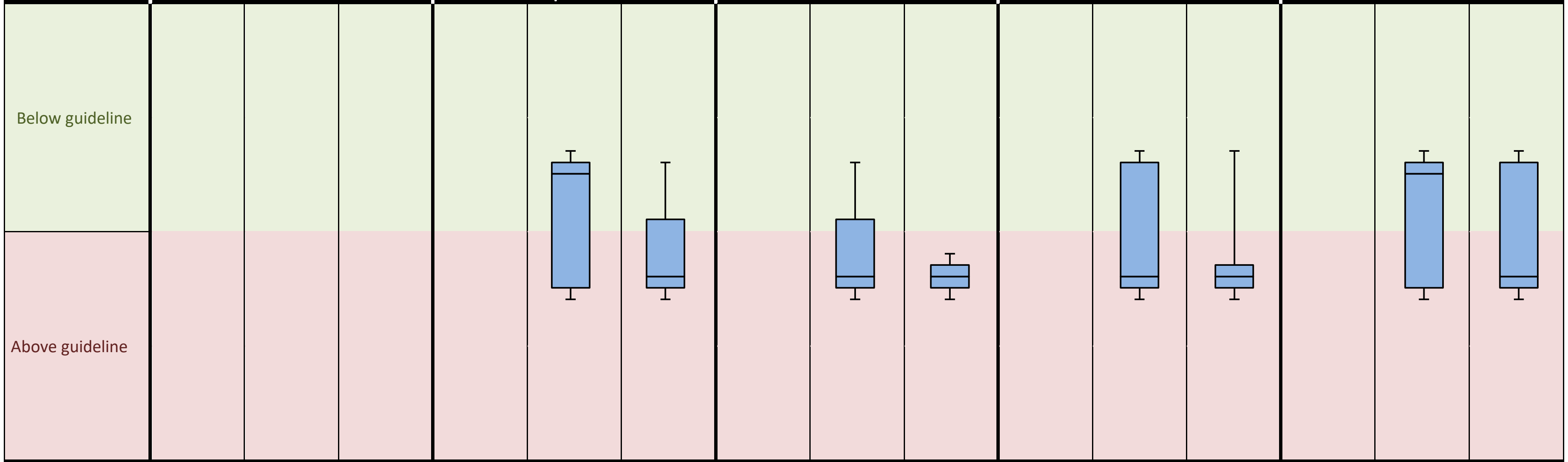
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites below guideline	-	-	-	-	3 75%	4 100%	-	10 91%	12 100%	-	8 100%	8 100%	-	7 100%	10 91%
Sites above guideline	-	-	-	-	1 25%	0 0%	-	1 9%	0 0%	-	0 0%	0 0%	-	0 0%	1 9%
Maintain	-	-	-	-	3 75%	4 100%	-	10 91%	12 100%	-	8 100%	8 100%	-	7 100%	10 91%
Improve	-	-	-	-	1 25%	0 0%	-	1 9%	0 0%	-	0 0%	0 0%	-	0 0%	1 9%

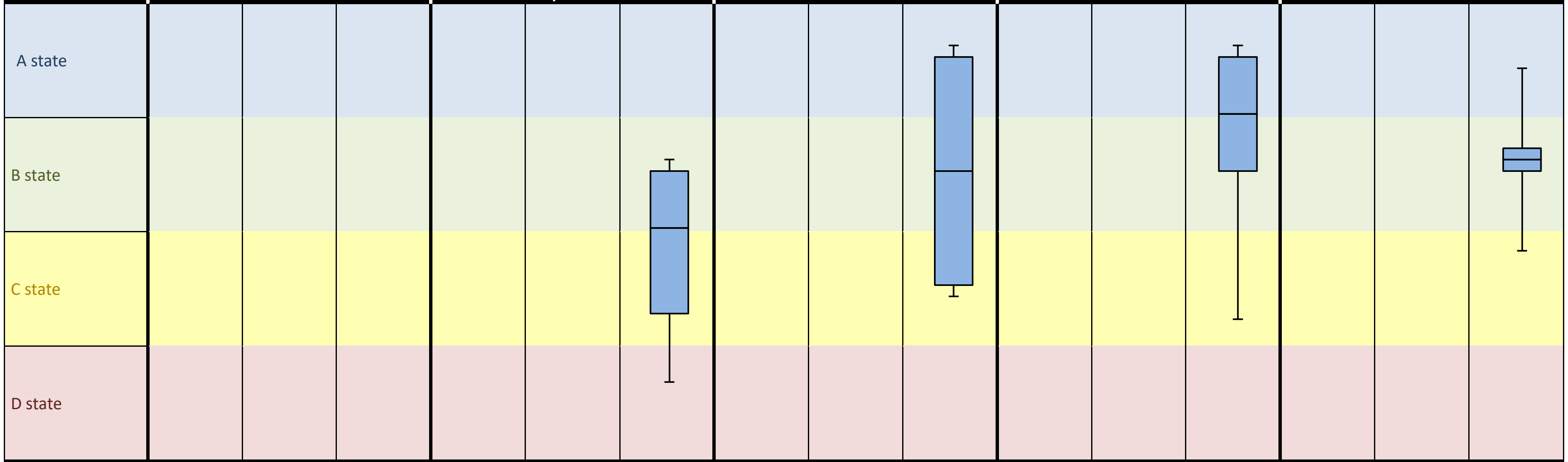
Table 30: Distribution of compliance with the Clapcott et al. (2011) Quorer method (SIS) guideline in the monitored rivers within each FMU, and a breakdown of the improvement required to meet the guideline.

FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		



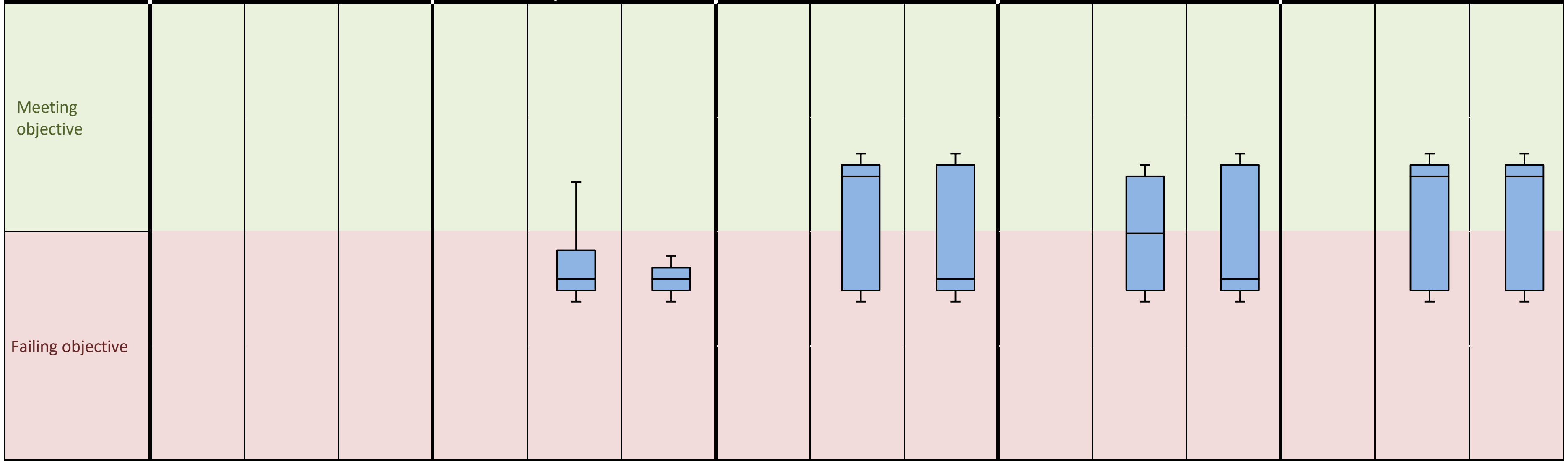
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites below guideline	-	-	-	-	9 53%	5 26%	-	6 26%	1 4%	-	7 30%	4 11%	-	9 64%	8 38%
Sites above guideline	-	-	-	-	8 47%	14 74%	-	17 74%	25 96%	-	16 70%	32 89%	-	5 36%	13 62%
Maintain	-	-	-	-	9 53%	5 26%	-	6 26%	1 4%	-	7 30%	4 11%	-	9 64%	8 38%
Improve	-	-	-	-	8 47%	14 74%	-	17 74%	25 96%	-	16 70%	32 89%	-	5 36%	13 62%

Table 31: Distribution of the periphyton biomass attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



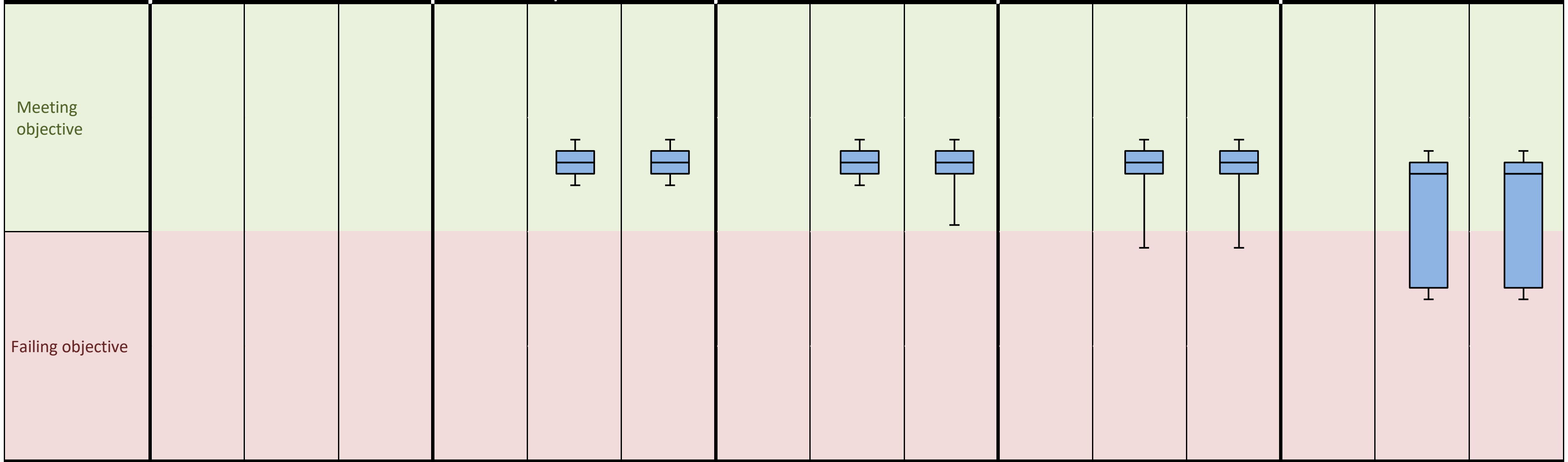
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	-	-	0 0%	-	-	5 45%	-	-	4 50%	-	-	1 14%
Sites in B state	-	-	-	-	-	2 50%	-	-	2 18%	-	-	3 38%	-	-	5 71%
Sites in C state	-	-	-	-	-	1 25%	-	-	4 36%	-	-	0 0%	-	-	1 14%
Sites in D state	-	-	-	-	-	1 25%	-	-	0 0%	-	-	1 13%	-	-	0 0%
Maintain	-	-	-	-	-	3 75%	-	-	11 100%	-	-	6 86%	-	-	6 86%
Improve 1 state	-	-	-	-	-	1 25%	-	-	0 0%	-	-	1 14%	-	-	0 0%
Improve 2 states	-	-	-	-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	1 14%
Improve 3 states	-	-	-	-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	0 0%

Table 32: Distribution of compliance with the FWO for long filamentous periphyton cover in the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



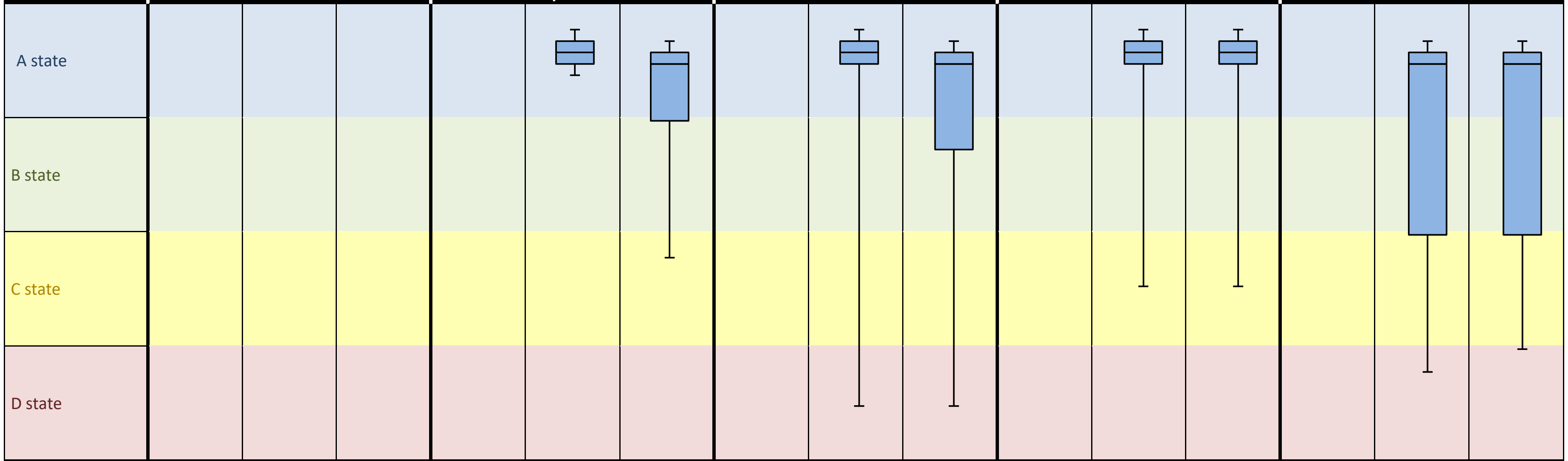
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites meeting objective	-	-	-	-	1 25%	0 0%	-	6 55%	4 33%	-	4 50%	3 38%	-	4 57%	6 55%
Sites failing objective	-	-	-	-	3 75%	4 100%	-	5 45%	8 67%	-	4 50%	5 63%	-	3 43%	5 45%
Maintain	-	-	-	-	1 25%	0 0%	-	6 55%	4 33%	-	4 50%	3 38%	-	4 57%	6 55%
Improve	-	-	-	-	3 75%	4 100%	-	5 45%	8 67%	-	4 50%	5 63%	-	3 43%	5 45%

Table 33: Distribution of compliance with the FWO for thick mat periphyton cover in the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



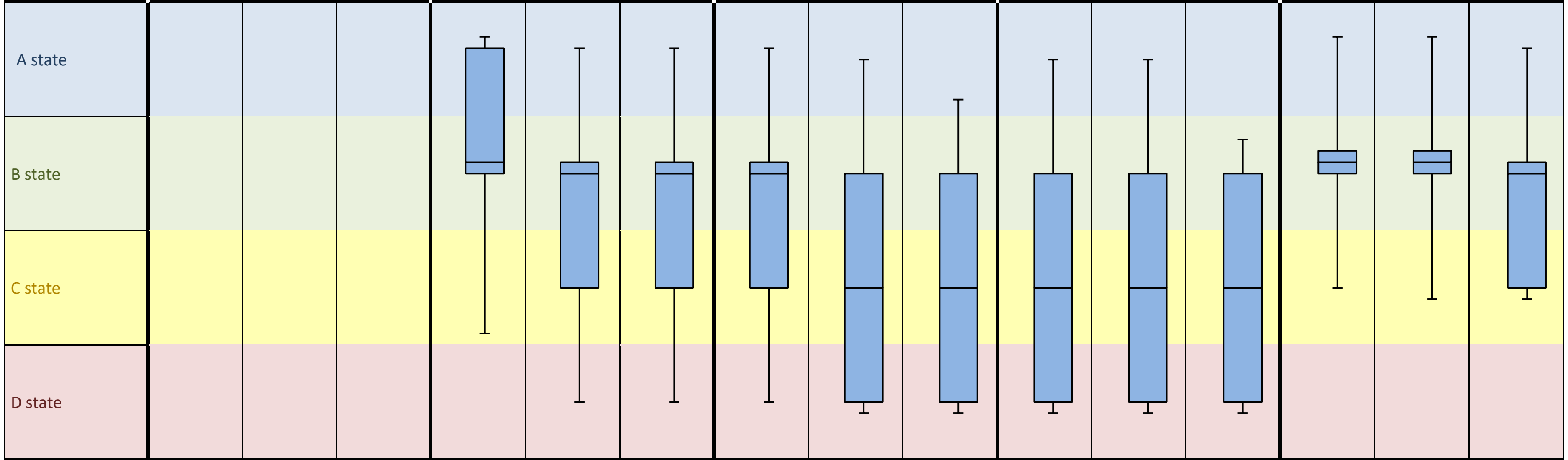
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites meeting objective	-	-	-	-	4 100%	4 100%	-	11 100%	11 92%	-	7 88%	7 88%	-	4 57%	7 64%
Sites failing objective	-	-	-	-	0 0%	0 0%	-	0 0%	1 8%	-	1 13%	1 13%	-	3 43%	4 36%
Maintain	-	-	-	-	4 100%	4 100%	-	11 100%	11 92%	-	7 88%	7 88%	-	4 57%	7 64%
Improve	-	-	-	-	0 0%	0 0%	-	0 0%	1 8%	-	1 13%	1 13%	-	3 43%	4 36%

Table 34: Distribution of the benthic cyanobacteria attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



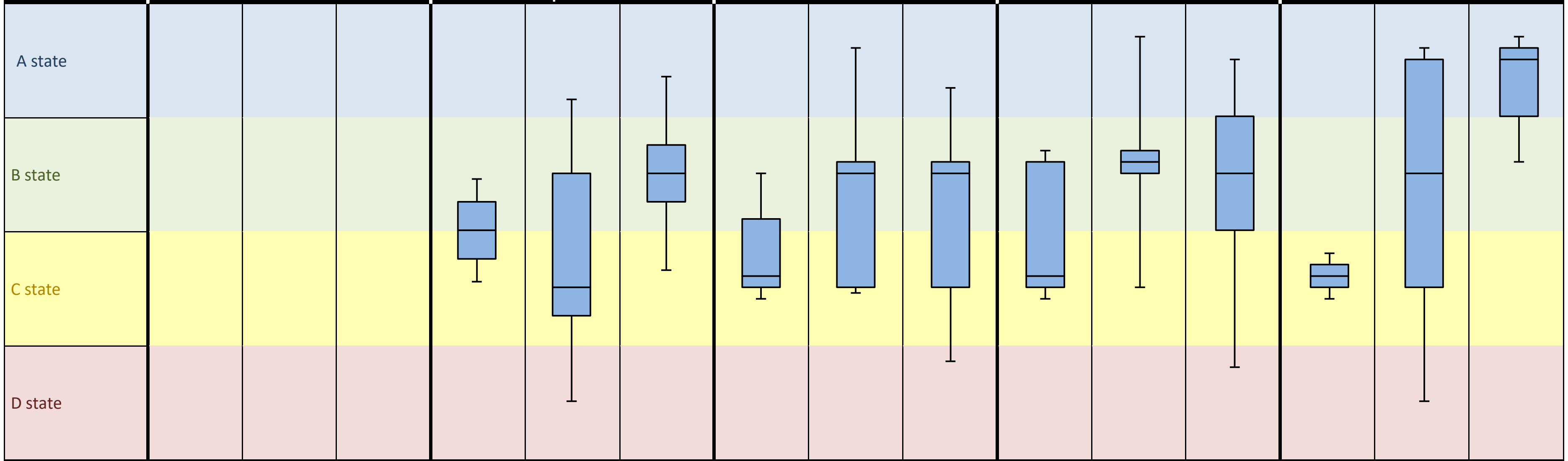
FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	-	4 100%	3 75%	-	9 82%	9 75%	-	7 88%	7 88%	-	4 57%	7 64%
Sites in B state	-	-	-	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	1 14%	1 9%
Sites in C state	-	-	-	-	0 0%	1 25%	-	0 0%	0 0%	-	0 0%	0 0%	-	1 14%	2 18%
Sites in D state	-	-	-	-	0 0%	0 0%	-	2 18%	3 25%	-	1 13%	1 13%	-	1 14%	1 9%
Maintain	-	-	-	-	4 100%	3 75%	-	9 82%	9 75%	-	6 86%	6 86%	-	4 57%	6 60%
Improve 1 state	-	-	-	-	0 0%	1 25%	-	0 0%	0 0%	-	0 0%	0 0%	-	2 29%	3 30%
Improve 2 states	-	-	-	-	0 0%	0 0%	-	1 9%	2 17%	-	1 14%	1 14%	-	1 14%	1 10%
Improve 3 states	-	-	-	-	0 0%	0 0%	-	1 9%	1 8%	-	0 0%	0 0%	-	0 0%	0 0%

Table 35: Distribution of the MCI attribute states of the monitored rivers within each FMU, and a breakdown of the improvement required to meet the FWO.



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	5 38%	5 24%	4 19%	5 20%	6 19%	2 7%	4 16%	4 12%	2 6%	2 12%	2 11%	4 19%
Sites in B state	-	-	-	6 46%	7 33%	8 38%	10 40%	9 29%	10 36%	6 24%	8 24%	10 29%	13 76%	14 74%	11 52%
Sites in C state	-	-	-	1 8%	5 24%	4 19%	5 20%	5 16%	6 21%	4 16%	9 27%	6 17%	2 12%	2 11%	6 29%
Sites in D state	-	-	-	1 8%	4 19%	5 24%	5 20%	11 35%	10 36%	11 44%	12 36%	17 49%	0 0%	1 5%	0 0%
Maintain	-	-	-	12 92%	17 81%	16 76%	19 76%	19 61%	16 57%	11 48%	18 58%	16 48%	13 100%	15 94%	17 100%
Improve 1 state	-	-	-	1 8%	4 19%	5 24%	6 24%	12 39%	12 43%	12 52%	13 42%	17 52%	0 0%	1 6%	0 0%
Improve 2 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Improve 3 states	-	-	-	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%

Table 36: Distribution of the IBI attribute states of the monitored rivers within each FMU.



FMU	Fiordland and the islands			Aparima			Mataura			Ōreti			Waiau		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	-	0 0%	1 13%	1 25%	0 0%	4 20%	1 13%	0 0%	2 13%	2 29%	0 0%	3 33%	2 67%
Sites in B state	-	-	-	1 50%	2 25%	2 50%	1 33%	10 50%	4 50%	2 40%	10 67%	3 43%	0 0%	3 33%	1 33%
Sites in C state	-	-	-	1 50%	3 38%	1 25%	2 67%	5 25%	2 25%	3 60%	3 20%	1 14%	1 100%	1 11%	0 0%
Sites in D state	-	-	-	0 0%	2 25%	0 0%	0 0%	1 5%	1 13%	0 0%	0 0%	1 14%	0 0%	2 22%	0 0%
Maintain	N/A														
Improve 1 state															
Improve 2 states															
Improve 3 states															

6.3 Class scale analysis

Results for all attributes and sites grouped into their parent river type classes are shown in Table 37 to Table 55. The distribution of results in each river class is shown by the box and whisker plots in the top part of each table. The number (and percentage) of sites meeting the draft FWOs in each class is shown in the middle rows of each table. The number (and percentage) of sites needing to improve by one, two or three bands to achieve the draft FWOs is shown in the bottom rows of each table.

Key messages from the river class scale analysis are as follows:

6.3.1 Natural State class

- For the 'Natural State' class most attributes are only sampled at a small number of sites (generally three or less). Almost all attributes at these sites were in A or B band state, with the exceptions of one site (Dunsdale Stream at Dunsdale Reserve) having a B band for DRP and *E. coli* and C band for clarity and native fish (IBI). A greater number of natural state sites are monitored for MCI and deposited fine sediment, with these results showing several sites in C band for MCI, and several failing the deposited fine sediment (Quorer SIS method) guideline, presumably all due to natural causes. It is interesting that the Natural State class scored lower than all the other classes for native fish (IBI) (Table 55). A possible explanation is that native fish (IBI) results can be lowered by natural factors such as distance from the sea and this is one of the reasons that no numeric FWO is currently proposed for native fish (IBI) in Southland.

6.3.2 Nutrients

- For the dissolved nutrient DIN there is a clear pattern of higher concentrations in Lowland Soft Bed and Lowland Hard Bed rivers (majority of sites in lower C and D band), with low concentrations in Natural State and Mountain rivers (A band) and Lake Fed rivers (upper B and A band), and with Hill rivers in between (mostly A-C band) (Table 39). However see third bullet below.

- For the dissolved nutrient DRP the pattern between classes is very similar to DIN as described above (Table 40).

- As described previously, both DIN and DRP are attributes in the group of "Additional proposed national compulsory attributes" and are currently recommended by Norton and Wilson (2019) for use as limits rather than as FWOs (see section 3.2). The ABCD band thresholds used for DIN and DRP in this report are from the proposed new draft NPSFM (September 2019) and were derived nationally. It is anticipated that regional-scale modelling work in Phase Three of the Regional Forum process will help more robustly estimate the percentage reductions in DIN and DRP needed in different catchments to meet river periphyton, lake phytoplankton and estuary macroalgae objectives. In the meantime the reductions in DIN to meet at least C band shown in this report can be considered indicative of what may be needed.

6.3.3 Toxicants, dissolved oxygen and temperature

- For nitrate and ammonia toxicity there is a clear pattern of higher concentrations in Lowland Soft Bed and Lowland Hard Bed rivers (B and C band) and lower concentrations in all other river classes (A band). However these two attributes are not a significant issue with almost 100% of sites in all river classes achieving the draft FWOs (Table 37 and Table 38). It is noted that the FWO for nitrate toxicity in particular is to some extent redundant because considerably lower concentrations are necessary in most cases to achieve the periphyton FWOs described further below.

- For dissolved oxygen (DO) there is a clear pattern of poorer state in the Lowland Soft Bed rivers (13% meet the draft FWO) and Lowland Hard Bed rivers (22% meet the draft FWO) compared to 63% and 100% of sites meeting draft FWOs in Hill and Mountain rivers respectively. The Lake Fed class shows a result for only one site and this fails to meet the draft FWO (Table 41).

- For temperature in summer (CRI) there is not a clear pattern of difference between the river classes. However the general deterioration (temperature increase) since 2010 observed earlier in the region scale and FMU scale analysis is also evident here (Table 42).

- For temperature in winter there is no difference between river classes and almost all sites fail to meet the draft FWO (a maximum of 11 °C for trout spawning), reinforcing the difficulty of achieving this objective as noted earlier (Table 43). As noted previously there are no obvious resource use causes (e.g., heated water discharges or large abstractions) contributing to warm water temperatures in winter in Southland.

6.3.4 *E. coli*

- For *E. coli* at monitored sites not designated as bathing sites there is again a clear pattern of higher concentrations and 100% failure to achieve FWOs in Lowland Soft bed sites (D-E band) and Lowland Hard Bed sites (D-E band), with low concentrations in Mountain river sites (A band) and with Hill and Lake Fed rivers in between with 81% and 67% of sites respectively failing FWOs (Table 45).

- As noted previously for *E. coli* at identified bathing sites (Table 14) all seven monitored popular bathing sites (i.e., 100% of sites) are in D band and would require substantial improvement by 3 bands to achieve the draft FWO of A band.

6.3.5 Sediment and clarity

- For water clarity (black disc) the same pattern is evident with poorer state in Lowland Soft Bed sites (29% meet FWOs) and Lowland Hard Bed sites (29% meet FWOs) compared to 88%, 100% and 100% of sites meeting FWOs in Hill, Mountain and Lake Fed rivers respectively (Table 44).

- For deposited fine sediment (% cover) there is no pattern of difference between classes and 100% of sites achieved A band when assessed against the new proposed draft NPSFM deposited fine sediment bands (released for public consultation September 2019) (Table 47). There is currently no draft FWO band set for deposited fine sediment but from these results it seems it may be reasonable to set the draft FWO at A band for all river types. Note that when deposited fine sediment (% cover) was assessed against the Clapcott et al., (2011) guideline almost all sites achieved the guideline (Table 48).

- For suspended sediment (measured as turbidity) the results were assessed against the new proposed draft NPSFM suspended sediment bands released for public consultation September 2019 (Table 46), and show a clear pattern of higher suspended sediment in Lowland Soft Bed and Lowland Hard Bed rivers (majority of sites in lower C and D band), with low concentrations in Natural State and Mountain rivers (A band) and Lake Fed rivers (mostly A band for 2016 and 2019), and with Hill rivers in between (69% A band, 13% C band and 19% D band in 2019). The results also suggest some improvement between 2010 and 2019 across all classes. There is currently no draft FWO band set for suspended sediment.

- For suspendible sediment (Quorer SIS method), which is not nationally compulsory or proposed but is included in this report as an additional attribute for interest because data are available (see section 3.2), the majority of sites failed the assessed guideline (Clapcott et al., 2011), including the Natural State river sites, and with no distinct pattern between classes (Table 49).

6.3.6 Periphyton, macroinvertebrates and native fish

- For periphyton biomass (chlorophyll *a*) the pattern is again clear with poorer state (greater biomass) evident in Lowland Hard Bed sites (78% meet FWOs) and Lowland Soft Bed sites compared to 100% of sites meeting FWOs in Hill and Mountain rivers. The one Lake Fed site is in C band and fails to meet the FWO (Table 50).

- For benthic cyanobacteria cover the pattern is different. In this case the problem occurs mostly in the Lowland Hard Bed class (67% meet FWOs), the Hill class (60% meet FWOs) and the one site in the Mountain class fails to meet the FWO (Table 53).

- For filamentous periphyton cover there is not a distinct pattern, with the majority of sites failing the FWOs in Lowland Soft Bed, Lowland Hard Bed and Mountain classes, and the majority of sites in Hill and Lake Fed classes achieving the FWOs (Table 51).

- For mat periphyton cover (diatoms and cyanobacteria) there is not a distinct pattern of difference between classes, with the significant majority (80-100%) of sites in all classes achieving the FWOs (Table 52).

- For macroinvertebrates (MCI) there is again a clear pattern of difference between classes with lower MCI scores in Lowland Soft Bed (C-D band), Lowland Hard Bed (C-D band) and Spring Fed (C-D band) classes, and higher MCI scores in Hill (A-B band) and Mountain classes (A-B band), with Lake Fed classes in between (B-C band). Despite this pattern the level of compliance with the draft FWOs was not so distinct between classes due to the different MCI score objectives applying to each class. The level of compliance with draft FWOs was 62%, 47%, 92%, 50%, 100% and 33% of sites for Lowland Soft bed, Lowland Hard Bed, Hill, Mountain, Lake Fed and Spring Fed classes respectively (Table 54).

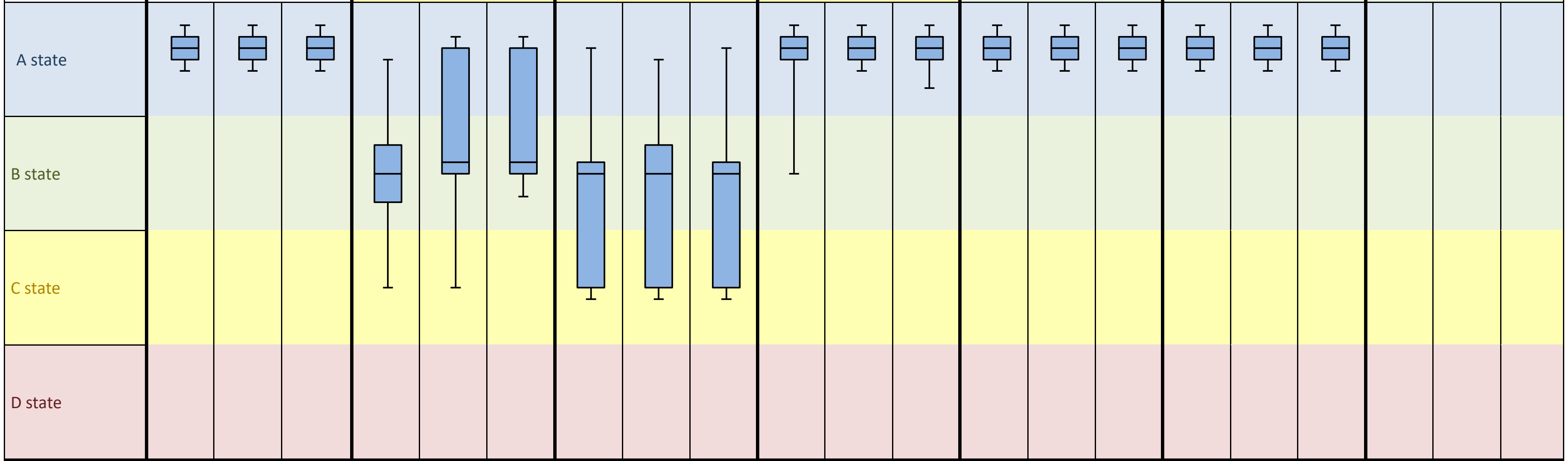
- For native fish (IBI) the highest IBI scores were in Mountain and Lake Fed classes (mostly A band) with somewhat lower scores in Hill rivers (mostly A-B band), mostly B-C band in lowland Soft Bed, Lowland Hard Bed and Spring Fed rivers, and including relatively low scores in the few Natural State river sites monitored (100% of sites in C band in 2010 and 2019; and 50% of sites in D band in 2016) (Table 55). As already noted above the low IBI scores in Natural State river sites are interesting and a possible explanation is that native fish (IBI) results can be lowered by natural factors such as distance from the sea. This is one of the reasons that no numeric FWO is currently proposed for native fish (IBI) in Southland. However IBI is one of the additional proposed national compulsory attributes in the new proposed draft NPSFM released for public consultation in September 2019 and so its inclusion will need to be reviewed when any new NPSFM is finalised.

6.3.7 Summary messages

- The river class scale analysis shows there are generally distinct patterns of difference between classes and this justifies the use of the different river classes for setting freshwater objectives. The results also show a clear pattern of different problems and priorities for attention in different river classes, most notably that nutrients, sediment and *E. coli* are key contaminant issues in Lowland Soft Bed and Lowland Hard Bed rivers, and to a lesser but still important extent in Hill and Lake Fed rivers. The Natural State and Mountain rivers are generally in very good condition.

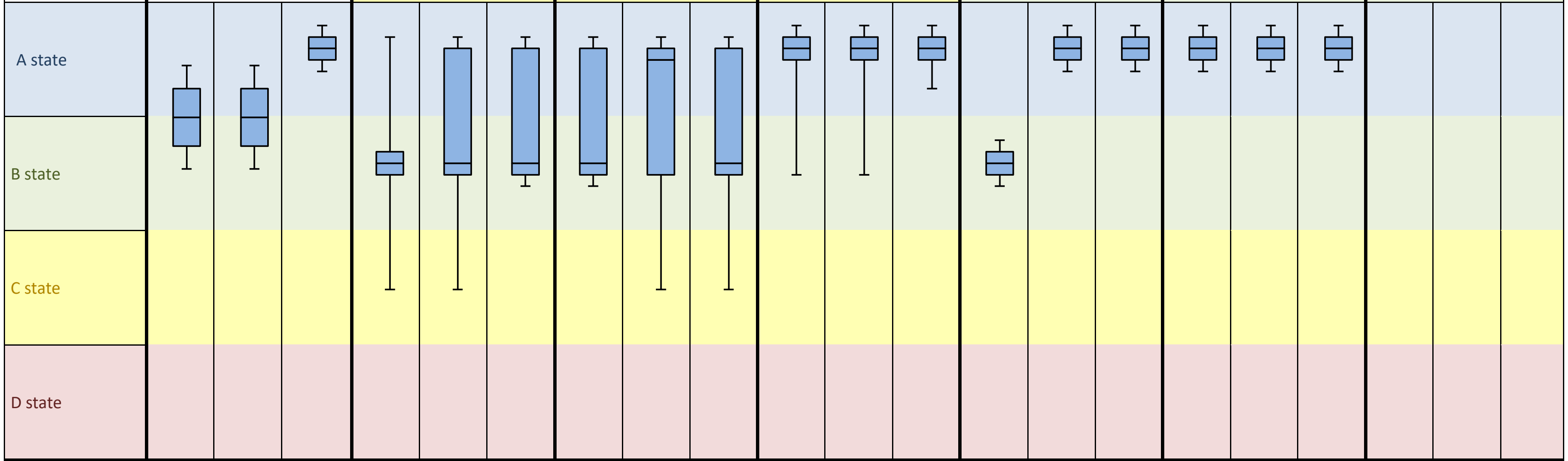
Table 37: Distribution of the NNN toxicity attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			C			C			C			B			B			B		



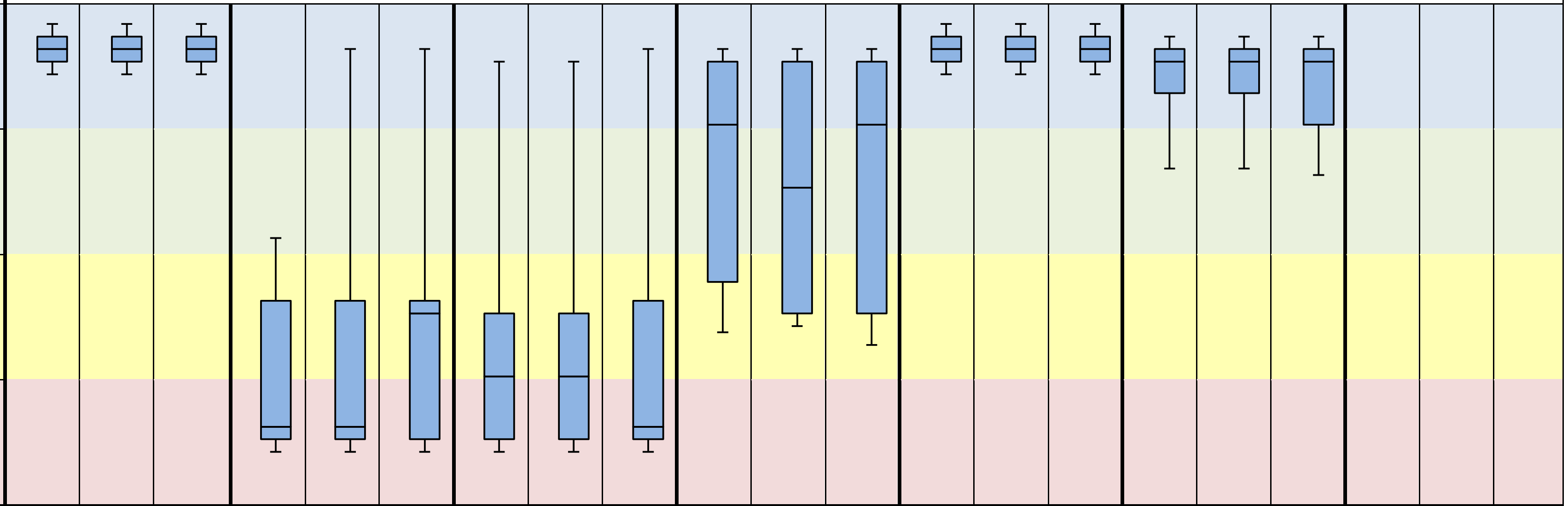
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 100%	2 100%	2 100%	4 25%	7 39%	6 35%	6 21%	8 25%	5 24%	13 81%	18 95%	15 94%	1 100%	1 100%	1 100%	4 100%	4 100%	3 100%	-	-	-
Sites in B state	0 0%	0 0%	0 0%	8 50%	9 50%	10 59%	12 43%	13 41%	9 43%	3 19%	1 5%	1 6%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in C state	0 0%	0 0%	0 0%	4 25%	2 11%	1 6%	9 32%	11 34%	7 33%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in D state	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	1 4%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Maintain	N/A			16 100%	18 100%	17 100%	27 96%	32 100%	21 100%	16 100%	19 100%	16 100%	1 100%	1 100%	1 100%	4 100%	4 100%	3 100%	-	-	-
Improve 1 state				0 0%	0 0%	0 0%	1 4%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Improve 2 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Improve 3 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-

Table 38: Distribution of the NH_4-N toxicity attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.



Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			C			C			C			B			B			B		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	1 50%	1 50%	2 100%	3 19%	7 39%	7 41%	10 36%	17 53%	6 29%	14 88%	16 84%	15 94%	0 0%	1 100%	1 100%	4 100%	4 100%	3 100%	-	-	-
Sites in B state	1 50%	1 50%	0 0%	10 63%	9 50%	10 59%	18 64%	12 38%	11 52%	2 13%	3 16%	1 6%	1 100%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in C state	0 0%	0 0%	0 0%	3 19%	2 11%	0 0%	0 0%	3 9%	4 19%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in D state	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Maintain	N/A			16 100%	18 100%	17 100%	28 100%	32 100%	21 100%	16 100%	19 100%	16 100%	1 100%	1 100%	1 100%	4 100%	4 100%	3 100%	-	-	-
Improve 1 state				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Improve 2 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Improve 3 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-

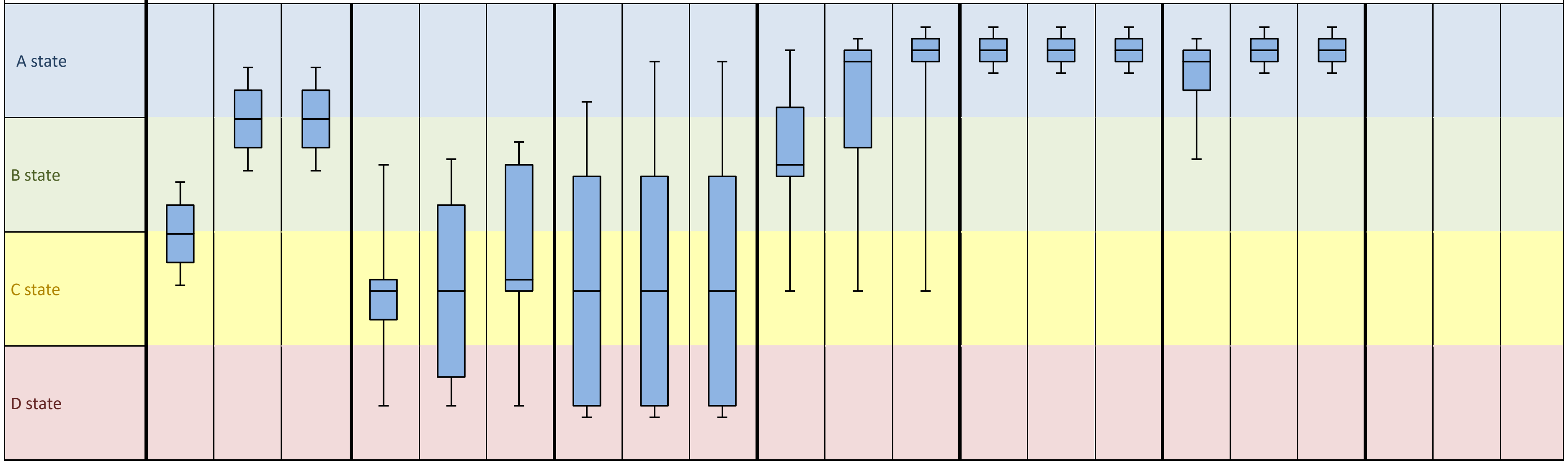
Table 39: Distribution of the DIN attribute states of the monitored rivers within each river class.



Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	N/A																				
A state																					
B state																					
C state																					
D state																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 100%	2 100%	2 100%	1 6%	2 11%	2 12%	6 20%	4 13%	2 10%	9 50%	9 47%	8 50%	1 100%	1 100%	1 100%	3 75%	3 75%	2 67%	-	-	-
Sites in B state	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	4 22%	3 16%	2 13%	0 0%	0 0%	0 0%	1 25%	1 25%	1 33%	-	-	-
Sites in C state	0 0%	0 0%	0 0%	6 38%	6 33%	8 47%	9 30%	12 38%	7 33%	4 22%	6 32%	5 31%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in D state	0 0%	0 0%	0 0%	9 56%	10 56%	7 41%	15 50%	16 50%	12 57%	1 6%	1 5%	1 6%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Maintain	N/A																				
Improve 1 state																					
Improve 2 states																					
Improve 3 states																					

Table 40: Distribution of the DRP attribute states of the monitored rivers within each river class.

Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	N/A																				



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	0 0%	1 50%	1 50%	0 0%	1 6%	1 6%	2 7%	5 16%	3 14%	4 27%	13 72%	13 81%	1 100%	1 100%	1 100%	3 75%	2 100%	1 100%	-	-	-
Sites in B state	1 50%	1 50%	1 50%	2 13%	4 22%	5 29%	6 21%	6 19%	5 24%	9 60%	3 17%	1 6%	0 0%	0 0%	0 0%	1 25%	0 0%	0 0%	-	-	-
Sites in C state	1 50%	0 0%	0 0%	10 63%	8 44%	8 47%	7 25%	8 25%	3 14%	2 13%	2 11%	2 13%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in D state	0 0%	0 0%	0 0%	4 25%	5 28%	3 18%	13 46%	13 41%	10 48%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Maintain	N/A																				
Improve 1 state																					
Improve 2 states																					
Improve 3 states																					

Table 41: Distribution of the DO attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			A			A			A			A			A			A		
A state																					
B state																					
C state																					
D state																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	1 100%	-	-	1 13%	-	-	2 22%	-	-	5 63%	-	-	1 100%	-	-	0 0%	-	-	-
Sites in B state	-	-	0 0%	-	-	3 38%	-	-	1 11%	-	-	2 25%	-	-	0 0%	-	-	0 0%	-	-	-
Sites in C state	-	-	0 0%	-	-	3 38%	-	-	4 44%	-	-	1 13%	-	-	0 0%	-	-	1 100%	-	-	-
Sites in D state	-	-	0 0%	-	-	1 13%	-	-	2 22%	-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	-
Maintain	N/A			-	-	1 13%	-	-	2 22%	-	-	5 63%	-	-	1 100%	-	-	0 0%	-	-	-
Improve 1 state				-	-	3 38%	-	-	1 11%	-	-	2 25%	-	-	0 0%	-	-	0 0%	-	-	-
Improve 2 states				-	-	3 38%	-	-	4 44%	-	-	1 13%	-	-	0 0%	-	-	1 100%	-	-	-
Improve 3 states				-	-	1 13%	-	-	2 22%	-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	-

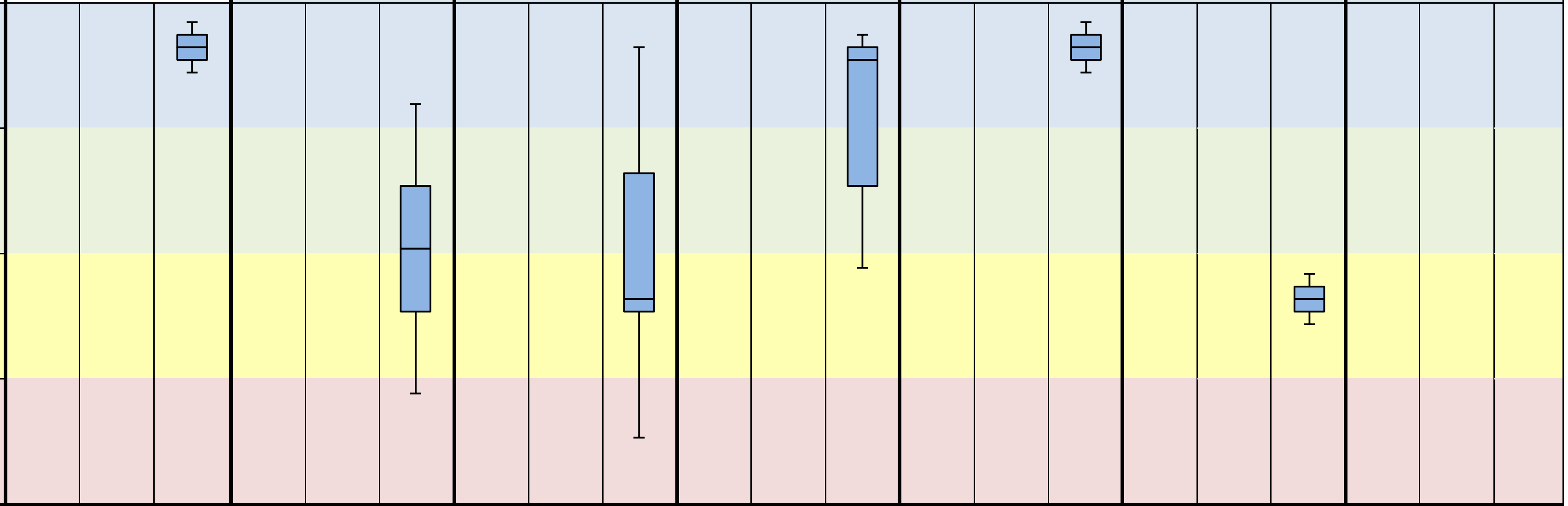
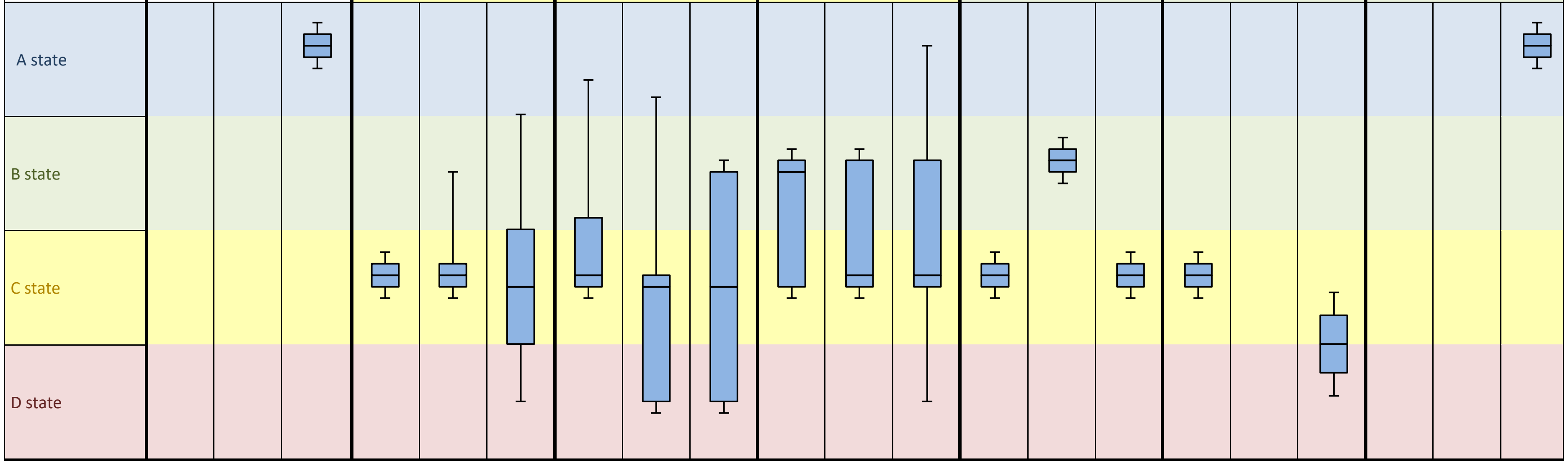


Table 42: Distribution of the temperature CRI attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.



Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			C			C			C			B			B			B		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	1 100%	0 0%	0 0%	1 9%	1 14%	1 10%	0 0%	0 0%	0 0%	2 18%	0 0%	0 0%	0 0%	0 0%	-	0 0%	-	-	1 100%
Sites in B state	-	-	0 0%	0 0%	1 20%	2 18%	1 14%	1 10%	6 40%	3 60%	2 40%	3 27%	0 0%	1 100%	0 0%	0 0%	-	0 0%	-	-	0 0%
Sites in C state	-	-	0 0%	2 100%	4 80%	5 45%	5 71%	4 40%	3 20%	2 40%	3 60%	4 36%	1 100%	0 0%	1 100%	1 100%	-	1 50%	-	-	0 0%
Sites in D state	-	-	0 0%	0 0%	0 0%	3 27%	0 0%	4 40%	6 40%	0 0%	0 0%	2 18%	0 0%	0 0%	0 0%	0 0%	-	1 50%	-	-	0 0%
Maintain	N/A			2 100%	5 100%	8 73%	7 100%	6 60%	9 60%	5 100%	5 100%	9 82%	0 0%	1 100%	0 0%	0 0%	-	0 0%	-	-	1 100%
Improve 1 state				0 0%	0 0%	3 27%	0 0%	4 40%	6 40%	0 0%	0 0%	2 18%	1 100%	0 0%	1 100%	1 100%	-	1 50%	-	-	0 0%
Improve 2 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	1 50%	-	-	0 0%
Improve 3 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	0 0%	-	-	0 0%

Table 43: Distribution of the max. winter temperature attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

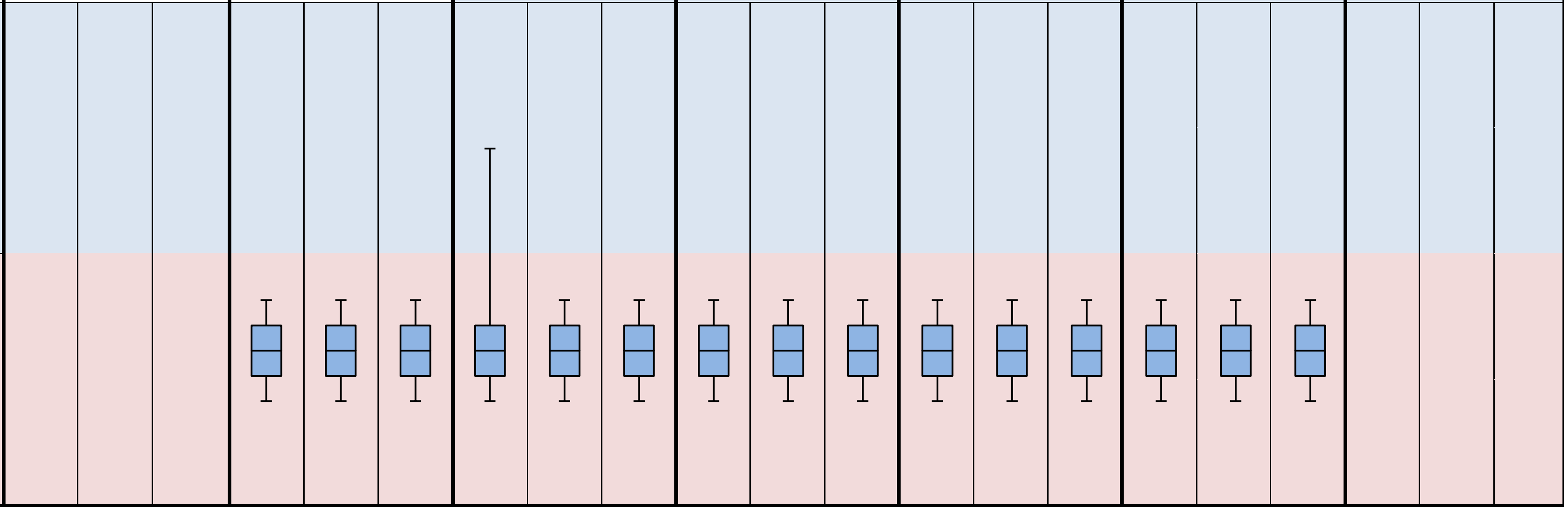
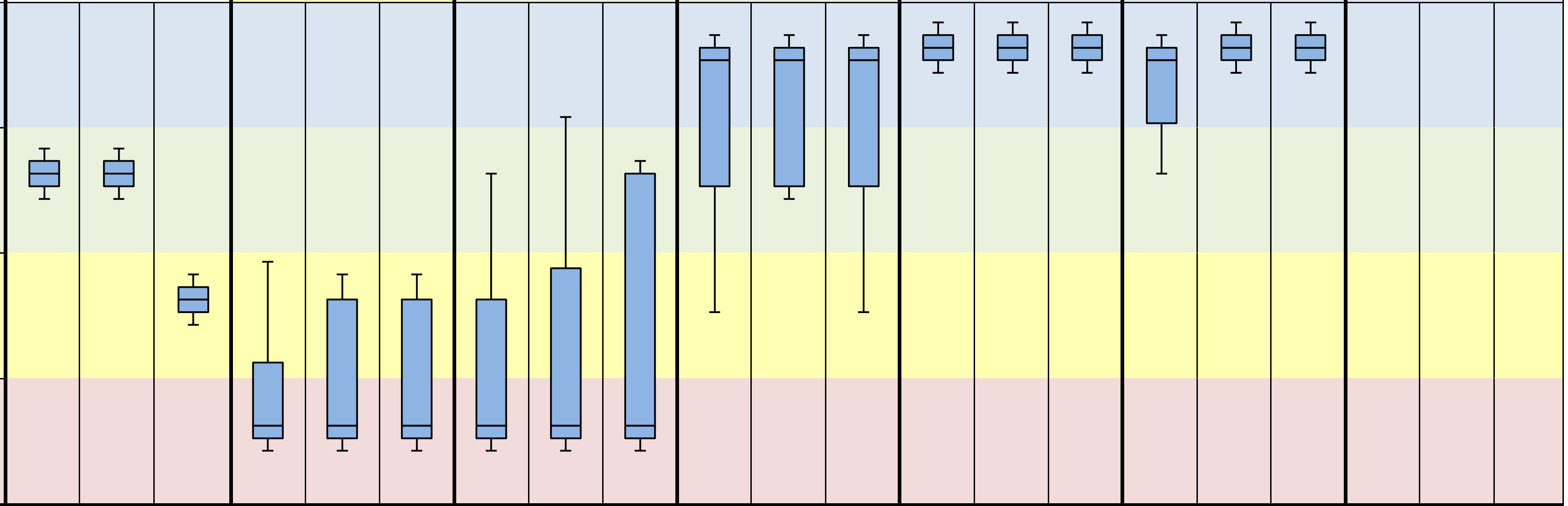
Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			N/A			A			A			A			A			A		
Pass (meeting objective) / Fail (failing objective)																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in Pass state	-	-	-	0 0%	0 0%	0 0%	1 14%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in Fail state	-	-	-	2 100%	2 100%	5 100%	6 86%	9 100%	9 100%	5 100%	5 100%	5 100%	1 100%	1 100%	1 100%	1 100%	1 100%	1 100%	-	-	-
Maintain	N/A						1 14%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Improve							6 86%	9 100%	9 100%	5 100%	5 100%	5 100%	1 100%	1 100%	1 100%	1 100%	1 100%	1 100%	-	-	-

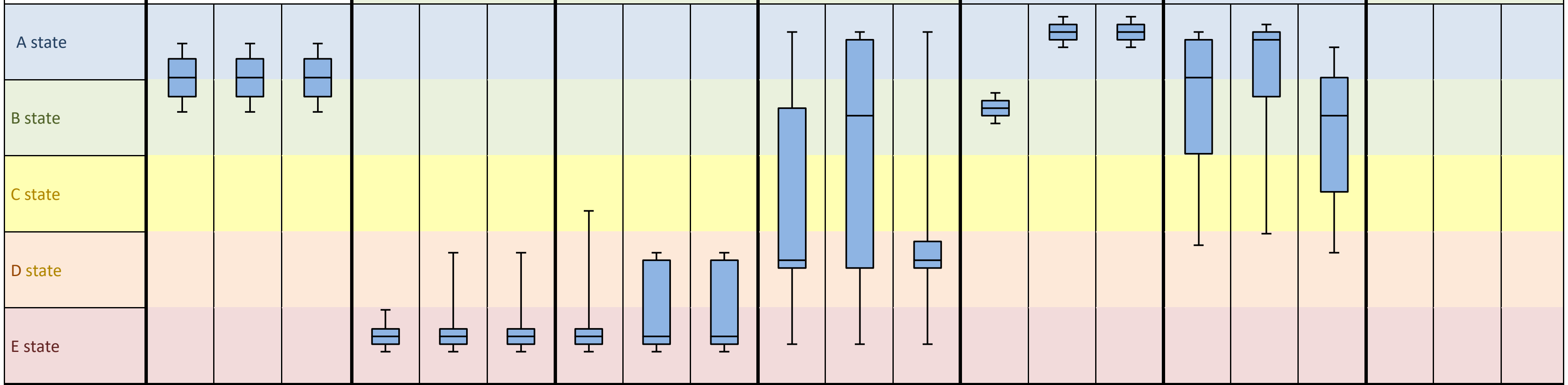
Table 44: Distribution of the visual clarity attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.



Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			C			B			B			A			A			A		
A state																					
B state																					
C state																					
D state																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	1 3%	2 6%	1 5%	11 65%	13 68%	10 63%	1 100%	1 100%	1 100%	2 67%	3 100%	2 100%	-	-	-
Sites in B state	1 100%	1 100%	0 0%	1 6%	1 6%	1 6%	2 7%	6 19%	5 24%	4 24%	5 26%	4 25%	0 0%	0 0%	0 0%	1 33%	0 0%	0 0%	-	-	-
Sites in C state	0 0%	0 0%	1 100%	3 19%	5 28%	4 24%	7 23%	7 22%	4 19%	2 12%	1 5%	2 13%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in D state	0 0%	0 0%	0 0%	12 75%	12 67%	12 71%	20 67%	17 53%	11 52%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Maintain	N/A			4 25%	6 33%	5 29%	3 10%	8 25%	6 29%	15 88%	18 95%	14 88%	1 100%	1 100%	1 100%	2 67%	3 100%	2 100%	-	-	-
Improve 1 state				12 75%	12 67%	12 71%	7 23%	7 22%	4 19%	2 12%	1 5%	2 13%	0 0%	0 0%	0 0%	1 33%	0 0%	0 0%	-	-	-
Improve 2 states				0 0%	0 0%	0 0%	20 67%	17 53%	11 52%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Improve 3 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-

Table 45: Distribution of the *E. coli* attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			B			B			B			A			A			B		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	1 50%	1 50%	1 50%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	3 18%	7 37%	3 19%	0 0%	1 100%	1 100%	2 50%	3 75%	1 33%	-	-	-
Sites in B state	1 50%	1 50%	1 50%	0 0%	0 0%	0 0%	1 3%	0 0%	0 0%	4 24%	5 26%	0 0%	1 100%	0 0%	0 0%	1 25%	0 0%	1 33%	-	-	-
Sites in C state	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	1 3%	1 3%	0 0%	1 6%	1 5%	1 6%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in D state	0 0%	0 0%	0 0%	1 6%	2 11%	3 18%	3 10%	8 25%	6 29%	7 41%	4 21%	10 63%	0 0%	0 0%	0 0%	1 25%	1 25%	1 33%	-	-	-
Sites in E state	0 0%	0 0%	0 0%	15 94%	16 89%	14 82%	25 83%	23 72%	15 71%	2 12%	2 11%	2 13%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Maintain				0 0%	0 0%	0 0%	1 3%	0 0%	0 0%	7 41%	12 63%	3 19%	0 0%	1 100%	1 100%	2 50%	3 75%	1 33%	-	-	-
Improve 1 state				0 0%	0 0%	0 0%	1 3%	1 3%	0 0%	1 6%	1 5%	1 6%	1 100%	0 0%	0 0%	1 25%	0 0%	1 33%	-	-	-
Improve 2 states	N/A			1 6%	2 11%	3 18%	3 10%	8 25%	6 29%	7 41%	4 21%	10 63%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Improve 3 states				15 94%	16 89%	14 82%	25 83%	23 72%	15 71%	2 12%	2 11%	2 13%	0 0%	0 0%	0 0%	1 25%	1 25%	1 33%	-	-	-
Improve 4 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-

Table 46: Distribution of compliance with the proposed draft NPSFM (September 2019) suspended sediment (turbidity) bands in the monitored rivers within each river class.

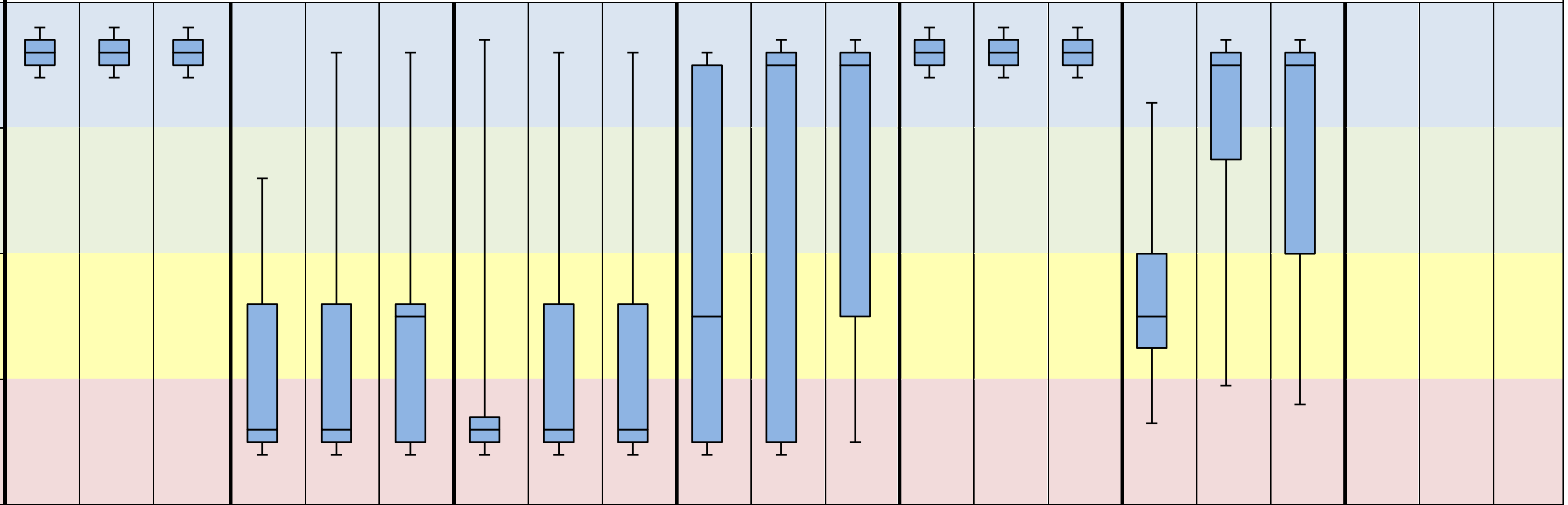
Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	N/A																				
A state																					
B state																					
C state																					
D state																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 100%	2 100%	2 100%	0 0%	2 11%	2 12%	3 10%	5 16%	4 19%	7 41%	11 58%	11 69%	1 100%	1 100%	1 100%	1 25%	3 75%	2 67%	-	-	-
Sites in B state	0 0%	0 0%	0 0%	3 19%	1 6%	2 12%	1 3%	2 6%	0 0%	1 6%	2 11%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	-	-	-
Sites in C state	0 0%	0 0%	0 0%	4 25%	5 28%	6 35%	1 3%	2 6%	5 24%	2 12%	0 0%	2 13%	0 0%	0 0%	0 0%	2 50%	0 0%	0 0%	-	-	-
Sites in D state	0 0%	0 0%	0 0%	9 56%	10 56%	7 41%	25 83%	23 72%	12 57%	7 41%	6 32%	3 19%	0 0%	0 0%	0 0%	1 25%	1 25%	1 33%	-	-	-
Maintain	N/A																				
Improve 1 state																					
Improve 2 states																					
Improve 3 states																					

Table 47: Distribution of compliance with the proposed draft NPSFM (September 2019) deposited fine sediment cover bands in the monitored rivers within each river class.

Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Guideline	N/A																				
A state																					
B state																					
C state																					
D state																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	1 100%	2 100%	-	9 100%	9 100%	-	9 100%	9 100%	-	9 100%	10 100%	-	1 100%	1 100%	-	1 100%	4 100%	-	-	-
Sites in B state	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	-	-
Sites in C state	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	-	-
Sites in D state	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	-	-
Maintain	N/A																				
Improve 1 state																					
Improve 2 states																					
Improve 3 states																					

Table 48: Distribution of compliance with the Clapcott et al. (2011) fine sediment cover guideline in the monitored rivers within each river class, and a breakdown of the improvement required to meet the guideline.

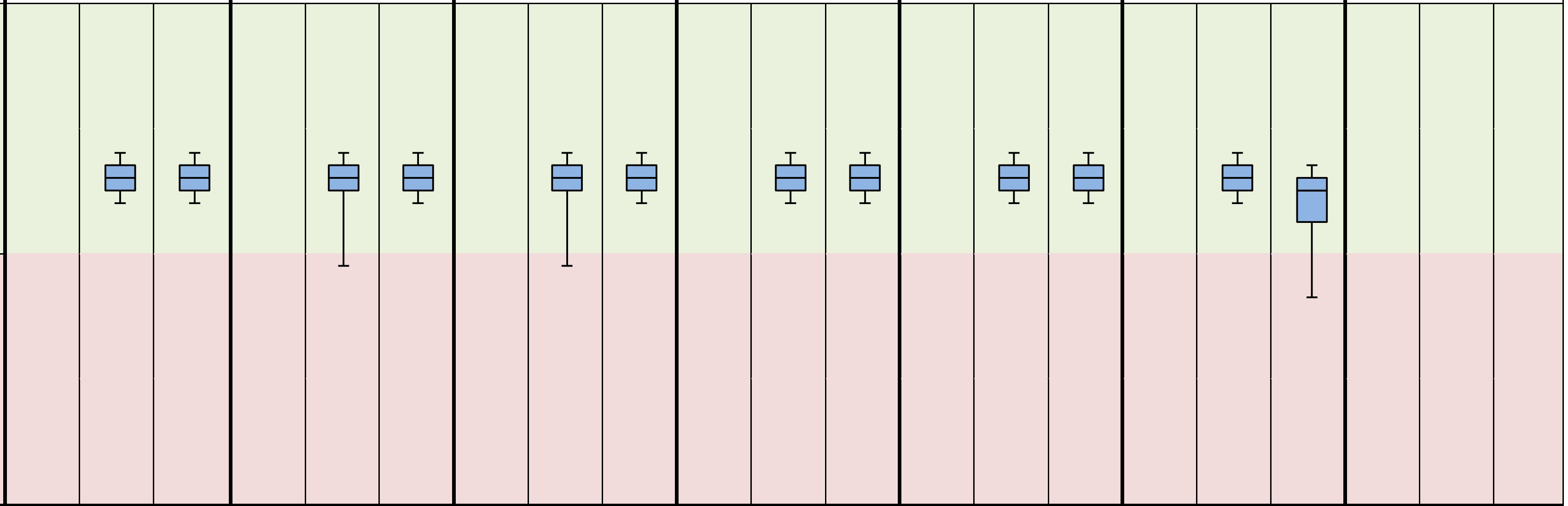
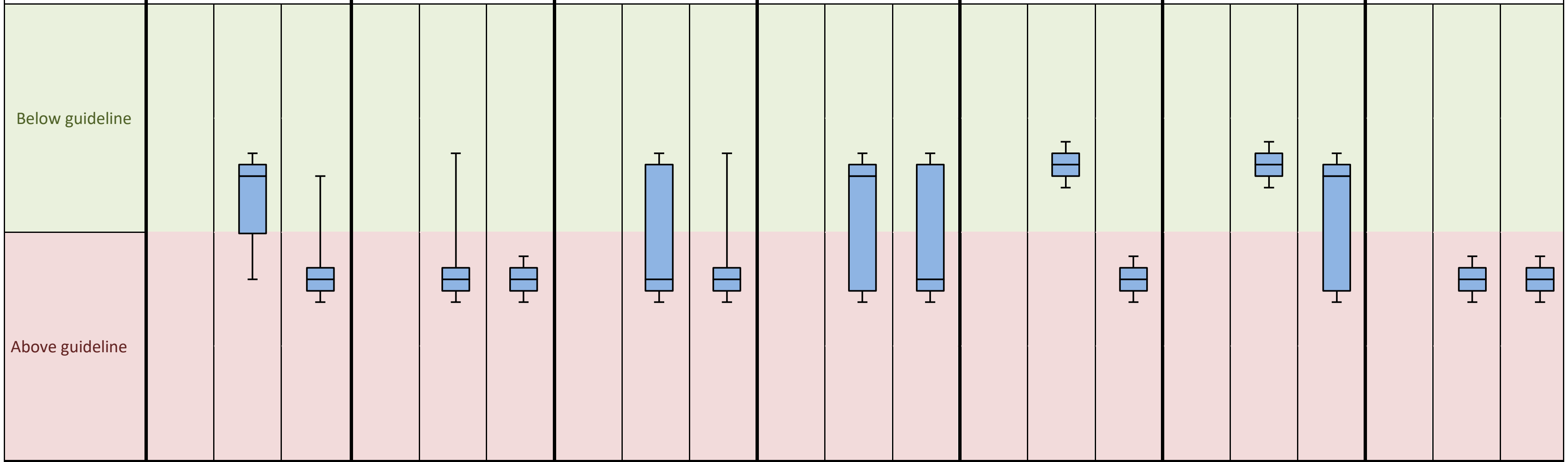
Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Guideline	No change			20% cover			20% cover			20% cover			20% cover			20% cover			20% cover		
Below guideline Above guideline																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites below guideline	-	1 100%	2 100%	-	8 89%	9 100%	-	8 89%	9 100%	-	9 100%	10 100%	-	1 100%	1 100%	-	1 100%	3 75%	-	-	-
Sites above guideline	-	0 0%	0 0%	-	1 11%	0 0%	-	1 11%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	1 25%	-	-	-
Maintain	N/A			-	8 89%	9 100%	-	8 89%	9 100%	-	9 100%	10 100%	-	1 100%	1 100%	-	1 100%	3 75%	-	-	-
Improve				-	1 11%	0 0%	-	1 11%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	1 25%	-	-	-

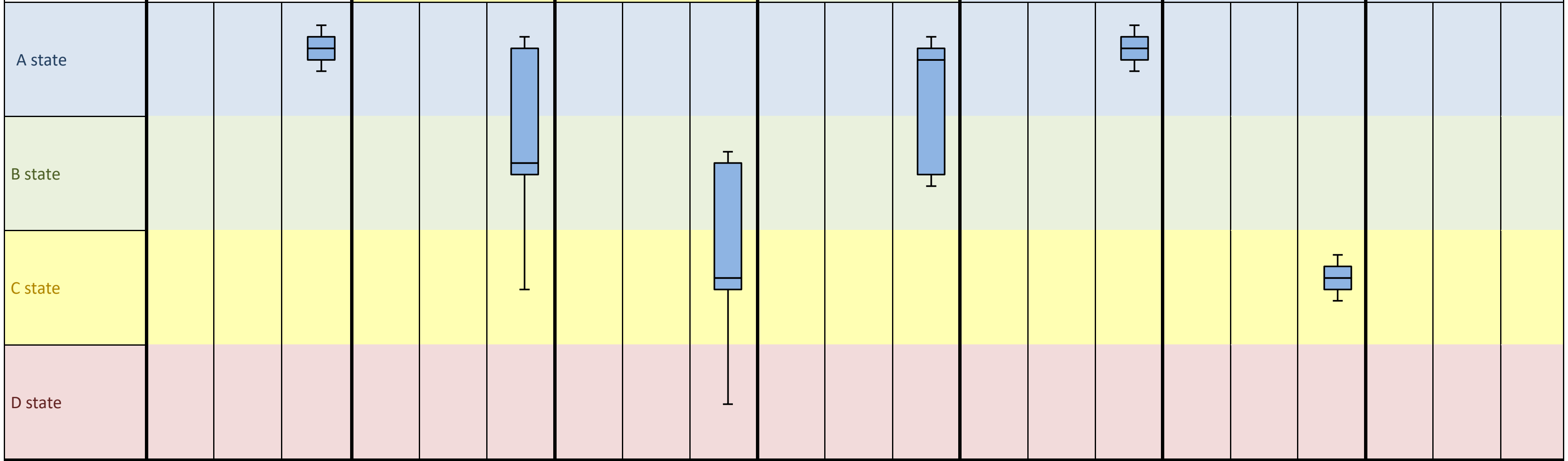
Table 49: Distribution of compliance with the Clapcott et al. (2011) Quorer method (SIS) guideline in the monitored rivers within each river class, and a breakdown of the improvement required to meet the guideline.



Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Guideline	No change			450 g/m^2			450 g/m^2			450 g/m^2			450 g/m^2			450 g/m^2			450 g/m^2		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites below guideline	-	2 67%	1 20%	-	2 10%	0 0%	-	10 40%	5 16%	-	12 52%	8 32%	-	1 100%	0 0%	-	4 100%	4 57%	-	0 0%	0 0%
Sites above guideline	-	1 33%	4 80%	-	18 90%	28 100%	-	15 60%	27 84%	-	11 48%	17 68%	-	0 0%	2 100%	-	0 0%	3 43%	-	1 100%	3 100%
Maintain	N/A			-	2 10%	0 0%	-	10 40%	5 16%	-	12 52%	8 32%	-	1 100%	0 0%	-	4 100%	4 57%	-	0 0%	0 0%
Improve				-	18 90%	28 100%	-	15 60%	27 84%	-	11 48%	17 68%	-	0 0%	2 100%	-	0 0%	3 43%	-	1 100%	3 100%

Table 50: Distribution of the periphyton biomass attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

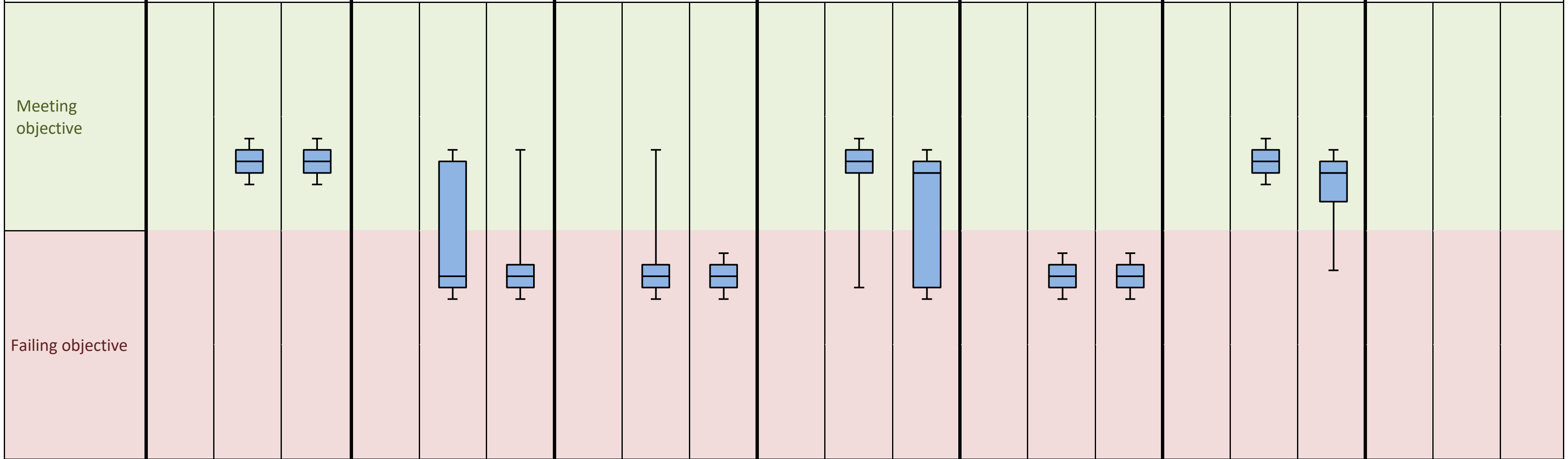
Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			C			C			B			A			A			A		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	-	1 100%	-	-	3 33%	-	-	0 0%	-	-	5 56%	-	-	1 100%	-	-	0 0%	-	-	-
Sites in B state	-	-	0 0%	-	-	4 44%	-	-	4 44%	-	-	4 44%	-	-	0 0%	-	-	0 0%	-	-	-
Sites in C state	-	-	0 0%	-	-	2 22%	-	-	3 33%	-	-	0 0%	-	-	0 0%	-	-	1 100%	-	-	-
Sites in D state	-	-	0 0%	-	-	0 0%	-	-	2 22%	-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	-
Maintain	N/A			-	-	9 100%	-	-	7 78%	-	-	9 100%	-	-	1 100%	-	-	0 0%	-		-
Improve 1 state				-	-	0 0%	-	-	2 22%	-	-	0 0%	-	-	0 0%	-	-	0 0%	-		-
Improve 2 states				-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	1 100%	-		-
Improve 3 states				-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	0 0%	-	-	0 0%	-		-

Table 51: Distribution of compliance with the FWO for long filamentous periphyton cover in the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

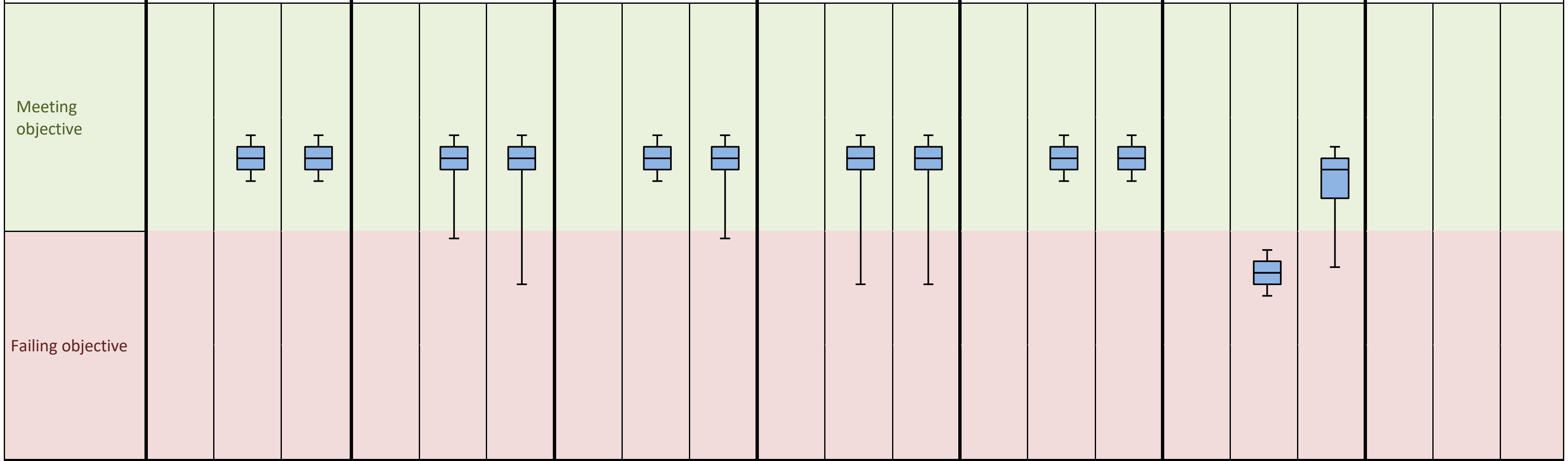
Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective	No change			N/A			30% cover			30% cover			30% cover			N/A			N/A		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites meeting objective	-	1 100%	2 100%	-	4 44%	2 22%	-	2 22%	0 0%	-	7 78%	6 60%	-	0 0%	0 0%	-	1 100%	3 75%	-	-	-
Sites failing objective	-	0 0%	0 0%	-	5 56%	7 78%	-	7 78%	9 100%	-	2 22%	4 40%	-	1 100%	1 100%	-	0 0%	1 25%	-	-	-
Maintain	N/A			-	4 44%	2 22%	-	2 22%	0 0%	-	7 78%	6 60%	-	0 0%	0 0%	-	1 100%	3 75%	-	-	-
Improve				-	5 56%	7 78%	-	7 78%	9 100%	-	2 22%	4 40%	-	1 100%	1 100%	-	0 0%	1 25%	-	-	-

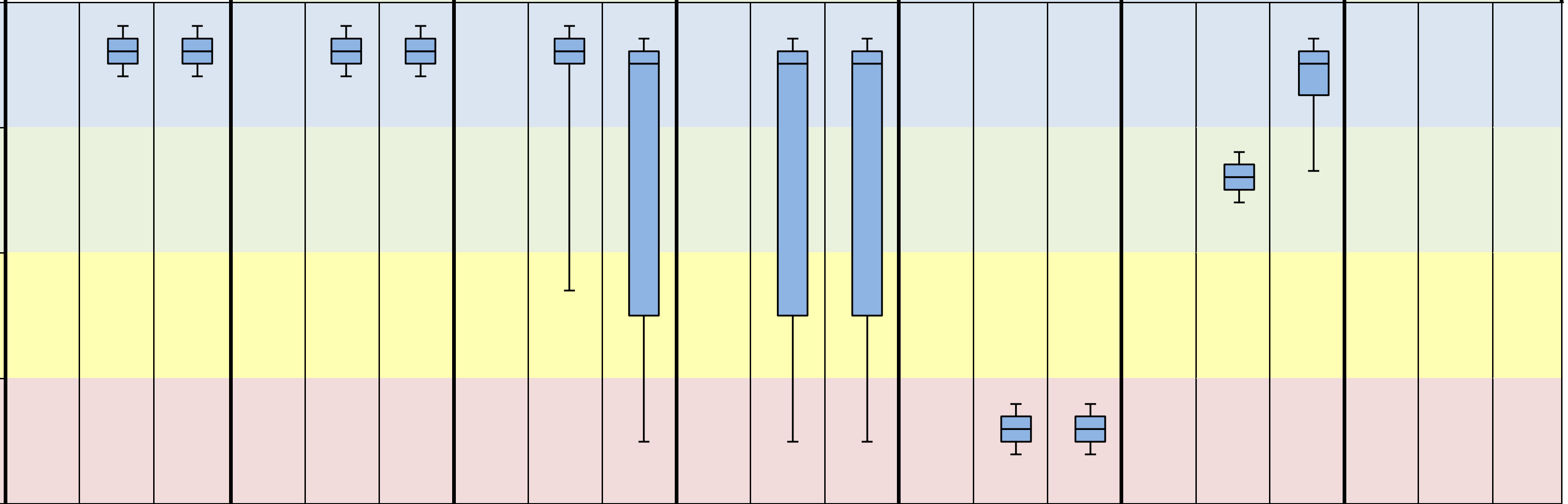
Table 52: Distribution of compliance with the FWO for thick mat periphyton cover in the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective	No change			N/A			60% cover			60% cover			60% cover			N/A			N/A		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites meeting objective	-	1 100%	2 100%	-	8 89%	7 78%	-	9 100%	8 89%	-	7 78%	8 80%	-	1 100%	1 100%	-	0 0%	3 75%	-	-	-
Sites failing objective	-	0 0%	0 0%	-	1 11%	2 22%	-	0 0%	1 11%	-	2 22%	2 20%	-	0 0%	0 0%	-	1 100%	1 25%	-	-	-
Maintain	N/A			-	8 89%	7 78%	-	9 100%	8 89%	-	7 78%	8 80%	-	1 100%	1 100%	-	0 0%	3 75%	-	-	-
Improve				-	1 11%	2 22%	-	0 0%	1 11%	-	2 22%	2 20%	-	0 0%	0 0%	-	1 100%	1 25%	-	-	-

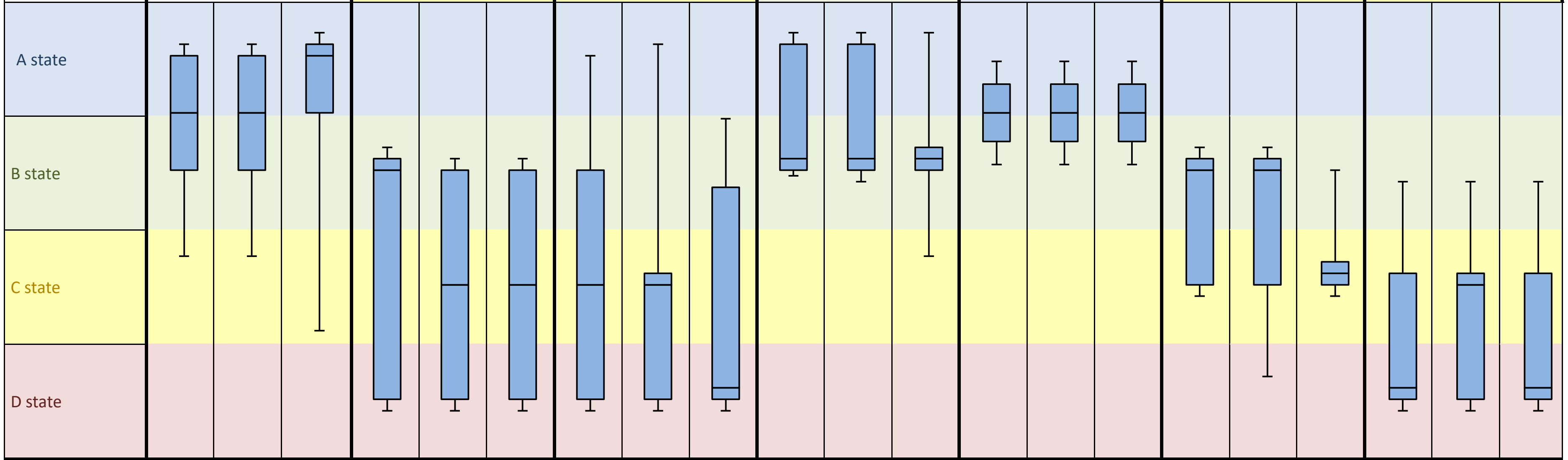
Table 53: Distribution of the benthic cyanobacteria attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.



Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			B			B			B			A			A			B		
A state																					
B state																					
C state																					
D state																					
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	-	1 100%	2 100%	-	9 100%	9 100%	-	8 89%	6 67%	-	6 67%	6 60%	-	0 0%	0 0%	-	0 0%	3 75%	-	-	-
Sites in B state	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	1 100%	1 25%	-	-	-
Sites in C state	-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	1 11%	-	1 11%	2 20%	-	0 0%	0 0%	-	0 0%	0 0%	-	-	-
Sites in D state	-	0 0%	0 0%	-	0 0%	0 0%	-	1 11%	2 22%	-	2 22%	2 20%	-	1 100%	1 100%	-	0 0%	0 0%	-	-	-
Maintain	N/A			-	9 100%	9 100%	-	8 89%	6 67%	-	6 67%	6 60%	-	0 0%	0 0%	-	0 0%	3 75%	-	-	-
Improve 1 state				-	0 0%	0 0%	-	0 0%	1 11%	-	1 11%	2 20%	-	0 0%	0 0%	-	1 100%	1 25%	-	-	-
Improve 2 states				-	0 0%	0 0%	-	1 11%	2 22%	-	2 22%	2 20%	-	0 0%	0 0%	-	0 0%	0 0%	-	-	-
Improve 3 states				-	0 0%	0 0%	-	0 0%	0 0%	-	0 0%	0 0%	-	1 100%	1 100%	-	0 0%	0 0%	-	-	-

Table 54: Distribution of the MCI attribute states of the monitored rivers within each river class, and a breakdown of the improvement required to meet the FWO.

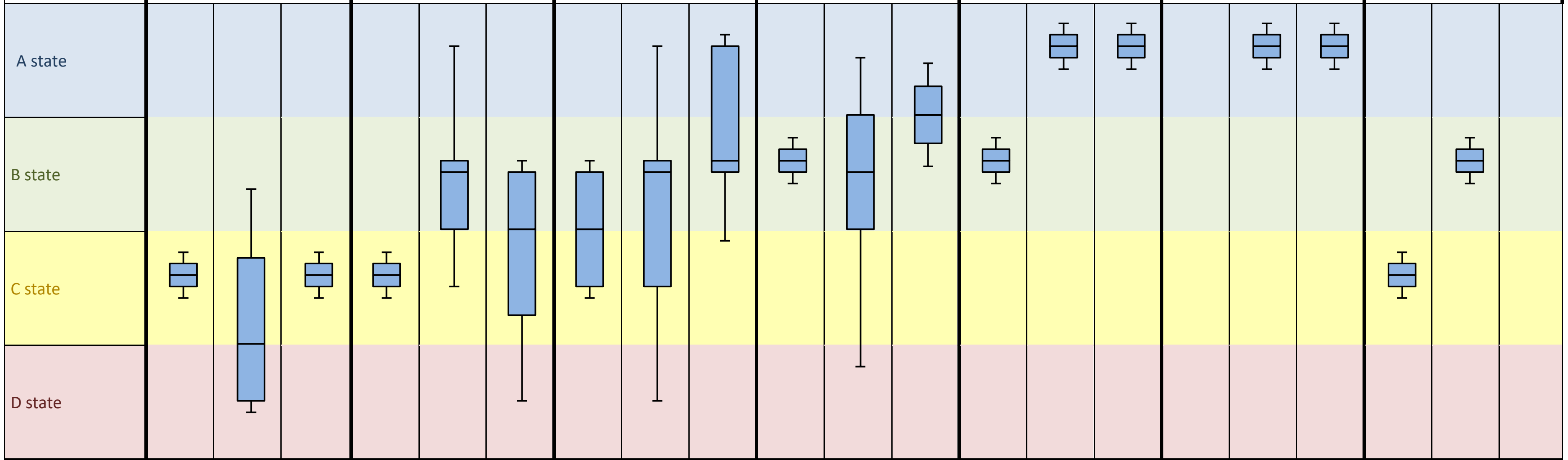
Class	Natural State Rivers			Lowland Soft Bed			Lowland Hard Bed			Hill			Mountain			Lake Fed			Spring Fed		
Objective state	No change			C			C			B			A			C			C		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	3 50%	3 50%	5 71%	0 0%	1 4%	0 0%	4 19%	3 9%	2 6%	8 40%	9 31%	4 15%	1 50%	1 50%	1 50%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Sites in B state	2 33%	2 33%	1 14%	12 57%	9 35%	9 31%	5 24%	4 13%	7 21%	11 55%	19 66%	20 77%	1 50%	1 50%	1 50%	3 60%	3 60%	1 20%	1 20%	1 20%	1 33%
Sites in C state	1 17%	1 17%	0 0%	2 10%	5 19%	9 31%	5 24%	11 34%	7 21%	1 5%	1 3%	2 8%	0 0%	0 0%	0 0%	2 40%	1 20%	4 80%	1 20%	2 40%	0 0%
Sites in D state	0 0%	0 0%	1 14%	7 33%	11 42%	11 38%	7 33%	14 44%	18 53%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	1 20%	0 0%	3 60%	2 40%	2 67%
Maintain	N/A			14 67%	15 58%	18 62%	14 67%	18 56%	16 47%	19 95%	28 97%	24 92%	1 50%	1 50%	1 50%	5 100%	4 80%	5 100%	2 40%	3 60%	1 33%
Improve 1 state				7 33%	11 42%	11 38%	7 33%	14 44%	18 53%	1 5%	1 3%	2 8%	1 50%	1 50%	1 50%	0 0%	1 20%	0 0%	3 60%	2 40%	2 67%
Improve 2 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Improve 3 states				0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%

Table 55: Distribution of the IBI attribute states of the monitored rivers within each river class.

Class	Natural State Rivers	Lowland Soft Bed	Lowland Hard Bed	Hill	Mountain	Lake Fed	Spring Fed
Objective state	N/A	N/A	N/A	N/A	N/A	N/A	N/A



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	0 0%	0 0%	0 0%	0 0%	4 21%	0 0%	0 0%	2 10%	3 33%	0 0%	2 29%	1 50%	0 0%	1 100%	1 100%	-	1 100%	1 100%	0 0%	0 0%	-
Sites in B state	0 0%	1 25%	0 0%	0 0%	10 53%	4 50%	2 50%	11 55%	5 56%	1 100%	3 43%	1 50%	1 100%	0 0%	0 0%	-	0 0%	0 0%	0 0%	1 100%	-
Sites in C state	1 100%	1 25%	1 100%	3 100%	5 26%	2 25%	2 50%	5 25%	1 11%	0 0%	1 14%	0 0%	0 0%	0 0%	0 0%	-	0 0%	0 0%	1 100%	0 0%	-
Sites in D state	0 0%	2 50%	0 0%	0 0%	0 0%	2 25%	0 0%	2 10%	0 0%	0 0%	1 14%	0 0%	0 0%	0 0%	0 0%	-	0 0%	0 0%	0 0%	0 0%	-

Maintain	N/A
Improve 1 state	
Improve 2 states	
Improve 3 states	

7 Lakes results

7.1 Key messages for lakes

7.1.1 Regional scale patterns for lakes

- The two most obvious spatial patterns for lake condition at the regional scale are associated with different levels of land development (e.g., natural state versus land developed for human rural and urban uses) and differences between high country and lowland parts of the region. Both of these patterns are reflected in differences between FMUs and lake classes as discussed further below.

7.1.2 FMU scale patterns for lakes

- The only obvious pattern in lake condition identifiable at FMU level is the distinct difference between the Fiordland and Islands FMU (which is more or less entirely in natural state) and the other four FMUs (Waiau, Aparima, Ōreti and Mataura) that have all been substantially developed for human uses over the last 150 years, particularly in lowland and undulating hill areas but also parts of the high country.

- The distinction of high enviromental quality in the Fiordland and Islands FMU is largely an assumed situation because few lakes are monitored in that FMU. However the distinction is observable through the example of higher quality state in the Lowland Shallow Lakes Sheila and Calder (both on Stewart Island/Rakiura) compared to Lowland Shallow Lakes in the other FMUs (e.g., Table 56 and Table 57).

- The data available from relatively few monitored lakes do not allow identification of any other distinct differences in condition between the other four developed FMUs. There are certainly lakes in different conditions in these FMUs but the data available indicate this is due to the type of lake (shallow, deep, or brackish), and development pressures (upland and lowland) in particular catchments rather than any difference attributable between those four FMUs.

7.1.3 Class scale patterns for lakes

- There are clear patterns of different lake conditions between the lake classes and this is not surprising given the classes were deliberately defined to help differentiate relevant lake types. The differences between lake classes vary by attribute and are therefore described under the attribute topic headings below.

- The very small number of lakes monitored in each class (and noting not even a single lake is monitored in the Upland Shallow Lake class) means the differences between classes cannot be rigorously tested statistically. Nonetheless, in general the monitoring data differences observed in this report, combined with the justification based on physical lake characteristics (Norton and Wilson 2019), supports the use of the proposed lake classes for the resource management planning process going forward at this time.

7.1.4 Phytoplankton and trophic state (TLI)

- For phytoplankton (chlorophyll *a*) there is a clear pattern of lower concentrations in the Deep (and Natural State) lakes (A to A+ band) compared to higher (worse) concentrations in the Lowland Shallow lakes and Brackish Lakes and Lagoons (Table 56 and Table 65).

- For the Lowland Shallow lakes for the 2019 baseline period, 2 sites met the draft FWO (B band), 2 sites were in C band and 2 sites failed national bottom lines (D band) (Table 65). Both Lake George (Uruwera) and The Reservoir failed the FWO, being graded C band and D band respectively for the 2019 baseline period (Table 56). For the three years presented the Lowland Shallow lakes meeting the draft FWO (B band) were Lakes Vincent, Sheila and Calder (the latter two being Natural State class lakes on Stewart Island/Rakiura as well as being Lowland Shallow lakes).

- For the monitored Brackish Lakes and Lagoons for the 2019 baseline period, 6 sites met the draft FWO (B band) or better and 5 sites failed by being in C band (Table 65). The Brackish Lakes and Lagoons meeting the draft FWO (B band) included Lake Brunton (A band) while Waituna Lagoon failed the draft FWO by being graded C band in both closed and open states for some sites in the 2019 baseline period (Table 56). It is important to consider the objectives for intermittently open and closed Brackish Lakes and Lagoons like Waituna in the closed state because this is when they are most vulnerable. It is noted that Waituna Lagoon has had some numeric attribute targets recommended as part of separate technical advice and discussions and it may be appropriate, on that basis, to set different FWOs for Waituna separately and uniquely from the other lakes in the Brackish Lakes and Lagoons class (e.g. through the Whakamana te Waituna Trust process).

- For the TLI score there was a very similar pattern as for phytoplankton described above, with A to A+ bands observed for Deep Lakes, C band for Lowland Shallow Lakes and a mix of B and C band for Brackish lakes and Lagoons. No draft FWO was suggested for TLI score by Norton and Wilson (2019), but they proposed that draft bands be set once current state analysis had been undertaken. The results in this report can now be used to suggest a minimum draft FWO for TLI score and this is done later in this report in section 9.

- While some sites meet draft FWOs for phytoplankton and TLI, improvement will be needed to meet FWOs at all lake sites in future. A part of this improvement is likely to require reductions in nutrients and potentially also other mitigation actions (discussed further below).

7.1.5 Nutrients

- For total nitrogen (TN) and total phosphorus (TP) there is a clear and very similar pattern to that described above for phytoplankton and TLI. The results show generally low nutrients in the Deep (and Natural State) lakes (A to A+ band) compared to higher nutrients in the Lowland Shallow and Brackish Lakes and Lagoons with the latter two classes showing approximately 90% of sites in the C band for TP and approximately 90% of sites between C-D grades for TN (Table 67 and Table 68).

- The situation is particularly poor for TN in Waituna Lagoon during times when it is in a closed state (D band). Similarly for the 2016 baseline period Lake Vincent was in D band although this improved to C band in Lake Vincent for the 2019 baseline period (Table 57).

- Improvement will be needed to both TN and TP in order to meet all draft FWOs in future.

7.1.6 Toxicants and dissolved oxygen

- While the concentrations of nitrate and ammonia are observably higher in Lowland Shallow lakes and Brackish Lakes and Lagoons compared to very low concentrations in Deep (and Natural State) lakes, they are not high enough to cause significant toxicity issues and currently meet the draft FWOs in all cases (Table 69 and Table 70). The FWO for nitrate toxicity in particular is to some extent redundant because the concentrations needed to achieve the TN, phytoplankton and TLI objectives described above are considerably lower, as was also the case described for rivers in section 6.3.3.

- Dissolved oxygen (lake bottom) has only been measured in a few Lowland Shallow lakes and Brackish Lakes and Lagoons (Table 59) and has been in A or B band in all cases to date. Dissolved oxygen is not currently thought to be an issue in other lake types in Southland and there is currently no draft FWO proposed for dissolved oxygen.

7.1.7 *E. coli* and cyanobacteria (planktonic)

- *E. coli* has generally met FWOs (A band) in Deep (and Natural State) lakes but has failed in some Lowland Shallow lakes (D band in Lake George (Uruwera)) and Brackish Lakes and Lagoons (D band in Waiau (Te Waewae) Lagoon; B band in Waituna Lagoon when in a closed state) (Table 60 and Table 76).

- Cyanobacteria (planktonic) has been A band in all cases except for Waituna Lagoon which was graded C band when sampled in a closed state during a year when a large bloom occurred (Table 60). No draft FWO was set for cyanobacteria by Norton and Wilson (2019), but they proposed that draft bands be set once current state analysis had been undertaken. The results in this report can now be used to suggest a minimum draft FWO for cyanobacteria (planktonic) and this is done later in this report in section 9.

7.1.8 Macrophytes

- Macrophytes (% cover) state is highly variable across different lake types, with A band recorded in some Lowland Shallow Lakes (Lake Vincent) and C band in others (e.g., Lake George (Uruwera)) and even in Lowland Shallow (Natural State) lakes has recorded C band (Lake Calder) and B band (Lake Sheila) (Table 63). D band was recorded in Lake Brunton.

- LakeSPI score is also variable across different lake types, with A to C bands recorded and no sites in D band (Table 61 and Table 72).

- No draft FWO bands were set for either macrophytes (% cover) or LakeSPI score by Norton and Wilson (2019), but they proposed that draft bands be set once current state analysis had been undertaken. The results in this report can now be used to suggest a minimum draft FWO for macrophytes and LakeSPI score and this is done later in section 9.

7.1.9 Fish

- Some fish data is available for both native and introduced pest fish in some lakes (Table 64) and could be used to help develop a narrative FWO for fish in lakes. No draft numeric FWO for fish is proposed for lakes.

7.1.10 Summary messages

- Nutrients, particularly total nitrogen (TN) but also total phosphorus (TP), are the key contaminants contributing to many of the failures to meet draft FWOs for lakes listed above, particularly in Lowland Shallow Lakes and Brackish Lakes and Lagoons. Notably, nutrients contribute to failures to meet phytoplankton (chlorophyll *a*) draft FWOs, probably lower band grades for TLI and possibly also for macrophyte cover and occasionally observed cyanobacteria (planktonic) blooms. Other known factors such as lake flow regimes and levels, the quality of marginal wetlands, invasive macrophytes, pest fish species and possibly also climate effects, may all also contribute in some places and times to lower band grades for lake ecosystem health attributes, notwithstanding that these non-contaminant related factors have not been quantitatively assessed in this report.

- Faecal microorganism contamination (e.g., *E. coli*) is a key contaminant affecting the value of human health for recreation and caused failure of draft FWOs for this attribute in some Lowland Shallow lakes and Brackish Lakes and Lagoons. While Deep and Upland Shallow lakes are generally better and likely to meet FWOs in most places there are probably small scale localised issues in some places.

- Lake water quality is generally very good in Southland's Deep and Natural State lakes. Managing any potential for increases to nutrients, sediment and/or faecal microorganism contamination (e.g., *E. coli*) will be a key part of maintaining that high state.

7.2 Individual lake results

Table 56: Phytoplankton (chlorophyll a) and TLI state for monitored lakes, and a breakdown of the percentage improvement required to meet the FWO.

Class	FMU	Site	Phytoplankton										TLI3						
				State			%↓ needed (median)			%↓ needed (maximum)				State			%↓ needed (mean)		
			Obj	10	16	19	10	16	19	10	16	19	Obj	10	16	19	10	16	19
Upland Shallow Lake	NA	NA	A	NA			NA			NA				NA			NA		
Lowland Shallow Lake	Aparima	Lake George	B	ND	B	D	ND	0	0	ND	0	72	NA	ND	C	C	NA		
Lowland Shallow Lake	Mataura	Lake Vincent	B		B	B		0	0		0	0			C	C			
Lowland Shallow Lake	Mataura	The Reservoir	B		D	C		69	44		19	0			C	C			
Brackish Lake or Lagoon	Waiau	Waiau (Te Waewae) Lagoon	B		ND	C		ND	0		ND	4			ND	C			
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - CLOSED	B	D	C	C	0	0	0	79	11	32		C	C	C			
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - OPEN	B	ND	C	C	ND	0	0	ND	0	7		ND	B	B			
Deep Lake (Natural State)	Waiau	Lake Te Anau	A	A	ND	A+	0	ND	0	0	ND	0		A+	ND	A+			
Deep Lake (Natural State)	Waiau	Lake Manapouri	A	A	ND	A+	0	ND	0	0	ND	0		A+	ND	A+			
Lowland Shallow Lake	Fiordland and Islands	Lake Sheila[1]	B	A	ND		0	ND		0	ND			A	NA		NA		
Lowland Shallow Lake	Fiordland and Islands	Lake Calder[1]	B	A			0			0				A					
Brackish Lake or Lagoon	Mataura	Lake Brunton[1]	B	A			0			0				B					

Table footnotes: 1 = Data from Schallenberg and Kelly (2012) Ecological condition of six shallow Southland lakes. This is an indicative state based on the data in the report, the minimum statistical requirement has not been met.

Table 57: Total Phosphorus (TP) and Total Nitrogen (TN) state for monitored lakes.

			Total Phosphorus							Total Nitrogen						
				State			%↓ needed (median)				State			%↓ needed (median)		
Class	FMU	Site	Obj	10	16	19	10	16	19	Obj	10	16	19	10	16	19
Upland Shallow Lake	NA	NA			NA							NA				
Lowland Shallow Lake	Aparima	Lake George			C	C						C	C			
Lowland Shallow Lake	Mataura	Lake Vincent			C	C						D	C			
Lowland Shallow Lake	Mataura	The Reservoir			C	C						C	C			
Brackish Lake or Lagoon	Waiau	Waiau (Te Waewae) Lagoon	NA		ND	C		NA		NA		ND	C		NA	
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - CLOSED		C	C	C					D	D	D			
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - OPEN		ND	C	C					ND	C	C			
Deep Lake (Natural State)	Waiau	Lake Te Anau		A+	ND	A+					A+	ND	A			
Deep Lake (Natural State)	Waiau	Lake Manapouri		A+	ND	A+					A+	ND	A			
Lowland Shallow Lake	Fiordland and Islands	Lake Sheila[1]		A							A					
Lowland Shallow Lake	Fiordland and Islands	Lake Calder[1]		A	ND			NA			A	ND			NA	
Brackish Lake or Lagoon	Mataura	Lake Brunton[1]		C							C					

Table footnotes: 1 = Data from Schallenberg and Kelly (2012) Ecological condition of six shallow Southland lakes. This is an indicative state based on the data in the report, the minimum statistical requirement has not been met.

Table 58: Nitrate toxicity and ammonia toxicity state for monitored lakes, and a breakdown of the percentage improvement required to meet the FWO.

Class	FMU	Site	Nitrate Obj	Nitrate State 10	Nitrate State 16	Nitrate State 19	Nitrate %↓ needed (median) 10	Nitrate %↓ needed (median) 16	Nitrate %↓ needed (median) 19	Nitrate %↓ needed (95th %ile) 10	Nitrate %↓ needed (95th %ile) 16	Nitrate %↓ needed (95th %ile) 19	Ammonia Obj	Ammonia State 10	Ammonia State 16	Ammonia State 19	Ammonia %↓ needed (median) 10	Ammonia %↓ needed (median) 16	Ammonia %↓ needed (median) 19	Ammonia %↓ needed (maximum) 10	Ammonia %↓ needed (maximum) 16	Ammonia %↓ needed (maximum) 19
Upland Shallow Lake	NA	NA	NA	NA			NA			NA			B	NA			NA			NA		
Lowland Shallow Lake	Aparima	Lake George		ND	A	A							C	ND	A	A	ND	0	0	ND	0	0
Lowland Shallow Lake	Mataura	Lake Vincent			A	A							C		B	A		0	0		0	0
Lowland Shallow Lake	Mataura	The Reservoir			A	A							C		A	A		0	0		0	0
Brackish Lake or Lagoon	Waiau	Waiau (Te Waewae) Lagoon			ND	A							C		A	B		ND	0		ND	0
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - CLOSED		B	B	B							C	B	A	B	0	0	0	0	0	0
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - OPEN		ND	B	C							C	ND	B	B	ND	0	0	ND	0	0
Deep Lake (Natural State)	Waiau	Lake Te Anau		A	ND	A							B	A	ND	A	0	ND	0	0	ND	0
Deep Lake (Natural State)	Waiau	Lake Manapouri		A	ND	A							B	A	ND	A	0	ND	0	0	ND	0
Lowland Shallow Lake	Fiordland and Islands	Lake Sheila[1]		A	ND		NA			NA			C	A	ND		0	ND		0	ND	
Lowland Shallow Lake	Fiordland and Islands	Lake Calder[1]		A									C	A			0			0		
Brackish Lake or Lagoon	Mataura	Lake Brunton[1]		A									C	A			0			0		

Table footnotes: 1 = Data from Schallenberg and Kelly (2012) Ecological condition of six shallow Southland lakes. This is an indicative state based on the data in the report, the minimum statistical requirement has not been met.

Table 59: Dissolved oxygen (lake bottom and mid-hypolimnetic) state for monitored lakes.

			Lake Bottom Dissolved Oxygen							Mid-Hypolimnetic Dissolved Oxygen						
				State			%↓ needed (minimum)				State			%↓ needed (minimum)		
Class	FMU	Site	Obj	10	16	19	10	16	19	Obj	10	16	19	10	16	19
Upland Shallow Lake	NA	NA			NA							NA				
Lowland Shallow Lake	Aparima	Lake George			A	A										
Lowland Shallow Lake	Mataura	Lake Vincent			A	A										
Lowland Shallow Lake	Mataura	The Reservoir			A	B										
Brackish Lake or Lagoon	Waiau	Waiau (Te Waewae) Lagoon	NA		ND	B		NA		NA	NA	NA	NA		NA	
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - CLOSED		A	A	A										
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - OPEN		ND	B	A										
Deep Lake (Natural State)	Waiau	Lake Te Anau		ND	ND	ND						ND				
Deep Lake (Natural State)	Waiau	Lake Manapouri		ND	ND	ND						ND				

Table 60: *E. coli* and cyanobacteria (planktonic) state for the monitored lakes, and a breakdown of the percentage improvement required to meet the FWO.

			E. coli																Cyanobacteria						
			Obj	State			%↓ needed (median)			%↓ needed (95th %ile)			%↓ needed (% exceedances >260)			%↓ needed (% exceedances >540)			Obj	State			%↓ needed (maximum)		
Class	FMU	Site		10	16	19	10	16	19	10	16	19	10	16	19	10	16	19		10	16	19	10	16	19
Upland Shallow Lake	NA	NA	A	NA			NA												NA	NA			NA		
Lowland Shallow Lake	Aparima	Lake George	B	ND	ND	D	ND	ND	7	ND	ND	0	ND	ND	0	ND	ND	0		ND	ND	A	NA		
Lowland Shallow Lake	Mataura	Lake Vincent	B			A			0			0			0			0				ND			
Lowland Shallow Lake	Mataura	The Reservoir	B			A			0			0			0			0				A			
Brackish Lake or Lagoon	Waiau	Waiau (Te Waewae) Lagoon	B			D			56			0			0			0				A			
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - CLOSED	B			B			0			0			0			0				C			
Brackish Lake or Lagoon	Mataura	Waituna Lagoon - OPEN	B			A			0			0			0			0				ND			
Deep Lake (Natural State)	Waiau	Lake Te Anau	A	A	A	A	0	0	0	0	0	0	0	0	0	0	0	0				A			
Deep Lake (Natural State)	Waiau	Lake Manapouri	A	A	A	A	0	0	0	0	0	0	0	0	0	0	0	0				A			

Table 61: LakeSPI Score for monitored lakes.

Class	FMU	Site	LakeSPI Score[1]						
			Obj	State			%↓ needed (LakeSPI Score)		
				10	16	19	10	16	19
Upland Shallow Lake	**NA**	**NA**			**ND**				
Lowland Shallow Lake	**Aparima**	**Lake George**			**A+**				
Lowland Shallow Lake	**Mataura**	**Lake Vincent**		**ND**	**B**				
Lowland Shallow Lake	**Mataura**	**The Reservoir**			**B**				
Brackish Lake or Lagoon	**Waiau**	**Waiau (Te Waewae) Lagoon**			**ND**				
Brackish Lake or Lagoon	**Mataura**	**Waituna Lagoon**	**NA**		**ND**	**ND**		**NA**	
Deep Lake (Natural State)	**Waiau**	**Lake Te Anau**		**B**	**C**				
Deep Lake (Natural State)	**Waiau**	**Lake Manapouri**		**C**	**C**				
Deep Lake	**Waiau**	**North Mavora Lake**		**B**	**ND**				
Deep Lake	**Waiau**	**South Mavora Lake**		**B**	**ND**				
Deep Lake (Natural State)	**Fiordland & Islands**	**Lake Hauroko**		**B**	**B**				

Table footnotes: 1 = Data sourced from NIWA Lake Submerged Plant Indicators Database (https://lakespi.niwa.co.nz/)

Table 62: LakeSPI (Native Condition Index) and LakeSPI (Invasive Impact Index) for monitored lakes.

Class	FMU	Site	LakeSPI Native Condition Index[1]							Lake SPI Invasive Impact Index						
				State			%↓ needed (Native Index)				State			%↓ needed (Invasive Index)		
			Obj	10	16	19	10	16	19	Obj	10	16	19	10	16	19
Upland Shallow Lake	NA	NA	NA	ND	ND	ND	NA			NA	ND	ND	ND	ND		
Lowland Shallow Lake	Aparima	Lake George			A							A				
Lowland Shallow Lake	Mataura	Lake Vincent			B							C				
Lowland Shallow Lake	Mataura	The Reservoir			B							B				
Brackish Lake or Lagoon	Waiau	Waiau (Te Waewae) Lagoon			ND							ND				
Brackish Lake or Lagoon	Mataura	Waituna Lagoon			ND							ND				
Deep Lake	Natural State	Lake Te Anau		C	C						B	C				
Deep Lake	Natural State	Lake Manapouri		C	C						C	C				
Deep Lake	Waiau	North Mavora Lake		B	ND						C	ND				
Deep Lake	Waiau	South Mavora Lake		B	ND						C	ND				
Deep Lake	Fiordland & Islands	Lake Hauroko		C	C						B	B				

Table footnotes: 1 = Data sourced from NIWA Lake Submerged Plant Indicators Database (https://lakespi.niwa.co.nz/)

Table 63: Macrophyte Cover (% cover) state for monitored lakes.

Class	FMU	Site	Obj	Macrophyte Cover: State 10	State 16	State 19	%↓ needed (%cover) 10	16	19
Upland Shallow Lake	NA	NA			ND	ND			
Lowland Shallow Lake	Aparima	Lake George		ND	C	C			
Lowland Shallow Lake	Mataura	Lake Vincent			A	A			
Lowland Shallow Lake	Mataura	The Reservoir	NA		C	C			
Brackish Lake or Lagoon	Waiau	Waiau (Te Waewae) Lagoon		C	ND	A		NA	
Brackish Lake or Lagoon	Mataura	Waituna Lagoon[1]		B	B	B			
Brackish Lake or Lagoon	Mataura	Lake Brunton		D	D	D			
Lowland Shallow Lake (Natural State)	Fiordland and Islands	Lake Sheila[2]		B	ND				
Lowland Shallow Lake (Natural State)	Fiordland and Islands	Lake Calder[2]		C					
Lowland Shallow Lake	Oreti	Lake Murihiku		ND	C	ND			

Table footnotes: 1 = Waituna Lagoon macrophyte state is based on average % cover rather than weighted % cover. These will need to be updated at a later date, however the average % cover provides an indicative state.; 2 = Data from Schallenberg and Kelly (2012) Ecological condition of six shallow Southland lakes. This is an indicative state based on the data in the report, the minimum statistical requirement has not been met.

Table 64: Fish presence (native and introduced species) in monitored lakes.

Class	FMU	Site	Obj	Fish						
				State 2013						
				Perch (Introduced)	Trout (Introduced)	Longfin Eel	Shortfin Eel	Giant Kokopu	Inanga	Narrative State[1]
Upland Shallow Lake	NA	NA	NA	ND						
Deep Lake	NA	NA		ND						
Lowland Shallow Lake	Aparima	Lake George		Yes	Yes	Yes	Yes	No	Yes	D
Lowland Shallow Lake	Mataura	The Reservoir		No	No	Yes	Yes	Yes	No	B
Lowland Shallow Lake	Mataura	Lake Vincent		Yes	No	Yes	Yes	Yes	No	C
Lowland Shallow Lake (Natural State)	Fiordland and Islands	Lake Sheila[2]		No	No	Yes	No	Yes	Yes	A
Lowland Shallow Lake	Oreti	Lake Murihiku		Yes	No	Yes	Yes	No	No	D

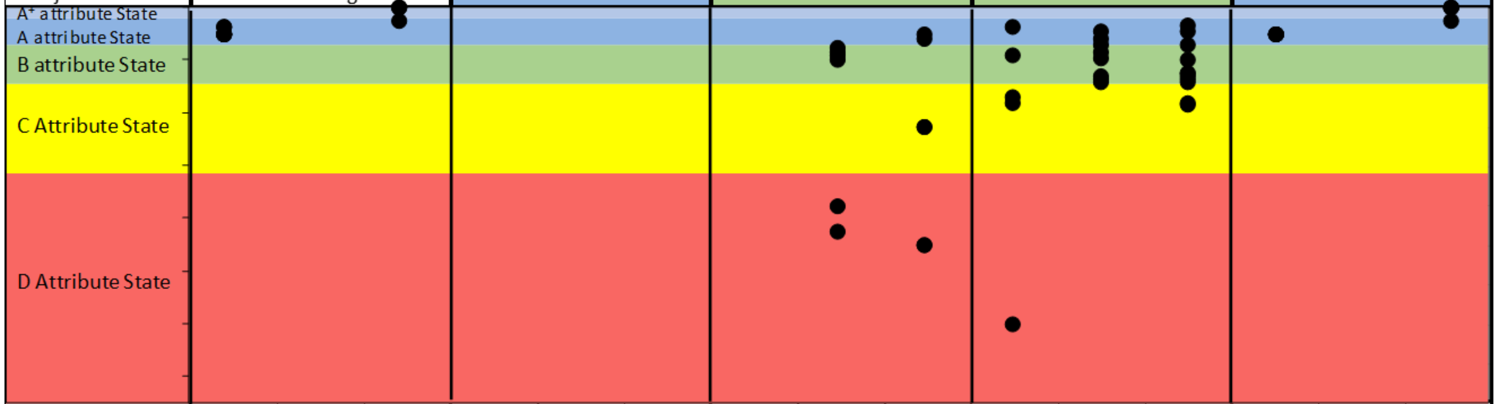
Table footnotes: 1 = An appropriate narrative state needs to be developed for Southland; the current assessment was based on the Greater Wellington Fish narrative attribute taking into consideration invasive species and important species to protect e.g. Giant Kokopu and Inanga.

2 = Data from Hicks (2013) Fish surveys in non-wadeable systems and Schallenberg and Kelly (2012) Ecological condition of six shallow Southland lakes. The data reported here is indicative of the fish community at these two time periods.

7.3 Lake class results

Table 65: Distribution of Phytoplankton (chlorophyll a) states of the monitored lakes within each lake class, and a breakdown of the improvement required to meet the FWO.

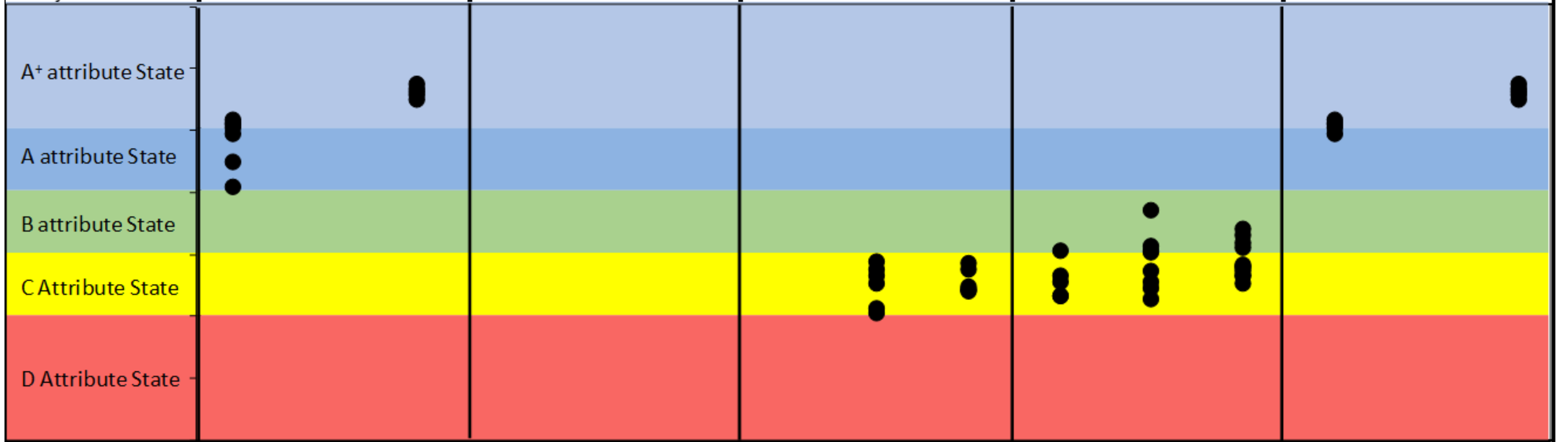
Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			A			B			B			A		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A+ state	0	ND	4 (80%)	ND			ND	0	0	0	0	0	0	ND	4 (80%)
Sites in A state	7 (100%)		1 (20%)					0	0	1 (20%)	1 (10%)	2 (18%)	5 (100%)		1 (20%)
Sites in B state	0		0					4 (66%)	2 (33%)	1 (20%)	4 (50%)	4 (36%)	0		0
Sites in C state	0		0					0	2 (33%)	2 (40%)	3 (40%)	5 (45%)	0		0
Sites in D state	0		0					2 (33%)	2 (33%)	1 (20%)	0	0	0		0
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			ND	4	2	2	5	6	5	ND	5
Improve 1 state								0	2	2	3	5	0		0
Improve 2 states								2	2	1	0	0	0		0
Improve 3 states								0	0	0	0	0	0		0

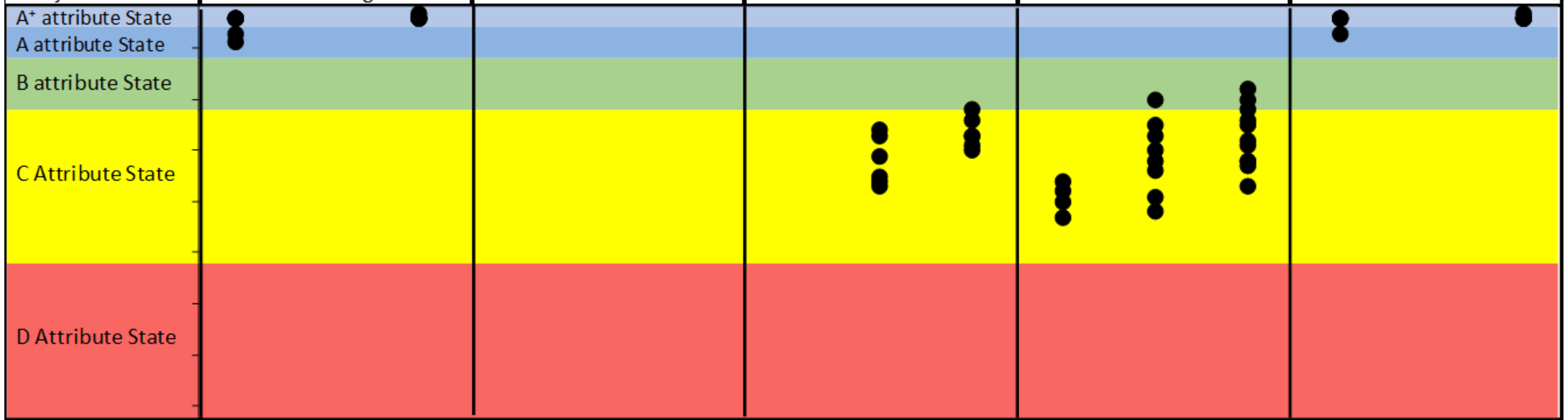
Table 66: Distribution of the Trophic Level Index (TLI3) states of the monitored lakes within each lake class.

Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A+ state	4 (57%)		5 (100%)					0	0	0	0	0	4 (80%)		5 (100%)
Sites in A state	3 (43%)		0					0	0	0	0	0	1 (20%)		0
Sites in B state	0	ND	0		ND		ND	0	0	1 (20%)	3 (37%)	4 (37%)	0	ND	0
Sites in C state	0		0					6 (100%)	6 (100%)	4 (80%)	5 (63%)	7 (63%)	0		0
Sites in D state	0		0					0	0	0	0	0	0		0
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			NA			NA			NA		
Improve 1 state															
Improve 2 states															
Improve 3 states															

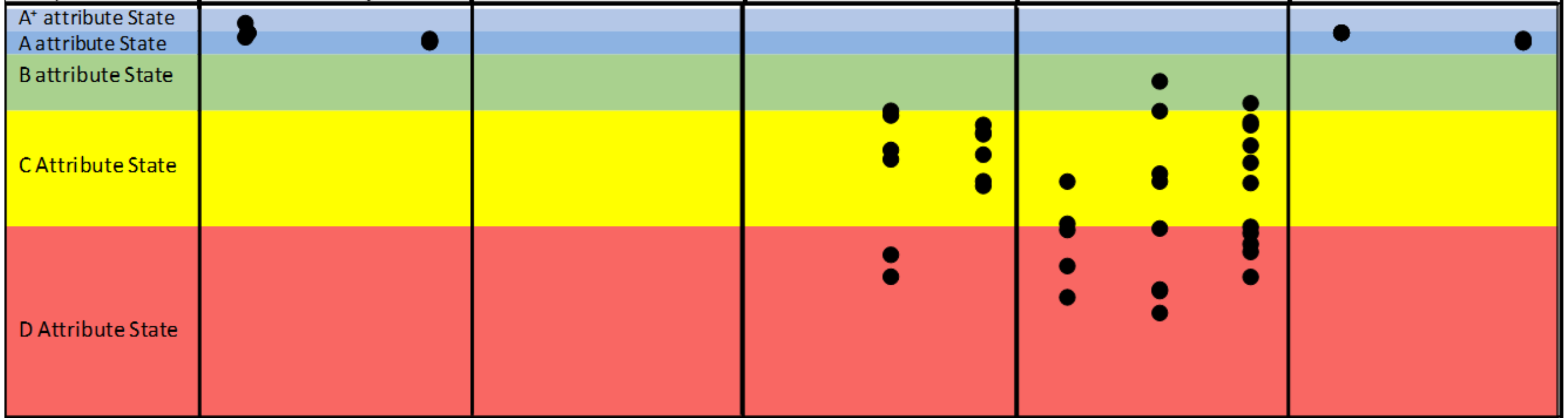
Table 67: Distribution of the Total Phosphorus (TP) states of the monitored lakes within each lake class.



Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A+ state	5 (72%)		5 (100%)					0	0	0	0	0	4 (80%)		5 (100%)
Sites in A state	2 (28%)		0					0	0	0	0	0	1 (20%)		0
Sites in B state	0	ND	0		ND		ND	0	1 (17%)	0	1 (12%)	2 (18%)	0	ND	0
Sites in C state	0		0					6 (100%)	5 (83%)	5 (100%)	7 (88%)	9 (82%)	0		0
Sites in D state	0		0					0	0	0	0	0	0		0
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			NA			NA			NA		
Improve 1 state															
Improve 2 states															
Improve 3 states															

Table 68: Distribution of the Total Nitrogen (TN) states of the monitored lakes within each lake class[1].

Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A+ state	5 (72%)		0					0	0	0	0	0	5 (100%)		0
Sites in A state	2 (28%)		5 (100%)					0	0	0	0	0	0		5 (100%)
Sites in B state	0	ND	0		ND		ND	1 (17%)	0	0	2 (25%)	1 (10%)	0	ND	0
Sites in C state	0		0					3 (50%)	6 (100%)	2 (40%)	2 (25%)	5 (45%)	0		0
Sites in D state	0		0					2 (33%)	0	3 (60%)	4 (50%)	5 (45%)	0		0
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*	NA	NA	NA	NA
Improve 1 state					
Improve 2 states					
Improve 3 states					

Table footnotes: 1 = The data for brackish lakes and lagoon is spread across the B to D bandings. The higher bandings, in general, are related to Waituna Lagoon under conditions where it is open to the sea.

Table 69: Distribution of the Nitrate toxicity states of the monitored lakes within each lake class.

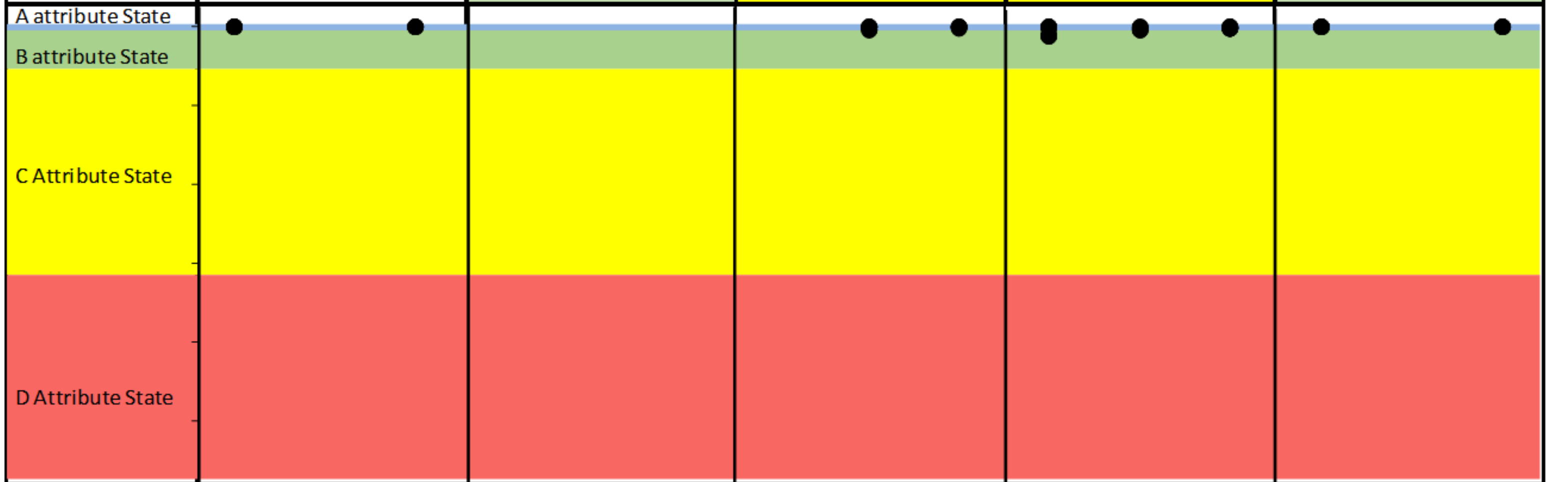
Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		

Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	7 (100%)		5 (100%)					6 (100%)	6 (100%)	1 (20%)	5 (63%)	10 (91%)	5 (100%)		5 (100%)
Sites in B state	0	ND	0		ND		ND	0	0	4 (80%)	3 (37%)	1 (9%)	0	ND	0
Sites in C state	0		0					0	0	0	0	0	0		0
Sites in D state	0		0					0	0	0	0	0	0		0

	Natural State Lakes	Upland Shallow Lakes	Lowland Shallow Lakes	Brackish Lakes & Lakes	Deep Lakes
Maintain Improve 1 state Improve 2 states Improve 3 states	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*	NA	NA	NA	NA

Table 70: Distribution of the Ammonia toxicity states of the monitored lakes within each lake class, and a breakdown of the improvement required to meet the FWO[1].

Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			B			C			C			B		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	7 (100%)	ND	5 (100%)	ND				6 (100%)	6 (100%)	1 (20%)	5 (63%)	7 (64%)	5 (100%)	ND	5 (100%)
Sites in B state	0		0					0	0	4 (80%)	3 (37%)	4 (36%)	0		0
Sites in C state	0		0					0	0	0	0	0	0		0
Sites in D state	0		0					0	0	0	0	0	0		0
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			NA	6	6	5	8	11	5	NA	5
Improve 1 state								0	0	0	0	0	0		0
Improve 2 states								0	0	0	0	0	0		0
Improve 3 states								0	0	0	0	0	0		0

Table footnotes: 1 = Note the A band for this attribute is <0.05 and therefore is very small compared to the other bands. There is a white gap above the A band to allow for the A band attribute label. This should not be filled in blue because this would represent a negative concentration value.

Table 71: Distribution of the Dissolved oxygen (lake bottom)[1] states of the monitored lakes within each lake class.

Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	ND			ND			ND	6 (100%)	5 (80%)	ND	7 (87%)	4 (80%)	ND		
Sites in B state								0	1 (20%)		1 (13%)	1 (20%)			
Sites in C state								0	0		0	0			
Sites in D state								0	0		0	0			
Maintain	NA			NA			NA			NA			NA		
Improve 1 state															
Improve 2 states															
Improve 3 states															

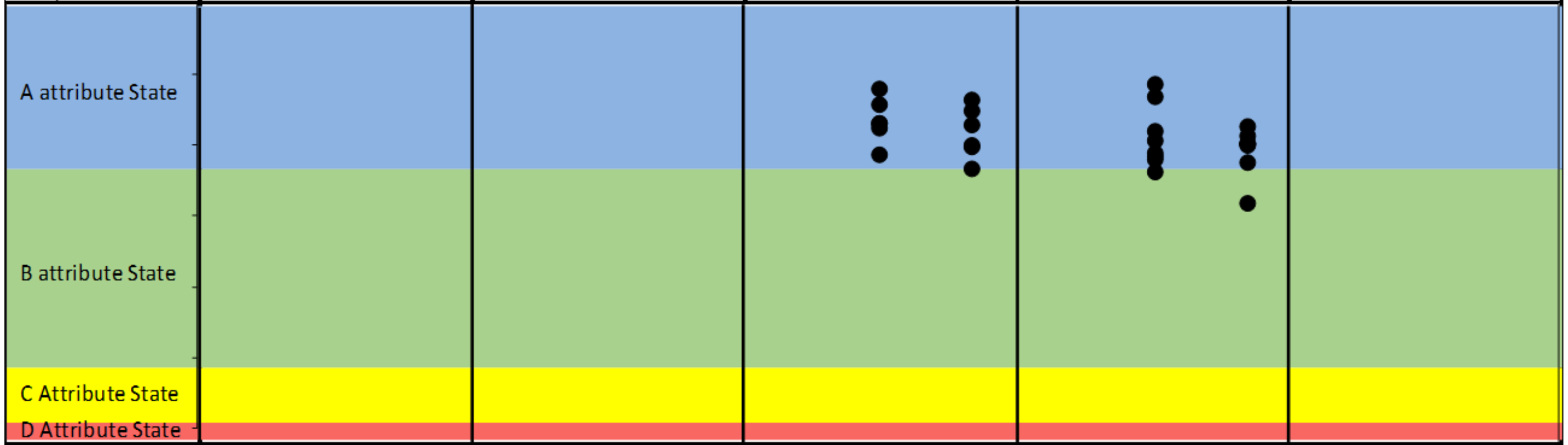


Table footnotes: 1 =Note the D band for this attribute is <0.5 and therefore is very small compared to the other bands. There is a white gap below the D band to allow for the D band attribute label. This should not be filled in red because this would represent a negative oxygen value.

Table 72: Distribution of the LakeSPI Score states of the monitored lakes within each lake class.

Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		

Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A^{+} state	0	0						1 (33%)					0	0	
Sites in A state	0	0						0					0	0	
Sites in B state	2 (67%)	1 (33%)	ND		ND		ND	2 (33%)	ND		ND		4 (80%)	1 (33%)	ND
Sites in C state	1 (33%)	2 (67%)						0					1 (20%)	2 (67%)	
Sites in D state	0	0						0					0	0	
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			NA			NA			NA		
Improve 1 state															
Improve 2 states															
Improve 3 states															

Table 73: Distribution of the LakeSPI (Native Condition Index) states of the monitored lakes within each lake class.

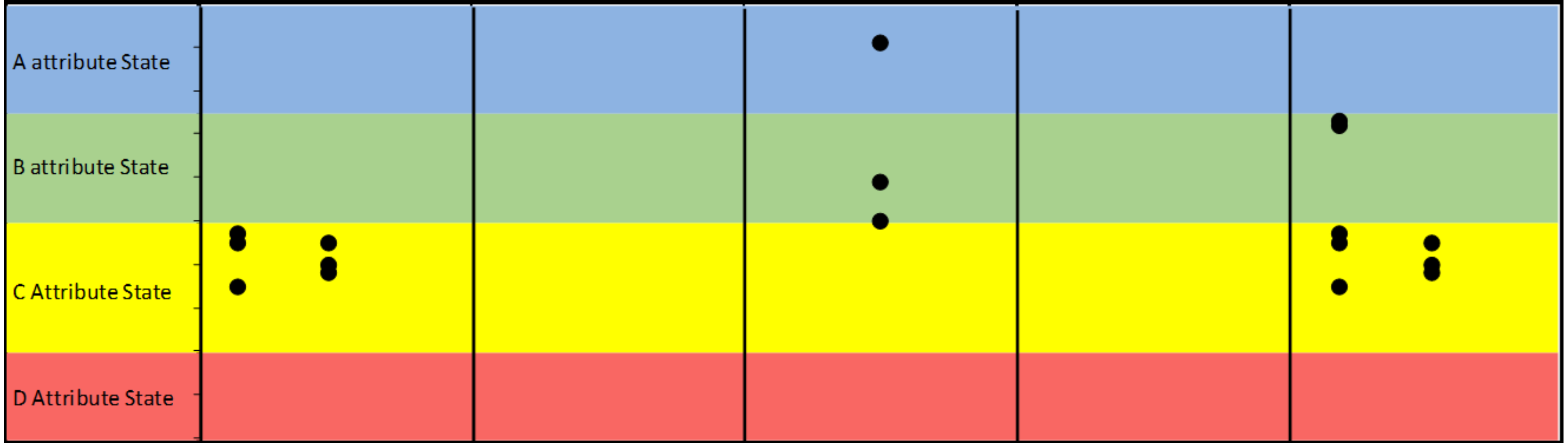
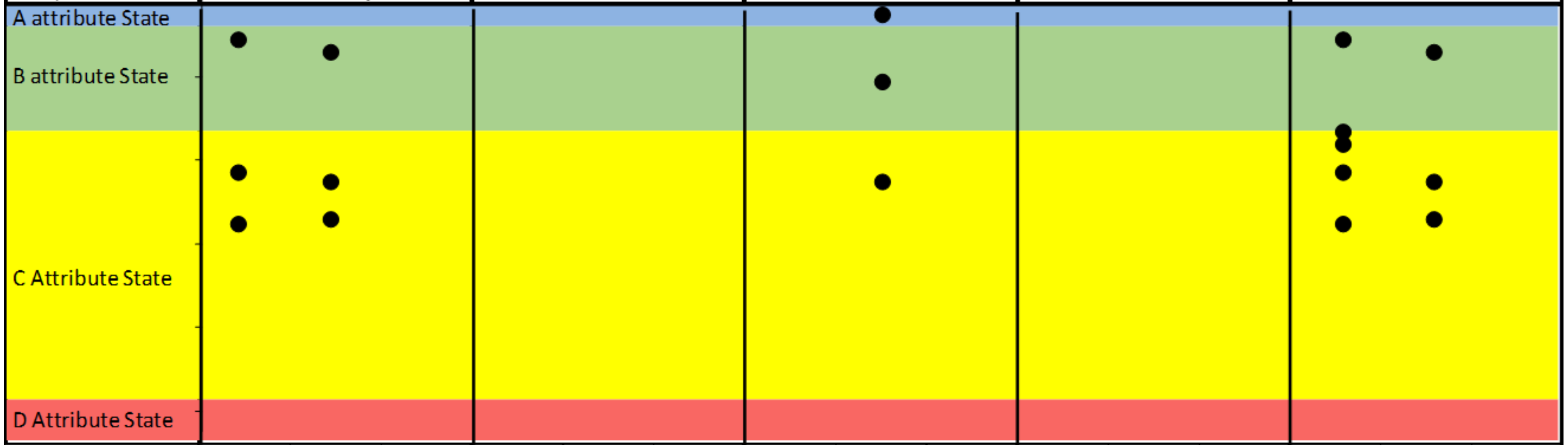
Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		
															
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	0	0	ND	ND			ND	1 (33%)	ND	ND			0	0	ND
Sites in B state	0	0						2 (67%)					2 (40%)	0	
Sites in C state	3 (100%)	3 (100%)						0					3 (60%)	3 (100%)	
Sites in D state	0	0						0					0	0	
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			NA			NA			NA		
Improve 1 state															
Improve 2 states															
Improve 3 states															

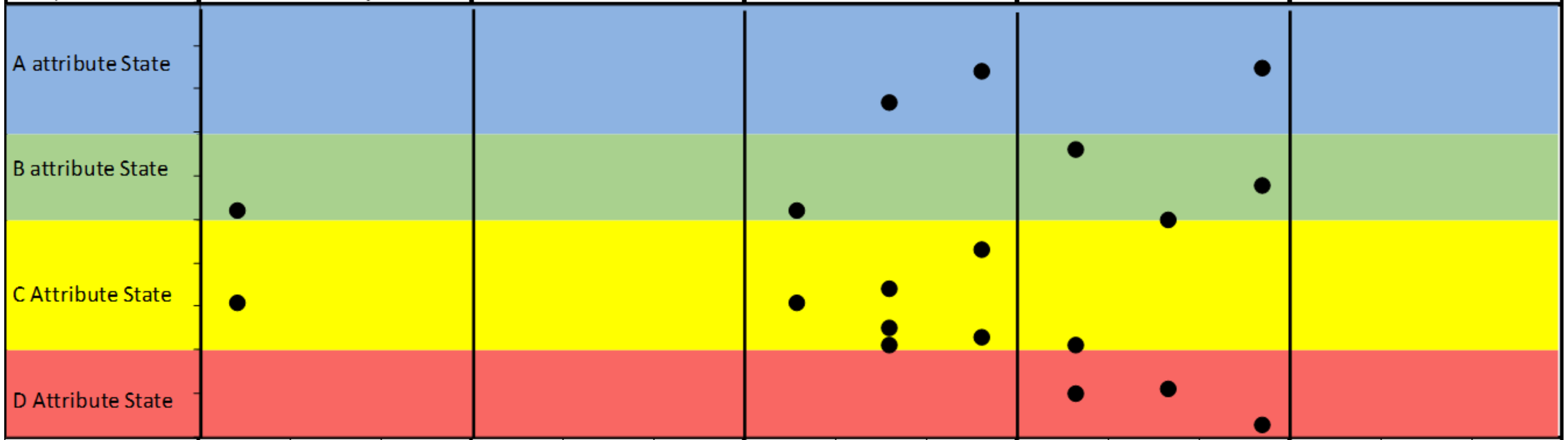
Table 74: Distribution of the LakeSPI (Invasive Impact Index) states of the monitored lakes within each lake class.

Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	0	0	ND	ND			ND	1 (33%)	ND	ND			0	0	ND
Sites in B state	2 (67%)	1 (33%)						1 (33%)					2 (40%)	1 (33%)	
Sites in C state	1 (33%)	2 (67%)						1 (33%)					3 (60%)	2 (67%)	
Sites in D state	0	0						0					0	0	
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			NA			NA			NA		
Improve 1 state															
Improve 2 states															
Improve 3 states															

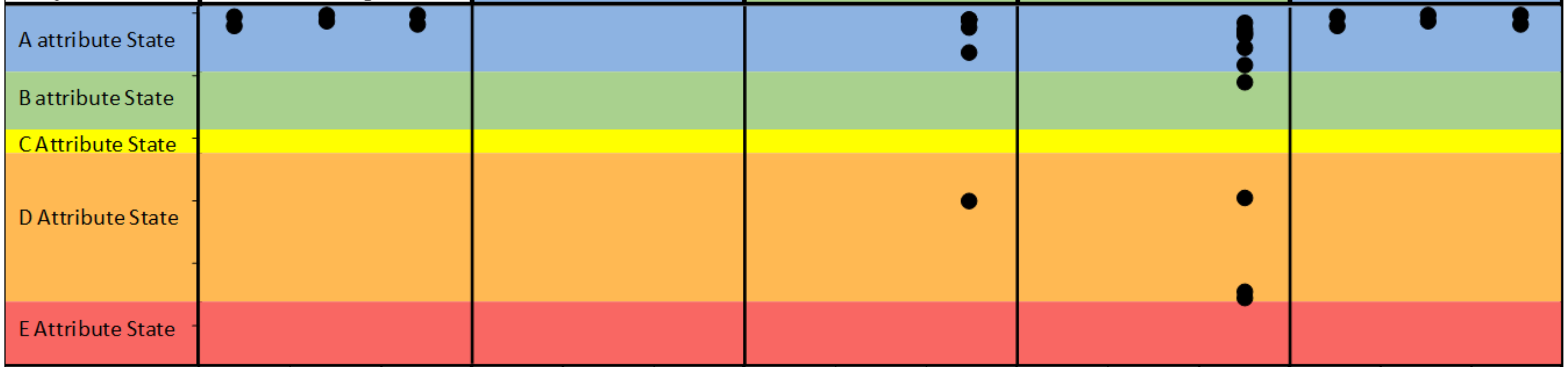
Table 75: Distribution of the Macrophyte Cover (% cover) states of the monitored lakes within each lake class.



Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	0	ND	ND	ND			0	1 (25%)	1 (33%)	0	0	1 (33%)	ND		
Sites in B state	1 (50%)						1 (50%)	0	0	1 (33%)	1 (33%)	1 (33%)			
Sites in C state	1 (50%)						1 (50%)	3 ('75%)	2 (67%)	1 (33%)	0	0			
Sites in D state	0						0	0	0	1 (33%)	1 (33%)	1 (33%)			
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			NA			NA			NA		
Improve 1 state															
Improve 2 states															
Improve 3 states															

Table 76: Distribution of the *E. coli* states of the monitored lakes within each lake class[1], and a breakdown of the improvement required to meet the FWO.

Class	Natural State Lakes			Upland Shallow Lakes			Lowland Shallow Lakes			Brackish Lakes & Lakes			Deep Lakes		
Objective state	No change			A			B			B			A		



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 (100%)	2 (100%)	2 (100%)	ND			ND	ND	5 (80%)	ND	ND	7 (64%)	2 (100%)	2 (100%)	2 (100%)
Sites in B state	0	0	0						0			1 (9%)	0	0	0
Sites in C state	0	0	0						0			0	0	0	0
Sites in D state	0	0	0						1 (20%)			3 (27%)	0	0	0
Sites in E state	0	0	0						0			0	0	0	0
Maintain	*Note: the deep glacial lakes are reported in both natural state and deep lakes. In 2010 natural state also includes Lake Sheila and Calder on Stewart Island*			NA			ND	ND	5	ND	ND	8	2	2	2
Improve 1 state									0			0	0	0	0
Improve 2 states									1			3	0	0	0
Improve 3 states									0			0	0	0	0

Table footnotes: 1 = Note: the *E. coli* state is determined by 4 statistics the graphs represents the relative position in the banding and has been scaled to provide a visual representation of state, the state was determined on the poorest statistic.

8 Estuaries and open coast results

8.1 Key messages for estuaries

8.1.1 Regional and FMU scale patterns for estuaries

- The only obvious pattern at regional and FMU spatial scales is that related to natural state versus developed catchment land use. Being at the bottom of catchments means that estuaries reflect the sum of flow and contaminants from their catchments. In this respect there is a clear difference between the largely pristine Fiordland and Islands FMU and the other four developed FMUs. Differences between estuaries in the four developed FMUs are related largely to the type of estuary (i.e., its class), the extent of development in and around estuary margins, and the level of contaminants (particularly nutrients and sediment) from the catchment.

8.1.2 Class scale patterns for estuaries

- The three estuary classes differ in sensitivity to contaminants from their catchments:

  i) Tidal Lagoon Estuaries (also called “shallow intertidal dominated estuaries” or SIDEs) have a moderate to high susceptibility to nutrients. Examples include Jacobs River, New River, Haldane, Waikawa and Freshwater Estuaries.

  ii) Tidal River Estuaries (also called “shallow short residence time tidal river estuaries” or SSRTRE) have a low susceptibility to nutrients due to their high river flushing potential. Examples include Toetoes (Fortrose) and Waimatuku Estuaries.

  iii) Fiords and Bays (also called “deeper subtidal dominated estuaries” or DSDE) have a moderate to low susceptibility to nutrients. Examples include Milford Sound and Doubtful Sound. In Southland, estuaries in the DSDE class are all also in the Natural State class.

- The different sensitivities can be seen to some extent in the monitoring results described for each attribute below. However it is noteworthy that most of the estuary monitoring effort is on Tidal Lagoon (SIDE) and Tidal River (SSRTRE) types that are either already impacted or at risk of being impacted by land development, and so the monitoring results reflect various degrees of development pressure as well as sensitivity. The one notable exception is the monitoring of Freshwater Estuary which is a near pristine Tidal Lagoon (SIDE) estuary on Stewart Island/Rakiura and is also in the Natural State class. As might be expected this estuary shows very good condition (generally A band) across all the attributes considered below.

8.1.3 Macroalgae and trophic (nutrient-related) state

- For macroalgae, as measured by the Ecological Quality Rating (EQR) index, the results clearly show a poor state for Jacobs River Estuary (D band), New River Estuary (D band) and Toetoes (Fortrose) Estuary (C band), while Waikawa and Haldane Estuaries show a moderate to good state (Table 77). Freshwater Estuary is not currently monitored for EQR but is assumed to be in a very good (A band) state.

- Although only two estuaries have sufficient data for macroalgae state to be assessed for each of the 3 baseline years, both estuaries show a deterioration in current (2019) macrogalae state since 2010 (New River Estuary shifting from C to D band and Toetoes (Fortrose) Estuary from A to C band).

- For Gross Eutrophic Zone (GEZ); which is an index of a combination of high macroalgae cover (>50%) and gross eutrophic sediment conditions with mud content greater than 25% and zero sediment oxygen, the pattern of results is similar to macroalgae above, with poor state for Jacobs River Estuary (D band) and New River Estuary (D band), and better state for Toetoes (Fortrose) (B band), Waikawa (A band) and Haldane Estuaries (A band) (Table 78). A reduction (deterioration) in GEZ state is evident in all of the estuaries monitored except for Waikawa Estuary which remained in A band between 2010 and 2016.

- A reduction in nutrient inputs to Jacobs River and New River Estuaries would be needed to avoid further deterioration and achieve C band or better consistently. A reduction in nutrient inputs to Fortrose Estuary would also likely be needed to avoid further deterioration despite showing a B banding as Tidal River (SSRTRE) estuaries do not generally express GEZ symptoms due to high flushing. The GEZ present in Fortrose indicates nutrient concentrations are beyond the processing capacity of that system.

- Phytoplankton data is only available for New River estuary currently; this shows for the 2019 state 4 sites in A band, 3 sites in B band and 1 site in D band (Table 89).

8.1.4 Muddiness, sedimentation and sediment oxygen levels

- For mud content (% mud content in the sediment at a site) the results are spatially variable across multiple sites within an estuary as shown by both Jacobs River and New River Estuaries having sites graded in both A+ band (<5% mud) and D band (>25% mud) (Table 79).

- While some areas of mud may occur naturally in estuaries at times, it is suggested that "mud extent" (i.e. the areal extent of muddiness – that is the area with greater than 25% mud content) would be at least maintained and preferably reduced through time where it has increased since the earliest available monitoring assessment. The attribute table for "mud extent" shown in Appendix 4 suggests a pass/fail guideline test where maintaining or improving mud extent compared to earliest monitoring data constitutes a 'pass' while increasing mud extent constitutes a 'fail'. Results for estuaries with data available are shown in Table 91. Both New River Estuary and Fortrose Estuary failed for all three time periods 2010, 2016 and 2019. Jacobs River Estuary failed in 2010 but has passed in 2016 ad 2019. Haldane Estaury failed in 2016 but couldn't be determined for 2010 and 2019. Waikawa Estuary passed in 2010 and 2016 but couldn't be determined for 2019.

- For sedimentation rate the limited monitoring results suggest that sedimentation rate is problematic for New River estuary. This attribute has no proposed bottom line so further thought may be needed for its application as an attribute. Literature guidelines suggest that sedimentation rates should, where possible, be less than 2mm/year greater than the natural state rate, to ensure adverse effects are avoided on estuary bed communities such as shellfish.

- For sedimentation rate the proposed FWO is based on conducting a long term trend analysis for high mud content sites (greater than 25% mud content) with at least 5 years of sedimentation rate data, to determine if the slope is statistically significantly greater than 2mm/year (above natural state rate) at a 90% confidence level, which would constitute failure of the FWO (see sedimentation rate attribute table in Appendix 4). Of six muddy sites with sufficient data to undertake such an analysis, two sites failed, showing sedimentation rates considerably greater than 2 mm/year (Table 90). Those sites were on the New River Estuary (Waihopai Central site 95% confidence sedimentation rate 24-38 mm/year; and Waihopai Upper site 13-23 mm/year). One site in Jacobs River Estuary (Site C) showed indeterminate trends. The remaining sites showed a 'pass' with sedimentation rates below the threshold.

- For sediment oxygen levels (as measured by aRPD) the results are spatially variable within estuaries, in a similar way (and related) to mud content as described above. This is seen by both Jacobs River and New River Estuaries having sites graded in both A band and D band (Table 80). Some sites in C and D band have also been recorded in other estuaries (e.g., Toetoes (Fortrose), Haldane, Waikawa and Waimatuku Estuaries) (Table 80).

- Significant reductions in catchment sediment loads is likely to be necessary, for Jacobs River and New River Estuaries in particular, to consistently achieve muddiness, sedimentation and sediment oxygen levels above D band (i.e. C band or better).

8.1.5 Toxicant metals

- For most toxicant metals in estuarine and coastal sediments the results show a generally good state (A or B band) in all estuaries monitored (Arsenic (Table 81); Cadmium (Table 82); Chromium (Table 83); Copper (Table 84); Lead (Table 85) and Mercury (Table 86)).

- Results for Zinc (Table 88) showed one site in C band for New River Estuary only.

- Results for Nickel (Table 87) showed one site in C band and one in D band for New River Estuary only.

- These results suggest toxicant metals in estuary and coastal sediments are likely to be from particular localised soures (e.g., industrial activities, wastewater discharges, landfill leachate etc) and could potentially be narrowly targeted to remediate those sources.

8.1.6 Habitat

- Assessing seagrass coverage in estuaries is based on change in the area of coverage compared to a baseline, so a baseline first needs to be determined. There are historical monitoring assessments in Southland that could be considered but currently this attribute is proposed to be included as part of a narrative rather than as a numeric FWO.

- Assessing saltmarsh coverage in estuaries is also based on change in the area of coverage compared to a baseline, so a baseline needs to be established. There are historical monitoring assessments in Southland that could be considered (see Ward and Roberts 2020) but currently this attribute is proposed to be included as part of a narrative rather than as a numeric FWO.

8.1.7 *E. coli* and enterococci

- Monitoring to indicate faecal contamination has included *E. coli* (the nationally preferred indicator for freshwater; Table 92 and Table 93) and Enterococci (the nationally preferred indicator for marine waters; Table 94 and Table 95). It is notable that the results for the two indicators do not always give the same grade for common sites, for reasons that are not entirely explainable. A plausible reason may be due to faster die-off rates of *E. coli* known to occur in saline waters, which is one of the reasons Enterococci is the nationally preferred indicator for marine waters.

- Notwithstanding the uncertainty described above the results show that several sites are graded D band, particularly at sites in Jacobs River Estuary and New River Estuary, but also at several sites on the open coast (e.g., Bluff Harbour at Ocean Beach and Monkey Island at Frentz Rd).

8.1.8 Summary messages

- New River Estuary, Jacobs River Estuary and Toetoes (Fortrose) Estuary are all currently receiving nutrient and sediment inputs beyond their assimilative capacity. They are showing signs of eutrophication and expansive degraded areas, as indicated by areas currently in D band state for macroalgae (EQR), Gross Eutrophic Zone (GEZ), mud content and extent, and sediment oxygen levels (aRPD). A reduction in nutrient and sediment inputs would be needed to improve all these attributes above D band at all sites in these estuaries.

- Waikawa Estuary and Haldane Estuary are in moderate to good ecosystem health state but would likely be sensitive to any increase in nutrients and/or sediment input.

- Faecal microorganism contamination (as indicated by both *E .coli* and enterococci) is a key contaminant affecting the value of human health for recreation in estuaries and the open coast, and caused D band grades at some sites. Reduced faecal contamination would be needed to achieve at least C band or better at all estuary and open coast sites.

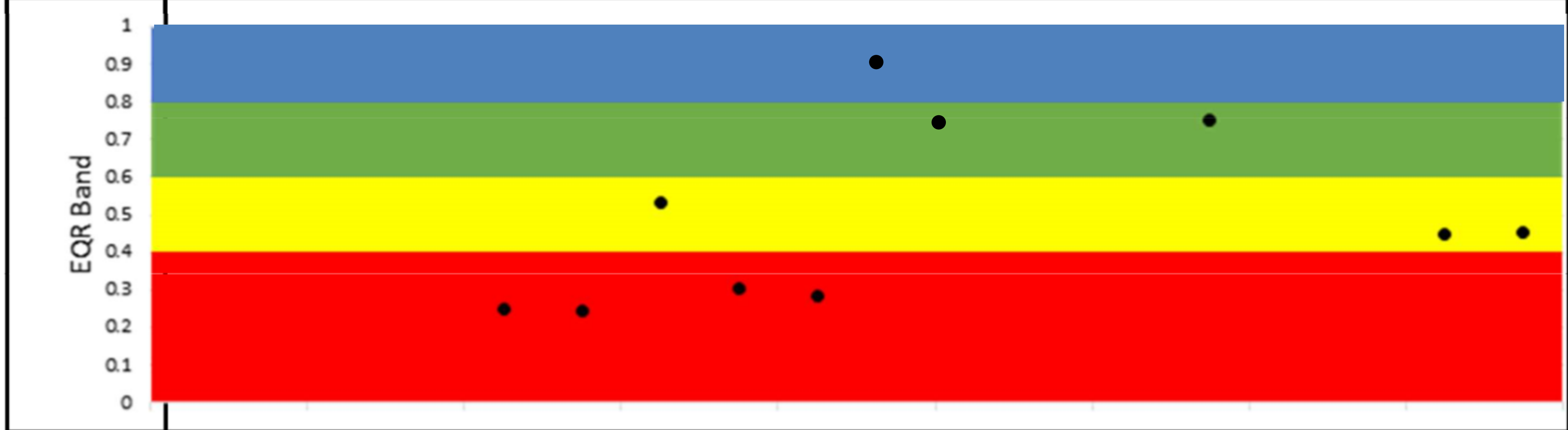
- Estuaries in the Natural State class, including all those in the Fiordland and Islands FMU (which includes all the Fiords and Bays (DSDE) class of estuaries), are assumed to be in excellent condition despite them not being monitored.

- The draft FWOs suggested by Norton and Wilson (2019) included all the above attributes for estuaries except that sediment oxygen (measured as aRPD) is a new addition suggested here. Norton and Wilson (2019) did not suggest which state band should be chosen as the FWO for each attribute because none could be inferred from previous regional plan decisions. The results in this report can now be used to suggest minimum draft FWO band states based on current state for all the above attributes; these are provided in section 9.

8.2 Estuary results tables

Table 77: Macroalgae state (as measured by the EQR index) for monitored estuaries within each estuary class.

FMU	Fiordland and Islands	Aparima	Oreti	Mataura		
Class	SIDE	SIDE	SIDE	SIDE	SIDE	SSRTRE
Estuary	Freshwater Estuary	Jacobs River Estuary	New River Estuary	Waikawa Estuary	Haldane Estuary	Fortrose Estuary
Objective state	NA	NA	NA	NA	NA	NA



Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
	ND	ND	ND	ND	D	D	C	D	D	A	B	ND	A	A	ND	A	C	C

Table 78: Gross Eutrophic Zone (GEZ) state for monitored estuaries within each estuary class.

State	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary		
Class	Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal River (SSRTRE)			Natural state			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
A attribute state							•							•								•		
B attribute state																							•	
C attribute state								•	•															
D attribute state																•	•	•	•	•	•			

Table 79: Mud content (% mud at each site) state for monitored estuaries within each estuary class.

Note that numbers indicate the number of sites within an estuary

State	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary		
Class	Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal River (SSRTRE)			Natural state			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
A attribute state							1	1		1								1	2		2	1		1
B attribute state								1							1			2	1		1	1		
C attribute state																								1
D attribute state													1		1			2		1	2			1

Table 80: Sediment oxygen level (as measured by aRPD) state for monitored estuaries within each estuary class.

Note that numbers indicate the number of sites within an estuary

State	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary		
	Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal River (SSRTRE)			Natural State			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)			Tidal Lagoon (SIDE)		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
A+ attribute state									1	1					1							2		
A attribute state								1	1	1				1			1	1	2	1	3		1	1
B attribute state							1							1	1			1	1				1	1
C attribute state																		1						1
D attribute state																	1	2		1	2			

Table 81: Arsenic (As) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state									2 (100%)						2 (100%)						2 (40%)						2 (67%)
Sites in B state																		5 (100%)			3 (60%)			2 (100%)			1 (33%)
Sites in C state																											
Sites in D state																											

Table 82: Cadmium (Cd) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 (100%)			2 (100%)			2 (100%)		2 (100%)	2 (100%)	2 (100%)		2 (100%)	2 (100%)	2 (100%)	3 (100%)	2 (100%)	5 (100%)	3 (100%)	2 (100%)	5 (100%)	2 (100%)	2 (100%)	2 (100%)			3 (100%)
Sites in B state																											
Sites in C state																											
Sites in D state																											

Table 83: Chromium (Cr) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 (100%)			2 (100%)			2 (100%)		2 (100%)	2 (100%)	2 (100%)		2 (100%)	2 (100%)	2 (100%)	3 (100%)	2 (100%)	5 (100%)	3 (100%)	2 (100%)	5 (100%)	2 (100%)	2 (100%)	2 (100%)			3 (100%)
Sites in B state																											
Sites in C state																											
Sites in D state																											

Table 84: Copper (Cu) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 (100%)			2 (100%)			2 (100%)		2 (100%)	2 (100%)	2 (100%)		2 (100%)	2 (100%)	2 (100%)	3 (100%)	2 (100%)	5 (100%)	3 (100%)	2 (100%)	5 (100%)	2 (100%)	2 (100%)	2 (100%)			3 (100%)
Sites in B state																											
Sites in C state																											
Sites in D state																											

Table 85: Lead (Pb) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 (100%)			2 (100%)			2 (100%)		2 (100%)	2 (100%)	2 (100%)		1 (100%)	2 (100%)	2 (100%)	3 (100%)	2 (100%)	5 (100%)	3 (100%)	1 (50%)	4 (80%)	2 (100%)	2 (100%)	2 (100%)			3 (100%)
Sites in B state																				1 (50%)	1 (20%)						
Sites in C state																											
Sites in D state																											

Table 86: Mercury (Hg) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state									2 (100%)		2 (100%)			2 (100%)	2 (100%)		2 (100%)	5 (100%)		1 (50%)	4 (80%)		2 (100%)	2 (100%)			3 (100%)
Sites in B state																				1 (50%)	1 (20%)						
Sites in C state																											
Sites in D state																											

Table 87: Nickel (Ni) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state	2 (100%)			1 (50%)			2 (100%)		2 (100%)	2 (100%)	2 (100%)			1 (50%)	1 (50%)	1 (33%)		1 (20%)		1 (50%)	2 (40%)	2 (100%)	1 (50%)	2 (100%)			
Sites in B state				1 (50%)									2 (100%)	1 (50%)	1 (50%)	1 (33%)	2 (100%)	1 (20%)	3 (100%)		1 (20%)		1 (50%)				3 (100%)
Sites in C state																1 (33%)		3 (60%)			1 (20%)						
Sites in D state																				1 (50%)	1 (20%)						

Table 88: Zinc (Zn) metal in sediment state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state							1 (100%)		2 (100%)	2 (100%)	2 (100%)		1 (100%)	2 (100%)	2 (100%)		2 (100%)	3 (60%)	3 (100%)	1 (50%)	4 (80%)	2 (100%)	2 (100%)	2 (100%)			3 (100%)
Sites in B state																		2 (40%)									
Sites in C state																				1 (50%)	1 (20%)						
Sites in D state																											

Table 89: Phytoplankton state for monitored estuaries within each estuary class.

Class	Open Coast			Bluff & Awarua Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state																					4 (50%)						
Sites in B state																					3 (38%)						
Sites in C state																											
Sites in D state			1 (100%)																		1 (12%)						

Table 90: Sedimentation rate state for monitored estuaries within each estuary class.

Class	Fortrose Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary		
Objective state	NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in Pass State						1 (100%)									2 (100%)
Sites in Fail State												2 (100%)			
Indeterminate									1 (100%)						

Note that no bottom line has been proposed as it is difficult to establish the appropriate bandings for this attriubute. The pass/fail threshold is the point at which an adverse effect is estimated to occur for the invertebrate community on the estuary bed. This would suggest that that the threshold (pass/fail) proposed may be towards the top of any banding. This attribute may be more suitable as a narrative.

Table 91: Mud extent (area with muddiness > 25% mud content) of estuary state for monitored estuaries within each estuary class.

Class	Awarua Bay Estuary			Bluff Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in Pass State																	P	P				P	P	
Sites in Fail State							F	F	F					F		F			F	F	F			
Unable to determine	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND		ND									ND

Note that no bottom line has been proposed as it is difficult to establish the spatial coverage of mud that is ‘excessive’ (D band) along with reference conditions. Therefore, this attribute may be more suited as a narrative or for the formation of a target (or part of). As this matter then becomes a value judgement it should be further deliberated.

Table 92: *E. coli* state for monitored estuaries within each estuary class.

Class	Open Coast			Bluff & Awarua Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state			1 (33%)	1 (100%)																							
Sites in B state																					1 (50%)						
Sites in C state			2 (66%)						1 (100%)									1 (100%)			1 (50%)						
Sites in D state																											
Sites in E state																											

Table 93: *E. coli* at popular bathing sites state for monitored estuaries within each estuary class.

Class	Open Coast			Bluff & Awarua Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state			3 (66%)			1 (100%)																					
Sites in B state			1 (33%)																								
Sites in C state																											
Sites in D state																		1 (100%)			2 (100%)						

Table 94: Enterococci state for monitored estuaries within each estuary class.

Class	Open Coast			Bluff & Awarua Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state																											
Sites in B state			1 (33%)																								
Sites in C state			1 (33%)						1 (100%)												2 (100%)						
Sites in D state			1 (33%)			1 (100%)												1 (100%)									

Table 95: Enterococci at popular bathing sites state for monitored estuaries within each estuary class.

Class	Open Coast			Bluff & Awarua Harbour			Fortrose Estuary			Freshwater Estuary			Haldane Estuary			Jacobs River Estuary			New River Estuary			Waikawa Estuary			Waimatuku Estuary		
Objective state	NA			NA			NA			NA			NA			NA			NA			NA			NA		
Baseline year	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Sites in A state			5 (62%)			1 (50%)																					
Sites in B state			3 (38%)			1 (50%)												1 (100%)									
Sites in C state																					1 (50%)						
Sites in D state																					1 (50%)						

9 Conclusions 1: Revisions to draft FWOs for "maintain or improve"

The NPSFM (2017) sets an objective to "maintain or improve" water quality and supports that by requiring[10] that councils may not set freshwater objectives at a lower (more degraded) state than existing at the time the freshwater objectives are set. The need to check the draft freshwater objectives against a baseline state was part of the method described and planned for in Norton and Wilson (2019); that step can now be completed. The results in this report have now been used to examine whether each draft freshwater objective is set at a level consistent with at least maintaining the 2010 or 2016 state band for the majority of sites representing that class. The findings from this are as follows.

9.1 Existing draft FWOs that require adjusting upwards

We suggest the existing draft freshwater objectives for nitrate toxicity in rivers (Norton and Wilson 2019) should be revised upwards as follows:

- Lowland Soft Bed rivers: shift from C to B band (94% of sites are already B or better[11])
- Hill rivers: shift from C to A band (94% of sites are already A band)
- Mountain rivers: shift from B to A band (100% of sites are already A band)
- Lake Fed rivers: shift from B to A band (100% of sites are already A band)

We suggest the existing draft freshwater objectives for ammonia toxicity in rivers (Norton and Wilson 2019) should be revised upwards as follows:

- Lowland Soft Bed rivers: shift from C to B band (100% of sites are already B or better)
- Lowland Hard Bed rivers: shift from C to B band (81% of sites are already B or better)
- Hill rivers: shift from C to A band (94% of sites are already A band)
- Mountain rivers: shift from B to A band (100% of sites are already A band)
- Lake Fed rivers: shift from B to A band (100% of sites are already A band)

We suggest the existing draft freshwater objectives for ammonia toxicity in lakes (Norton and Wilson 2019) should be revised upwards as follows:

- Lowland Shallow lakes: shift from C to A band (100% of sites are already A band)
- Brackish Lakes and Lagoons: shift from C to B band (100% of sites are already B or better)
- Deep lakes: shift from B to A band (100% of sites are already A band)

9.2 Attributes for which a minimum draft FWO can now be identified

Some of the attributes previously suggested for use as freshwater objectives by Norton and Wilson (2019) could not have their band inferred from previous plan decisions and so the choice of whether to set the objective at A, B or C band remained open; this was indicated by expressing those draft freshwater objectives as "A-C" state. The current state results in this report can now be used to suggest "minimum" draft freshwater objective band states based on assessed current state, notwithstanding that decisions could still yet be made later in the process to set draft

[10] Specifically through Policy CA2e)iiaA)

[11] There is no direction in the NPSFM or in Ministry for the Environment guidance on the NPSFM to direct what might be an appropriate threshold to determine whether a freshwater objective should be adjusted upwards based on a significant proportion of sites already achieving a better state. In our analysis here we have nominally suggested that if greater than 80% of sites already meet a higher objective then it could be revised upwards. If a threshold of 90% was chosen then one of our suggested revisions (the shift from C to B band for Lowland Hard Bed rivers) would not be made.

freshwater objectives at a better state than this. The key point here is that the NPSFM (2017) requires that freshwater objectives must "maintain or improve" and not be set lower than current state. On this basis the suggested "minimum" draft freshwater objectives are as laid out in the following subsections.

9.3 Revisions to groundwater FWOs

We suggest the draft freshwater objectives for nitrate concentration – with respect to potential effects on groundwater ecosystem health – should be set at a minimum of C band on the basis that C band is the national bottom line for toxicity effects in surface waters and large areas of groundwater are currently in C band (e.g., Table 12). The draft numeric freshwater objectives are unchanged from those in Norton and Wilson (2019) and are reproduced in Table 96.

Table 96: Minimum suggested draft freshwater objectives for groundwater.

	Draft minimum freshwater objectives for Groundwater[1]		
Attributes	**Potable Groundwater**	**Naturally Non-potable Groundwater**	**Groundwater Drinking Supply Protection Zones**
E. coli (MPN/ 100mL) - human health for drinking[2]	Pass	Pass[3]	Pass
Nitrate (mg/L) – human health for drinking[2]	Pass	n/a[4]	Pass
All other DWSNZ[2] contaminants – human health for drinking	Pass	n/a	Pass
Groundwater-related ecosystem health	The draft freshwater objectives below apply to all groundwater		
Nitrate-Nitrite nitrogen (mg/L) – ecological toxicity[5]	A to C		

Table footnotes:
Note that this table only includes draft numeric FWOs; Draft narrative FWOs are shown in Norton and Wilson (2019).
Coloured cells represent draft freshwater objectives inferred from region-wide Objective 8 in the existing pSWLP.
Uncoloured (white) cells represent the range of options for FWOs that can't be inferred further from current plans.
1: For numbers and other detail associated with "ABCD" or "pass / fail" states see Appendix 1.
2: Based on DWSNZ = Drinking Water Standards New Zealand (Ministry of Health 2008). This is a pass/fail freshwater objective.
3: The recommended 'Pass' objective is reflective of the reality that some water in this class is used for drinking following various states of treatment; and that this objective should be able to be achieved everywhere due to the primarily anthropogenic source and control.
4: n/a indicates that this attribute is not assessed within this class.
5: Attribute band options are based on the attribute option table for nitrate toxicity for surface ecosystem health (NOF 2017; and Hickey 2013) [It is noted the NPSFM (2020) has revised the national bottom line for surface ecosystem health upwards to the B/C threshold].

9.4 Revisions to river FWOs

For rivers there were already many draft freshwater objective state bands inferred from previous plan decisions (Norton and Wilson 2019). We have suggested some of those require upwards revision as laid out in section 9.1 above. We can also now revise the draft freshwater objectives for deposited fine sediment (% cover) and suspended sediment (measured as turbidity) based on suggesting a minimum of the current state results presented in this report. This means A band for all classes for deposited fine sediment (% cover) and "A to C" band for suspended sediment (turbidity); these two are shown as uncoloured rows. The revised suggested draft numeric freshwater objectives are shown in Table 97.

Table 97: Minimum suggested draft freshwater objectives for rivers.

	Draft minimum freshwater objectives for rivers[1]						
	Natural State rivers	Lowland Soft Bed	Lowland Hard Bed	Hill	Mountain	Lake Fed	Spring Fed
National Compulsory Attributes							
Periphyton (Chl-*a*; mg/m^2)	no change[2]	C	C	B	A	A	A
Nitrate Toxicity (mg/L)		B	B	A	A	A	B
Ammonia Toxicity (mg/L)		B	B	A	A	A	B
Dissolved Oxygen (mg/L)		A	A	A	A	A	A
E. coli (*E. coli*/ 100mL)		B	B	B	A	A	B
Cyanobacteria[4] (biovolume mm^3/L)		n/a	n/a	n/a	n/a	A	n/a
Southland Attributes							
E. coli (at "Popular Bathing Sites")[3]		A	A	A	A	A	A
Macroinvertebrate Community Index (MCI) (wadeable rivers only)[5]	no change[2]	C	C	B	A	C	C
Temperature (°C, 5-day CRI during Summer Period, 1 Dec - 30 Mar)[6]		C	C	C	B	B	B
Temperature (°C max, May- Sept)[5,8]		n/a	A	A	A	A	A
Clarity (visible distance; m)[5,7]		C	B	B	A	A	A
Benthic Cyanobacteria (% cover)		A	B	B	A	A	B
Deposited fine sediment (%cover)		A	A	A	A	A	A
Suspended sediment - turbidity		A to C	A to C	A to C	A	A to C	A to C
Filamentous algae[5,8]		n/a	Pass	Pass	Pass	n/a	n/a
Diatoms and cyanobacteria[5,8]		n/a	Pass	Pass	Pass	n/a	n/a

Table footnotes:
Note that this table only includes draft numeric FWOs; Draft narrative FWOs are shown in Norton and Wilson (2019).
Coloured cells represent draft freshwater objectives inferred from Appendix E of the existing pSWLP.
Uncoloured (white) cells represent the range of options for FWOs that can't be inferred further from current plans.
1: For numbers and other detail associated with "ABCD" or "Pass / Fail" states see Appendix 2.
2: The wording used currently in the pSWLP Appendix E is "*The natural quality of the water shall not be altered*."
3: "Popular Bathing Sites" are listed in the pSWLP Appendix G.
4: Cyanobacteria – Planktonic.
5: Based on current pSWLP Appendix E receiving water quality standards.
6: Reference: Davies-Colley et al., (2013)
7: Reference: Ryder (2004)
8: This is a pass or fail freshwater objective

9.5 Revisions to lake FWOs

For lakes, the minimum freshwater objective state bands now suggested are as shown in Table 98. The new suggested minimum state bands are shown as uncoloured rows. The previous draft freshwater objectives have been revised as laid out in section 9.1 and are shown as coloured rows. Note that there was little data basis to suggest minimum state bands for Upland Shallow lakes and so these remain mostly as "A to C" in the table.

Table 98: Minimum suggested draft freshwater objectives for lakes based on current state.

	Draft minimum freshwater objectives for lakes[1]				
	Natural State lakes	Lowland shallow lakes	Upland shallow lakes	Deep lakes	Brackish Lakes and Lagoons
National Compulsory Attributes					
Phytoplankton (Chl-*a*; mg/m^3)	no change[2]	B	A to B	A	B
Total Phosphorus (mg/m^3)		A+ to C	A+ to C	A+	A+ to C
Total Nitrogen (mg/m^3)		A+ to C	A+ to C	A+ to A	A+ to C
Ammonia Toxicity (mg/L)		A	B to C[9]	A	B
Cyanobacteria[4] (biovolume mm^3/L)		A	A to C	A	A to C
E. coli (*E. coli*/ 100mL)		B	A	A	B
Southland Attributes					
E. coli (at "Popular Bathing Sites")[3]		A	A	A	A
Trophic Level Index (TLI)[5]	no change[2]	A+ to C	A+ to C	A+	A+ to C
Macrophytes (percentage cover)[6]		A to C	A to C	N/A	A to C
LakeSPI (overall index)[7]		A to B	A to B	A to C	N/A
LakeSPI (native condition index)[7]		A to B	A to B	A to C	N/A
LakeSPI (invasive impact index)[7]		A to C	A to C	A to C	N/A
Nitrate Toxicity (mg/L)[8]		A	A to C[9]	A	A to B

Table footnotes:
Note that this table only includes draft numeric FWOs; Draft narrative FWOs are shown in Norton and Wilson (2019).
Coloured cells represent draft freshwater objectives inferred from Appendix E of the existing pSWLP.
Uncoloured (white) cells represent the range of options for FWOs that can't be inferred further from current plans.
1: For numbers and other detail associated with "ABCD" states see Appendix 3.
2: The wording used currently in the pSWLP Appendix E is "*The natural quality of the water shall not be altered*."
3: "Popular Bathing Sites" are listed in the pSWLP Appendix G, but none are identified in any lakes at this time.
4: Cyanobacteria – Planktonic.
5: Reference: Burns and Bryers (2000)
6: Reference: Hamill et al., (2014); Kelly et al., (2016)
7: Reference: Burton et al (2015) and using the LakeSPI native condition and invasive impact indices as provided in the Draft NPSFM released for public consultation as part of the Essential Freshwater Package (September 2019).
8: Reference: Hickey et al., (2013)
9: Note NPSFM (2020) revised the national bottom line for nitrate and ammonia toxicity upwards to the B/C threshold.

9.6 Revisions to estuary FWOs

For estuaries, the minimum freshwater objective state bands now suggested are shown in Table 99. Note that the minimum state for the coloured rows is to some extent inferred for sediment metals and faecal indicators (*E. coli* and enterococci) from the Regional Coastal Plan for Southland as described previously in Norton and Wilson (2019). Note also that a minimum state has not yet been assessed for phytoplankton.

Table 99: Minimum suggested draft numeric freshwater objectives for estuaries based on current state.

	Draft minimum freshwater objectives for Estuaries[1]			
	Natural State estuaries	**Tidal Lagoon Estuaries (SIDE)**	**Tidal River Estuaries (SSRTRE)**	**Fiords and Bays (DSDE)**
National Compulsory Attributes				
There are no nationally compulsory attributes for estuaries				
Southland Attributes				
Phytoplankton (Chl-*a*; mg/m³)[4]	no change[2]	A to C	A to C	A to C
Toxicant metals in sediment (mg/kg dry weight)[5]		A to B	A to B	A
Gross Eutrophic Zone (GEZ) (% intertidal area)[6]		A to C	A to B	n/a
Mud content - site specific (% mud)[7]		A to C	A to B	n/a
Sedimentation rate (5 year rolling average ≤ 2mm/year above natural state rate)[8]		MC[12]	MC[12]	n/a
Sediment oxygen level (aRPD in mm)		A to C	A to B	n/a
Macroalgae (Ecological Quality Rating; EQR)[4,9]		A to C	A to B	n/a
E. coli (*E. coli*/ 100mL)[10]		A to C	A to C	A
E. coli (at "Popular Bathing Sites")[3]		A to C	A to C	A
Enterococci (enterococci/ 100mL)[11]		A to C	A to C	A
Enterococci (at "Popular Bathing Sites")[3]		A to C	A to C	A

Table footnotes:
Note that this table only includes draft numeric FWOs; Draft narrative FWOs are shown in Norton and Wilson (2019).
Coloured cells represent range of options for FWOs inferred from objectives and Appendix 10 RCPS criteria.
Unshaded (white) cells represent the range of options for FWOs that can't be inferred further from current plans.
n/a means it is recommended the attribute not apply for that class – primarily due to practical measurement difficulties.
1: For numbers and other detail associated with "ABCD" states see Appendix 4.
2: The wording used in pSWLP Appendix E for rivers and lakes is "*The natural quality of the water shall not be altered*."
3: "Popular Bathing Sites" are listed in the pSWLP Appendix G, but none are identified in any estuaries at this time.
4: Reference: Revilla (2010)
5: Reference: ANZECC (2018) sediment guidelines
6: Reference: Ecological Condition Gradient work; e.g., Robertson et al., (2015)
7: Reference: Robertson et al., (2015)
8: Reference: ANZECC (2018)
9: Reference: Estuary Trophic Index work; e.g., Robertson et al., (2016)
10: Reference: NPSFM for freshwater applied here to estuaries
11: Reference: MoH/MfE (2003) Recreational guidelines
12: Sedimentation attribute does not have a defined ABC gradient. "MC" means minimum is at least "maintain current" rate.

9.7 Revisions to open coast FWOs

For the open coast the minimum freshwater objective state bands now suggested based on current state are as shown in Table 100.

Table 100: Minimum suggested draft freshwater objectives for open coast based on current state.

	Draft freshwater objectives for Open Coast[2]
Secondary Attributes	
Enterococci (Ent/ 100mL)[1] – human health for recreation	A
Toxicant metals in sediment (mg/kg dry weight)[3]	A

Table footnotes:
Note that this table only includes draft numeric FWOs; Draft narrative FWOs are shown in Norton and Wilson (2019).
Coloured cells represent range of options for draft FWOs inferred from objectives and Appendix 10 criteria in the RCPS.
1: Reference: MoH/MfE (2003) Recreational guidelines
2: For numbers and other detail associated with the choice of “ABCD” states see Appendix 4
3: Reference: ANZECC (2018) sediment guidelines

10 Conclusions 2: The size of the "gap" to achieve draft FWOs

The results presented in this report have shown that the size of the gap to achieve draft freshwater objectives varies for different attributes across different FMUs, classes and waterbodies. The size of the gaps for different attributes are summarised for groundwater (in section 5.4), rivers (in sections 6.1 to 6.3), lakes (in section 7.1) and estuaries (in section 8.1). Several overarching conclusions can be drawn.

- It is assumed there is no gap to close for the majority of water bodies in the Fiordland and Islands FMU, most of which are in the Natural State Waters class and are currently in near pristine condition. It is necessary to maintain that situation and thus the draft freshwater objectives for the Natural State Waters class are all "no change".

- In the other four developed FMUs many sites do meet freshwater objectives (see sections noted above for detail), but a substantial number do not, as described further below.

- There is a substantial gap to close to meet freshwater objectives for faecal indicators (*E. coli* and/or enterococci) for both groundwater drinking supply and for the value of human health for recreation, for many sites in groundwater and particularly lowland river and lake classes draining both rural and urban land, and in estuaries. Some sites in hill rivers also did not meet *E. coli* objectives. Most sites in mountain rivers, deep lakes and many open coast sites meet objectives for faecal indicators (*E. coli* and/or enterococci).

- There is a substantial gap to close to meet freshwater objectives at some sites, particularly in lowland rivers and lakes and in estuaries, for nutrients (nitrogen and phosphorus) and a related string of other freshwater objectives that are influenced by elevated nutrients, such as objectives for periphyton and macroinvertebrates in rivers, phytoplankton and macrophytes in lakes, and macroalgae and gross eutrophic zone (GEZ) conditions in estuaries.

- There is a substantial gap to close to meet freshwater objectives at some sites, again particularly in lowland rivers and lakes and in estuaries, related to sediment, such as objectives for deposited fine sediment, suspended sediment and visual clarity in rivers, trophic condition (TLI) in lakes, and muddiness, sedimentation rate, sediment oxygen level and gross eutrophic zone (GEZ) conditions in estuaries.

- The gaps described above will not be solved only by addressing the four big contaminants (nitrogen, phosphorus, sediment and faecal micro-organisms). While not assessed in this report it is well known that many other factors also contribute to the problems and will need to be part of the solutions. This includes provision of sufficient water quantity; i.e., setting environmental flows and levels to support ecosystem health in rivers, lakes, groundwater and wetlands. It is likely to include riparian and instream habitat improvements for rivers, and marginal wetland improvements for some lakes. It is also likely to include biodiversity enhancements, invasive weed and pest control, and practical restoration projects. It may even involve innovative technological and/or engineering projects for some situations. Climate change may also affect the freshwater objectives in future.

11 Conclusions 3: Topics for management and planning

11.1 Awareness of environmental variability – in space and through time

The state of natural and altered environments is inherently very variable in both space (i.e., across different areas) and through time (e.g., through daily, seasonal, annual and decadal weather and climate cycles, and through long term climate change). When we sample attributes at particular sites we get snapshots of information for that place and time, and we use that information to estimate the state of the broader environment. The more attributes, sites and times we sample, the better we cover for environmental variability, and the better our estimate of the state of the environment will be. However, there are practical and cost constraints to sampling effort. In the end we must use the data we have, knowing the limitations and associated uncertainty about state and its variability, to make resource management decisions.

The uncertainty associated with estimating the current state of attributes in this report is considerable and would be difficult to quantify. In general we are most certain about state for attributes and sites that are sampled frequently, and we are least certain about attributes we sample infrequently and at few sites. An indication of the relative level of uncertainty with different attributes can be seen by observing the number of sites shown in the results tables cross-referenced in the key messages sections of this report (sections 5.4, 6.1, 7.1 and 8.1 for groundwater, rivers, lakes and estuaries respectively).

In general we have more data for groundwater sites and river sites than for lakes and estuaries and are thus more uncertain about the latter. In particular we sample only a handful of lakes and estuaries; there are hundreds that we do not monitor and therefore must infer their condition from sampling others of the same class. We do not monitor a single lake in the Upland Shallow lakes class; we assume these are in generally good condition due to their locations but this is uncertain. We are also generally more certain about water quality contaminant concentrations for nutrients (nitrogen and phosphorus) than we are about sediment, *E.coli* and ecological attributes like periphyton, MCI and the native fish IBI. We are very uncertain about the attributes we don't monitor at all, such as several of those proposed for inclusion in the new draft (September 2019) NPSFM (see tables in section 3.2).

Ultimately we must acknowledge that uncertainty is inevitable and proceed with making resource management decisions based on what we know today. We can also continue to monitor through time to check whether our decisions remain the right ones and to revise accordingly. The results presented in this report suggest that once freshwater objectives, limits and other methods are finalised later in the process, it would be timely and prudent to review the design of existing monitoring programmes to ensure that progress towards meeting freshwater objectives is effectively monitored going forward. This is particularly true for estuaries, where numeric freshwater objectives will be set for the first time in this process. In addition Government's Essential Freshwater Package includes proposed changes to the NPSFM (September 2019) that include the new compulsory attributes mentioned above; these could also influence monitoring programme review.

11.2 Considerations of different spatial scales: site vs class vs FMU vs region

Related to environmental variability is the question of what spatial scale to investigate and report at. Inevitably every small part of every waterbody is unique at some level, but it is obviously impractical to monitor and report everywhere. It is also impractical to set unique freshwater objectives for every small part, or even every whole, waterbody.

The draft freshwater objectives provided in Norton and Wilson (2019) were identified for each class of rivers, lakes, estuaries and groundwater, and they sit within the context of the Southland region and the five identified FMUs for the region. For the purpose of this report the assessment of state has been made at site level initially, but the results have then been grouped and presented at the level of classes, FMUs and the whole region where practical. We have learned different things at each level of analysis:

11.2.1 Region scale

Results analysed at this scale (see sections 5.1, 6.1, 7.1.1 and 8.1.1) illustrate what the key problems are; such as the key contaminants nitrogen, phosphorus, sediment and faecal microorganisms (as indicated by *E. coli*), which directly and indirectly contribute to numerous failures to meet draft freshwater objectives. However, results analysed at regional scale don't tell us clearly where the problems are occurring.

11.2.2 FMU scale

Results analysed at this scale (see sections 5.2, 6.2, 7.1.2 and 8.1.1) reinforced the clear distinction between the largely pristine state of the Fiordland and Islands FMU compared to the other four FMUs with more developed land uses (Waiau, Aparima, Ōreti and Mataura). The data did not show any particular distinction in state between these four developed FMUs. While there are certainly rivers, lakes and estuaries in different environmental states across these four FMUs the data suggest differences are related to the type (and therefore sensitivity) of each waterbody and the extent of development in each catchment, rather than significant differences between the four FMUs.

11.2.3 Class scale

Results analysed at this scale (see sections 5.3, 6.3, 7.1.3 and 8.1.2) showed clear patterns of difference between the classes, particularly for rivers and lakes. In general, the monitoring results combined with justification for the proposed classes based on physical characteristics (Norton and Wilson 2019), supports the use of the proposed river, lake and estuary classes for resource management planning processes going forward at this time.

11.2.4 Individual waterbody scale

Results at this scale illustrate how variable the environment can be, even for waterbodies within the same class and sites within the same waterbody. While draft freshwater objectives have currently only been proposed at the level of classes and not for individual waterbodies, it remains a possibility to assign one or more particularly important waterbodies with their own unique freshwater objectives as discussed in more detail in Norton and Wilson (2019). This could be done either within the current process or in subsequent future plan changes after first establishing freshwater objectives region-wide.

Assigning unique freshwater objectives for individual waterbodies might be justified on the basis of waterbodies with particularly important values or pressures, or both. Possible candidates include Waituna Lagoon, which already has some work done to support catchment specific numeric attribute targets, and major estuaries in developed catchments such as Jacobs River Estuary and New River Estuary. Whether or not to do this will be a subject of discussion during the next phase of the Regional Forum process.

11.3 Deciding on when the "baseline year" for maintain and improve should be

This report presents results for three potential baseline years (2010, 2016 and current 2019), although there was not data available for all attributes and sites for all time periods, particularly the earlier periods. The reason for presenting all three periods is that there is uncertainty on whether the target of "maintain or improve" water quality should be applied to the baseline year of 2010 (the year the Regional Water Plan for Southland, 2010 became operative) or 2016 (where the proposed Southland Water and Land Plan (pSWLP) specifies a baseline date of 1 June 2016, the date the plan was notified). At the time of writing this is a topic of contention in the Environment Court appeals process on the pSWLP and will ultimately require a decision. This report presents estimates of environmental state for both those baseline years to cover both possibilities for that decision. The 2019 results provide the nominal "current state" at time of writing for comparison.

11.4 Operating with "maintain or improve"

From what we know about environmental variability and the uncertainty inherent in monitoring environmental state, it is clear that the imperative to "maintain or improve" water quality[12] presents a conundrum in terms of exactly what state should be maintained or improved, at what scale it should be applied, and with what allowance for variability caused by natural processes and/or factors outside the control of resource managers (e.g., climate change).

One pragmatic approach that has been employed in some regions, and is alluded to in the NPSFM (2017), is to strive to ensure that all sites remain within the state band (A, B or C) of their given freshwater objective, thus allowing for some variability within the band. However this presents an issue that in some cases deterioration from near the top of a band to near the bottom of a band represents significant and unintended degradation. For example, movement from the top to the bottom of A band would represent significant deterioration in Southland's Deep class lakes (e.g., Lakes Manapōuri and Te Anau). This approach also does not solve the issue that the exact breakpoints between ABCD bands are somewhat arbitrary and a very small shift from one side of a threshold to the other is meaningless in terms of effects in the environment. To solve that particular issue though, it would become necessary to do away with the pragmatic ABCD system and set unique numeric freshwater objectives for every site. That would bring us right back to the problem of practical constraints and the inevitable uncertainty in monitoring exactly what that state is, and whether it changes in future (i.e., detecting trends typically takes considerable sampling effort for many years).

There does not seem to be a perfect solution to this conundrum. A pragmatic approach that we suggest could be considered by planners for plan-writing purposes, would be to proceed with using the ABCD banding system for setting and then monitoring and reporting against freshwater objectives, but to also explicitly recognise a narrative policy intent that "maintain and improve" should apply at site scales unless transgressed due to natural causes. The ABCD system would then be monitored and reported pragmatically as the first level indication of state and progress towards achieving freshwater objectives (e.g., freshwater accounting as required by the NPSFM and plan effectiveness monitoring). Meanwhile state of environment monitoring would continue to be used to track what is happening at individual sites as well as regionally representative changes through time.

There will ultimately need to be decisions made about how to handle "maintain or improve" in plan writing that takes account of the difficulties described here.

[12] i.e., under Objective A2 of the NPSFM (2017)

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Appendix 1: Groundwater Attribute State Option Tables

Value	Water supply
Freshwater body type	Groundwater
Attribute group	Southland attribute
Attribute name	*E. coli*
Attribute unit	MPN/100mL (Most probable number per 100 millilitres)
Attribute band and description	**Numeric Attribute State**
	Annual maximum*
Pass Will rarely result in waterborne illness to humans through consumption of water.	≤1
Proposed minimum acceptable state	**1**
Fail Unsuitable for human consumption. Indicative of faecal contamination and increased risk of waterborne illness to humans.	>1

* Assessed annually (no minimum number of samples per bore). The annual maximum is proposed as this provided the greatest certainty that the bore or well complies with the New Zealand Drinking Water Standard: Ministry of Health (2018). *Drinking water standards for New Zealand 2005 (revised 2018).* Wellington: Ministry of Health.

Value	Water supply	
Freshwater body type	Groundwater	
Attribute group	Southland attribute	
Attribute name	Nitrate	
Attribute unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)	
Attribute band and description	**Numeric Attribute State**	
	5-year median*	Maximum
Pass Suitable for human consumption with respect to low risk of methaemoglobinaemia in bottle fed infants.	≤8.5	≤11.3
Proposed minimum acceptable state	**8.5**	**11.3**
Fail Unsuitable for human consumption with respect to high risk of methaemoglobinaemia in bottle fed infants.	>8.5	>11.3

* 5 year mean with a minimum of 10 samples and data from at least 4 of the 5 years. This is used as it has particular relevance to the frequency which groundwater samples are usually collected in Southland and the general temporal variability in groundwater chemistry.

Value	Water supply	
Freshwater body type	Groundwater	
Attribute group	Southland attribute	
Attribute name	Other parameters* in DWSNZ with assigned MAV	
Attribute unit	Dependant on attribute	
Attribute band and description	**Numeric Attribute State**	
	Annual mean	Annual maximum
Pass Suitable for human consumption with low risk of health effects from contaminant concentrations. On the basis of present knowledge, it is considered not to cause any significant risk to the health of the consumer over 70 years of consumption of 2 litres per day of that water (MOH, 2018).	≤75% of MAV	≤100% of MAV
Proposed minimum acceptable state	**75% of MAV**	**MAV**
Fail Unsuitable for human consumption. On the basis of present knowledge, it is considered to cause significant risk to the health of the consumer over 70 years of consumption of 2 litres per day of that water (MOH, 2018).	>75% of MAV	>100% of MAV
* These include microbiological measures, pesticides, organics, inorganics, heavy metals, and measures of radiation or radioactive elements. Ministry of Health (2018). *Drinking water standards for New Zealand 2005 (revised 2018).* Wellington: Ministry of Health.		

Value	Ecosystem health
Freshwater body type	Groundwater
Attribute group	Southland attribute
Attribute name	Nitrate
Attribute unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)
Attribute band and description	**Numeric Attribute State**
	5-year mean
A High conservation value system. Unlikely to be effects even on sensitive stygofauna species.	≤1.0
B Likely growth effect on some stygofauna species.	>1.0 and ≤2.4
C Growth effects on a proportion of stygofauna species. Potential effects on groundwater ecosystem function.	>2.4 and <6.9
Proposed minimum acceptable state[1]	**6.9[1]**
D Likely impacts on growth of many stygofauna species and effects on groundwater ecosystem function.	>6.9

[1] NPSFM (2020) revised the national bottom line for nitrate toxicity in rivers and lakes upwards to the B/C threshold

Appendix 2: River Attribute State Option Tables

Value	Ecosystem health	
Freshwater body type	Rivers and streams	
Attribute group	National compulsory attribute	
Attribute name	Nitrate (toxicity)	
Attribute unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)	
Attribute band and description	**Numeric Attribute State**	
	Annual median	Annual 95th percentile
A High conservation value system. Unlikely to be effects even on sensitive species.	≤1.0	≤1.5
B Some growth effect on up to 5% of species.	>1.0 and ≤2.4	>1.5 and ≤3.5
C Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.	>2.4 and ≤6.9	>3.5 and ≤9.8
National bottom line[1]	**6.9[1]**	**9.8[1]**
D Impacts on growth of multiple species, and starts approaching acute impact level (i.e. risk of death) for sensitive species at higher concentrations (>20 mg/L).	>6.9	>9.8

Note: This attribute measures the toxic effects of nitrate, not the trophic state. Where other attributes measure trophic state, for example periphyton, freshwater objectives, limits and/or methods for those attributes may be more stringent.

[1] Note the NPSFM (2020) revised the national bottom line for nitrate toxicity in rivers and lakes upwards to the B/C threshold

Value	Ecosystem health	
Freshwater body type	Rivers and streams	
Attribute group	National compulsory attribute	
Attribute name	Periphyton	
Attribute unit	mg chl-*a*/m^2 (milligrams chlorophyll-*a* per square metre)	
Attribute band and description	**Numeric Attribute State (default class)**	**Numeric Attribute State (productive class)**
	Exceeded no more than 8% of samples	Exceeded no more than 17% of samples
A Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.	≤50	≤50
B Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat.	>50 and ≤120	>50 and ≤120
C Periodic blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat.	>120 and ≤200	>120 and ≤200
National bottom line	**200**	**200**
D Regular and/or extended-duration nuisance blooms reflecting very high nutrient enrichment and/or very significant alteration of the natural flow regime.	>200	>200

1. Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC “Dry” Climate categories (i.e. Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (i.e. Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class.
2. Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chl-*a*) is 3 years

Note: To achieve a freshwater objective for periphyton within a freshwater management unit, regional councils must at least set appropriate instream concentrations and exceedance criteria for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP). Where there are nutrient sensitive downstream receiving environments, criteria for nitrogen and phosphorus will also need to be set to achieve the outcomes sought for those environments.

Regional councils must use the following process, in the following order, to determine instream nitrogen and phosphorus criteria in a freshwater management unit:

a) either –
   i) if the freshwater management unit supports, or could support, conspicuous periphyton, derive instream concentrations and exceedance criteria for DIN and DRP to achieve a periphyton objective for the freshwater management unit; or
   ii) if the freshwater management unit does not support, and could not support, conspicuous periphyton, consider the nitrogen and phosphorus criteria (instream concentrations or instream loads) needed to achieve any other freshwater objectives:

b) if there are nutrient sensitive downstream environments, for example, a lake and/or estuary, derive relevant nitrogen and phosphorus criteria (instream concentrations or instream loads) needed to achieve the outcomes sought for those sensitive downstream environments:

c) compare all nitrogen and phosphorus criteria derived in steps (a) – (b) and adopt those necessary to achieve the freshwater objectives for the freshwater management unit and outcomes sought for the nutrient sensitive downstream environments.

Value	**Ecosystem health**	
Freshwater body type	Rivers and streams	
Attribute group	National compulsory attribute	
Attribute name	Ammonia (toxicity)	
Attribute unit	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)	
Attribute band and description	**Numeric Attribute State**	
	Annual median*	Annual maximum*
A 99% species protection level: No observed effect on any species tested.	≤0.03	≤0.05
B 95% species protection level: Starts impacting occasionally on the 5% most sensitive species.	>0.03 and ≤0.24	>0.05 and ≤0.40
C 80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).	>0.24 and ≤1.30	>0.40 and ≤2.20
National bottom line[1]	**1.30[1]**	**2.20[1]**
D Starts approaching acute impact level (i.e. risk of death) for sensitive species	>1.30	>2.20
*Based on pH 8 and temperature of 20°C Compliance with the numerical attribute states should be undertaken after pH adjustment		

[1] Note the NPSFM (2020) revised the national bottom line for ammonia toxicity in rivers and lakes upwards to the B/C threshold

Value	Ecosystem health	
Freshwater body type	Rivers and streams (below point sources) [1]	
Attribute group	National compulsory attribute	
Attribute name	Dissolved oxygen	
Attribute unit	mg/L (milligrams per litre)	
Attribute band and description	**Numeric Attribute State**	
	7-day mean minimum[1] (summer period: 1 November to 30 April)	1-day minimum[2] (summer period: 1 November to 30 April)
A No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.	≥8.0	≥7.5
B Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.	≥7.0 and <8.0	≥5.0 and <7.5
C Moderate stress on a number of aquatic organisms caused by dissolved oxygen levels exceeding preference levels for periods of several hours each day. Risk of sensitive fish and macroinvertebrate species being lost.	≥5.0 and <7.0	≥4.0 and <5.0
National bottom line	**5.0**	**4.0**
D Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.	<5.0	<4.0
[1] The mean value of 7 consecutive daily minimum values [2] The lowest daily minimum across the whole summer period		

[1] Note that for Southland this attribute is being proposed to apply to all rivers

Value	**Human health for recreation**			
Freshwater body type	Lakes and rivers			
Attribute group	National compulsory attribute			
Attribute name	*Escherichia coli* (*E. coli*)			
Attribute unit	*E. coli*/100 mL (number of *E. coli* per hundred millimetres)			
Attribute band and description	**Numeric Attribute State**			
	% exceedances over 540 cfu/100 mL	% exceedances over 260 cfu/100 mL	Median concentration (cfu/100 mL)	95th percentile of *E. coli*/100 mL
A For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 1%*.	<5%	<20%	≤130	≤540
B For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 2%*.	5 to 10%	20 to 30%	≤130	≤1,000
C For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 3%*.	10 to 20%	20 to 34%	≤130	≤1,200
D 20 to 30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >3%*.	20 to 30%	>34%	>130	>1,200
E For more than 30% of the time the estimate risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is 7%*.	>30%	>50%	>260	>1,200

* The predicted average infection risk is the overall average infection to swimmers based on a random exposure on a random day, ignoring any possibility of not swimming during high flows or when a surveillance advisory is in place (assuming that the *E. coli* concentration follows a lognormal distribution). Actual risk will generally be less if a person does not swim during high flows.

[1] Attribute state should be determined by using a minimum of 60 samples over a maximum of 5 years, collected on a regular basis regardless of weather and flow conditions. However, where a sample has been missed due to adverse weather or error, attribute state may be determined using samples over a longer timeframe.

[2] Attribute state must be determined by satisfying all numeric attribute states.

Value	Ecosystem health
Freshwater body type	Lakes and lake-fed rivers
Attribute group	National compulsory attribute
Attribute name	Cyanobacteria (planktonic)
Attribute unit	Biovolume – mm^3/L (cubic millimetres per litre)
Attribute band and description	**Numeric Attribute State**
	80^{th} percentile*
A Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with fresh water).	≤0.5 mm^3/L biovolume equivalent for the combined total of all cyanobacteria
B Low risk of health effects from exposure to cyanobacteria (from any contact with fresh water).	>0.5 and ≤1.0 mm^3/L biovolume equivalent for the combined total of all cyanobacteria
C Moderate risk of health effects from exposure to cyanobacteria (from any contact with freshwater).	>1.0 and ≤1.8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR >1.0 and ≤10 mm^3/L total biovolume of all cyanobacteria
National bottom line	**1.8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR** **10 mm^3/L total biovolume of all cyanobacteria**
D High health risks (e.g. respiratory, irrigation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with fresh water).	>1.8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR >10 mm^3/L total biovolume of all cyanobacteria
*The 80^{th} percentile must be calculated using a minimum of 12 samples collected over 3 years. 30 samples collected over 3 years is recommended.	

Value	Ecosystem health
Freshwater body type	Rivers and streams
Attribute group	Southland attribute
Attribute name	Macroinvertebrates (wadeable rivers only)
Attribute unit	Macroinvertebrate Community Index (MCI)
Attribute band and description	**Numeric Attribute State**
	3-year rolling mean
A High quality environment where species composition is close to natural state most of the time.	>120
B Good quality environment where human activities and/or natural disturbances cause some loss of sensitive species.	100 to 120
C Fair quality environment where moderately-highly tolerant species dominate.	90 to 100
Proposed minimum acceptable state	**90**
D Poor quality environment where highly tolerant species dominate most of the time.	<90

Notes:

1. This attribute table has been developed using a combination of the receiving water quality standards in the pSWLP (which were based on supporting documentation in Ryder 2004 which was in turn based on Stark 1998) and a proposed NOF attribute table for MCI prepared for the Ministry for the Environment by Collier et al., (2014) (which was also based partly on Stark 1998). In addition, while the A/B and B/C thresholds are based on the above references, the C/D threshold (i.e., the proposed minimum acceptable state threshold) of an MCI score of 90 is reproduced from the draft NPSFM released for public consultation with Government's Essential Freshwater Package September 2019, for the reasons given below.
2. The proposed minimum acceptable state is 90, whereas the pSWLP has a minimum MCI score of 80 for the "Lowland Soft Bed" classification. The minimum acceptable state of 90 was taken from the draft NPSFM (September 2019) and has been used here because Environment Southland's historic sampling protocol and actual stream bed substrate at the majority of monitored locations defined as Lowland Soft Bed class has been a hard bed sampling (and assessment protocol) in gravel habitats. Retaining the minimum acceptable state of 90 is therefore considered most appropriate for the majority of Environment Southland's currently monitored Lowland Soft Bed sites. Nevertheless, there may be situations where due to naturally occurring characteristics the natural condition of some waterways may be below an MCI of 90, for example in highly dystrophic (low pH) or high organic content tannin stained waters.

Value	Human health for recreation
Freshwater body type	Primary contact in lakes and rivers
Attribute group	Southland attribute
Attribute name	*Escherichia coli* (*E. coli*) at popular bathing sites
Attribute unit	*E. coli*/100 mL (number of *E. coli* per hundred millimetres)
Attribute band and description	**Numeric Attribute State**
	95th percentile during the bathing season
A Estimated risk of Campylobacter infection has a <0.1% occurrence, 95% of the time.	≤ 130
B Estimated risk of Campylobacter infection has a 0.1 – 1.0% occurrence, 95% of the time.	> 130 and ≤ 260
C Estimated risk of Campylobacter infection has a 1 - 5% occurrence, 95% of the time.	> 260 and ≤ 540
National guideline for primary contact*	**540**
D Estimated risk of Campylobacter infection has a >5% occurrence, 95% of the time.	> 540
The narrative attribute state description assumes "% of time" equals "% of samples" *National bottom line proposed in the Essential Freshwater Package (September 2019) amendments to the NSPFM	

Notes:
This attribute table is derived from the *E. coli* table for primary contact sites in the draft NPSFM released for public consultation with Government's Essential Freshwater Package (September 2019). It is noted this attribute table has subsequently been included in the new NPSFM (2020) and the C/D threshold shown has become a "national bottom line" (i.e., 540 E. coli/100 mL)

Value	Ecosystem health
Freshwater body type	Rivers and streams
Attribute group	Southland attribute
Attribute name	Water temperature - summer
Attribute unit	°C (degrees Celsius)
Attribute band and description	**Numeric Attribute State**
	Summer period measurement of the Cox-Rutherford Index (CRI), averaged over the five hottest days from inspection of continuous record
A No thermal stress on any aquatic organisms that are present at matched reference (near pristine) sites.	≤18°C
B Minor thermal stress on occasion (clear days in summer) on particularly sensitive organisms such as certain insects and fish.	>18°C and ≤20°C
C Some thermal stress on occasion, with elimination of certain sensitive insects and absence of certain sensitive fish.	>20°C and ≤24°C
Proposed minimum acceptable state	**24°C**
D Significant thermal stress on a range of aquatic organisms. Risk of local elimination of keystone species with loss of ecological integrity.	>24°C

Notes: This attribute table is derived from Davies-Colley et al., (2013).

Value	Ecosystem health
Freshwater body type	Rivers and streams
Attribute group	Southland attribute
Attribute name	Water temperature - winter
Attribute unit	°C (degrees Celsius)
Attribute band and description	**Numeric Attribute State**
	May to September (inclusive) maximum
Pass Suitable for trout spawning areas	≤11°C
Proposed minimum acceptable state	**11°C**
Fail Unsuitable for trout spawning areas	>11°C

Notes: This attribute table is derived from the Appendix E standards in the pSWLP, which in turn came from the Water Plan for Southland 2010.

Value	Human health for recreation
Freshwater body type	Rivers and streams
Attribute group	Southland attribute
Attribute name	Clarity (visual distance)
Attribute unit	Horizontal black disk viewing distance in m (metres)
Attribute band and description	**Numeric Attribute State**
	Annual median of samples at ≤ median flow
A Eminently suitable for recreational use.	≥3.0
B Suitable for recreational use.	≥1.6 and <3.0
C Marginally suitable for recreational use.	≥1.3 and <1.6
Proposed minimum acceptable state	**1.3**
D Unsuitable for recreational use.	<1.3

Notes: This attribute table is derived from the clarity standards in Appendix E in the pSWLP, which in turn came from the Water Plan for Southland 2010 and supporting documentation from Ryder (2004).

Value	Human health for recreation
Freshwater body type	Rivers and streams
Attribute group	Southland attribute
Attribute name	Cyanobacteria (benthic)
Attribute unit	% cover (percentage cover of river/stream bed)
Attribute band and description	**Numeric Attribute State**
	Rolling 3 year Maximum
A Minimal risk of health exposure from benthic cyanobacteria.	<20
B Low to moderate risk of health exposure or dog deaths from benthic cyanobacteria.	≥20 and <30
C Moderate to high risk of health exposure or dog deaths from benthic cyanobacteria.	≥30 and <50
Proposed minimum acceptable state	**50**
D Potential health risks from exposure to benthic cyanobacteria, potential risks to dogs walking along river margins.	>50 OR Dislodging and accumulating mats

Notes: This attribute table is derived from the alert framework provided in section 3.5 of the *New Zealand Guidelines for Cyanobacteria in Recreational Waters – Interim Guidelines* (MfE 2009).

Value	Ecosystem health
Freshwater body type	Rivers and streams*
Attribute group	Southland attribute
Attribute name	Filamentous algae
Attribute unit	% cover (percentage cover of river/stream bed)
Attribute band and description	**Numeric Attribute State**
	Maximum
Pass	Filamentous algae >2cm covers ≤30% of visible stream bed
Proposed minimum acceptable state	**30**
Fail	Filamentous algae >2cm covers >30% of visible stream bed
*Applies to lowland hard bed, hill and mountain classes only.	

Note: this threshold is as appears in water quality standards in Appendix E to the proposed Southland Land and Water Plan and was originally derived from the New Zealand Periphyton Guidelines (Biggs 2000).

Value	Ecosystem health
Freshwater body type	Rivers and streams*
Attribute group	Southland attribute
Attribute name	Diatoms and cyanobacteria
Attribute unit	% cover (percentage cover of river/stream bed)
Attribute band and description	**Numeric Attribute State**
	Maximum
Pass	Diatoms and cyanobacteria >0.3 cm thick covers ≤60% of visible stream bed
Proposed minimum acceptable state	**60**
Fail	Diatoms and cyanobacteria >0.3 cm thick covers >60% of visible stream bed
*Applies to lowland hard bed, hill and mountain classes only.	

Note: this threshold is as appears in water quality standards in Appendix E to the proposed Southland Land and Water Plan and was originally derived from the New Zealand Periphyton Guidelines (Biggs 2000).

Value	Ecosystem health
Freshwater body type	Wadeable rivers and streams
Attribute group	Additional indicator used in this report
Attribute name	Deposited fine sediment (Quorer)
Attribute unit	g/m^2 (grams per square metre)
Attribute band and description	**Numeric Attribute State**
	Maximum
Pass	≤450
Proposed minimum acceptable state	450
Fail	>450

Note: this threshold is derived from *Sediment Assessment Methods: protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values* (Clapcott et al., 2011). This threshold has not yet been proposed as a draft freshwater objective for Southland but is included here to allow a basis to compare the current state of Southland Rivers against an established national guideline. At time of original drafting some different draft national bottom lines for deposited fine sediment had been released with the Draft NPSFM as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released with a further changed attribute table and bottom line for deposited fine sediment; however that new attribute has not yet been assessed for Southland at time of writing. It is anticipated the new NPSFM (2020) deposited fine sediment attribute table will replace the table above in due course.

Value	Ecosystem health
Freshwater body type	Wadeable rivers and streams
Attribute group	Additional indicator used in this report
Attribute name	Deposited fine sediment
Attribute unit	% cover
Attribute band and description	**Numeric Attribute State**
	Maximum
Pass	≤20
Proposed minimum acceptable state	**20**
Fail	>20

Note: this threshold is derived from *Sediment Assessment Methods: protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values* (Clapcott et al., 2011). This threshold has not yet been proposed as a draft freshwater objective for Southland but is included here to allow a basis to compare the current state of Southland Rivers against an established national guideline. At time of original drafting some different draft national bottom lines for deposited fine sediment had been released with the Draft NPSFM as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released with a further changed attribute table and bottom line for deposited fine sediment; however that new attribute has not yet been assessed for Southland at time of writing. It is anticipated the new NPSFM (2020) deposited fine sediment attribute table will replace the table above in due course.

Value	Ecosystem health	
Freshwater body type	Rivers and streams	
Attribute group	Additional proposed national compulsory attribute requiring a limit	
Attribute name	Dissolved inorganic nitrogen	
Attribute unit	DIN mg/L (milligrams per litre)	
Attribute band and description	**Numeric Attribute State**	
	Median	95^{th} percentile
A Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to DIN enrichment are expected.	≤0.24	≤0.56
B Ecological communities are slightly impacted by minor DIN elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates.	>0.24 and ≤0.50	>0.56 and ≤1.10
C Ecological communities are impacted by moderate DIN elevation above natural reference conditions, but sensitive species are not experiencing nitrate toxicity. If other conditions also favour eutrophication, DIN enrichment may cause increased algal and plant growth, loss of sensitive macroinvertebrate and fish taxa, and high rates of respiration and decay.	>0.50 and ≤1.0	>1.10 and ≤2.05
Proposed national bottom line	**1.0**	**2.05**
D Ecological communities impacted by substantial DIN elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DIN enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia and nitrate toxicity are lost.	>1.0	>2.05
Groundwater concentrations also need to be managed to ensure resurgence via springs and seepage does not degrade rivers through DIN enrichment. Numeric attribute state must be derived from the rolling median of monthly monitoring over five years.		

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has not included an attribute table for DIN.

Value	Ecosystem health	
Freshwater body type	Rivers and streams	
Attribute group	Additional proposed national compulsory attribute requiring a limit	
Attribute name	Dissolved reactive phosphorus	
Attribute unit	DRP mg/L (milligrams per litre)	
Attribute band and description	**Numeric Attribute State**	
	Median	95^{th} percentile
A Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to DRP enrichment are expected.	≤0.006	≤0.021
B Ecological communities are slightly impacted by minor DRP elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates.	>0.006 and ≤0.010	>0.021 and ≤0.030
C Ecological communities are impacted by moderate DRP elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate and fish taxa, and high rates of respiration and decay.	>0.010 and ≤0.018	>0.030 and ≤0.054
Proposed national bottom line	**0.018**	**0.054**
D Ecological communities impacted by substantial DRP elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DRP enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost.	>0.018	>0.054
Numeric attribute state must be derived from the rolling median of monthly monitoring over five years.		

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above for DRP but without setting a national bottom line at the C/D band threshold.

Value	Ecosystem health											
Freshwater body type	Rivers and streams											
Attribute group	Southland attribute											
Attribute name	Suspended fine sediment											
Attribute unit	Turbidity (FNU)											
Attribute band and description	**Numeric Attribute State**											
	1	2	3	4	5	6	7	8	9	10	11	12
A Minimal impact of suspended sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	<0.2	<6.2	<1.3	<3.3	<7.5	<4.8	<2.3	<4.3	<1.2	<1.1	<1.1	<2.4
B Low to moderate impact of suspended sediment on instream biota. Abundance of sensitive fish species may be reduced.	<2.5	<7.9	<1.6	<3.9	<9.8	<6.3	<2.8	<5.2	<1.4	<1.3	<1.3	<2.7
C Moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost.	<3.2	<10.5	<2.0	<4.8	<13.1	<8.3	<3.3	<6.4	<1.6	<.5	<1.6	<3.1
Proposed national bottom line	**3.2**	**10.5**	**2.0**	**4.8**	**13.1**	**8.3**	**3.3**	**6.4**	**1.6**	**1.5**	**1.6**	**3.1**
D High impact of suspended sediment on instream biota. Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	>3.2	>10.5	>2.0	>4.8	>13.1	>8.3	>3.3	>6.4	>1.6	>1.5	>1.6	>3.1
The minimum record length for grading a site is two years of at least monthly samples (at least 24 samples). See Tables on next 2 pages for the definition of each suspended sediment class and its River Environment Classification composition.												

Note: the attribute does not apply in the following rivers and streams due to naturally occurring processes:

1. Naturally highly coloured brown-water streams;
2. Glacial flour affected streams and rivers;
3. Selected lake-fed REC classes (particularly warm climate classes) where high turbidity may reflect autochthonous phytoplankton production (as opposed to organic/inorganic sediment derived from the catchment).

Note: the attribute table above is sourced from the draft national bottom lines for suspended fine sediment released with the Draft NPSFM as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released with a further changed attribute table and bottom line for suspended fine sediment; however that new attribute has not yet been assessed for Southland at time of writing. It is anticipated the new NPSFM (2020) suspended fine sediment attribute table will replace the table above in due course.

Value	Ecosystem health											
Freshwater body type	Rivers and streams											
Attribute group	Southland attribute											
Attribute name	Deposited fine sediment											
Attribute unit	% fine sediment cover											
Attribute band and description	**Numeric Attribute State**											
	1	2	3	4	5	6	7	8	9	10	11	12
A Minimal impact of deposited fine sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	<84	<9	<42	<12	<80	<30	<41	<22	<48	<15	<76	<27
B Low to moderate impact of deposited fine sediment on instream biota. Abundance of sensitive macroinvertebrate species may be reduced.	<90	<15	<50	<17	<86	<38	<48	<33	<54	<22	<82	<36
C Moderate to high impact of deposited fine sediment on instream biota. Sensitive macroinvertebrate species may be lost.	≤97	≤21	≤60	≤23	≤92	≤46	≤56	≤45	≤61	≤29	≤89	≤45
Proposed national bottom line	**97**	**21**	**60**	**23**	**92**	**46**	**56**	**45**	**61**	**29**	**89**	**45**
D High impact of deposited fine sediment on instream biota. Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	>97	>21	>60	>23	>92	>46	>56	>45	>61	>29	>89	>45
The indicator score is percentage cover of the streambed in a run habitat determined by the instream visual method, SAM2, and the monitoring method is defined in p. 17-20 of Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) *Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream value*s. Cawthron Institute, Nelson, New Zealand. The minimum recorded length for grading a site is 24 samples taken over 2 years of monthly monitoring, or longer for sites where flow conditions only permit monthly monitoring seasonally. See Tables on next 2 pages for the definition of each class' River Environment Classification composition.												

Note: the attribute table above is sourced from the draft national bottom lines for deposited fine sediment released with the Draft NPSFM as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released with a further changed attribute table and bottom line for deposited fine sediment; however that new attribute has not yet been assessed for Southland at time of writing. It is anticipated the new NPSFM (2020) deposited fine sediment attribute table will replace the table above in due course.

Sediment classification tables

Note: the tables below apply to the suspended fine sediment and deposited fine sediment attribute tables on the 2 pages above; they were sourced from the Draft NPSFM (September 2019). Since then the new NPSFM (2020) has been released with new classification tables that will replace those shown on the 2 pages below in due course.

Suspended Sediment Class	Suspended sediment REC groups
1	WW_Low_VA; CW_Low_VA
2	WD_Low_AI
3	CD_Low_HS
4	CW_Low_SS
5	WW_Low_SS; WD_Low_SS
6	WW_Low_HS
7	CD_Low_AI; CW_Hill_VA
8	CD_Low_SS
9	CW_Hill_HS; CD_Hill_HS; CW_Low_AI
10	CW_Lake_Any
11	CW_Low_HS
12	CW_Mount_HS; CW_Hill_SS

Deposited Sediment Class	Deposited sediment REC groups
1	WD_Low_VA; WD_Low_AI
2	WW_Hill_HS; CW_Mount_VA
3	CW_Lake_Any; CW_Low_AI; CD_Hill_SS
4	CW_Mount_SS
5	WD_Low_SS
6	WW_Low_VA; WW_Low_HS; CD_Low_VA; CD_hill_AI; CD_Low_HS
7	WW_Low_SS; CD_Low_SS; CD_Low_AI
8	WW_Lake_Any
9	WD_Low_HS
10	WW_Hill_VA; CW_Hill_HS; CW_Low_HS; CW_Mount_HS; CW_Hill_SS; CW_Hill_AI; CD_Mount_HS; CW_Mount_AI
11	WW_Low_AI
12	CW_Hill_VA; CW_Low_VA; CW_Low_SS; CD_Hill_HS

REC Variable	REC Values	SSC abbreviation
Climate	Warm-Wet	Warm-Wet (WW)
	Warm-Extremely Wet	
	Warm-Dry	Warm-Dry (WD)
	Cold-Wet	Cold-Wet (CD)
	Cold-Extremely Wet	
	Cold-Dry	Cold-Dry (CD)
Topography (source of flow)	Lowland	Lowland (Low)
	Lakefed	Lakefed (Lake)
	Hill	Hill (Hill)
	Mountain	Mountain (Mount)
	Glacial Mountain	
Geology	Soft Sedimentary	Soft Sedimentary (SS)
	Plutonic Volcanic	
	Miscellaneous	
	Hard Sedimentary	Hard Sedimentary (HS)
	Alluvium	Alluvium (Al)
	Volcanic Basic	Volcanic (VA)
	Volcanic Acidic	

Value	Ecosystem health	
Freshwater body type	Wadeable rivers and streams	
Attribute group	Additional proposed national compulsory attribute requiring an action plan	
Attribute name	Macroinvertebrates	
Attribute unit	Macroinvertebrate Community Index (MCI) score; Quantitative Macroinvertebrate Community Index (QMCI) score	
Attribute band and description	**Numeric Attribute State**	
	QMCI	MCI
A Macroinvertebrate community indicative of pristine conditions with almost no organic pollution or nutrient enrichment.	≥6.5	≥130
B Macroinvertebrate community indicative of mild organic pollution or nutrient enrichment. Largely composed of taxa sensitive to organic pollution/nutrient enrichment.	≥5.5 and <6.5	≥110 and <130
C Macroinvertebrate community indicative of moderate organic pollution or nutrient enrichment. There is a mix of taxa sensitive and insensitive to organic pollution/nutrient enrichment.	≥4.5 and <5.5	≥90 and <110
Proposed national bottom line	**4.5**	**90**
D Macroinvertebrate community indicative of severe organic pollution or nutrient enrichment. Communities are largely composed of taxa insensitive to organic pollution/nutrient enrichment.	<4.5	<90
MCI and QMCI scores to be determined using annual samples taken between December and March inclusive with either fixed counts with at least 200 individuals, or full counts, and with current state calculated as the five-year rolling average score. All sites in Deposited Sediment Classes 1, 5, and 11 are to use soft-sediment sensitive scores and taxonomic resolution as defined in Table A1.1 in Clapcott et al. 2017 *Macroinvertebrate metrics for the National Policy Statement for Freshwater Management.* Cawthron: Nelson, New Zealand. MCI and QMCI to be assessed using the method defined in Stark JD, Maxted, JR 2007. *A user guide for the Macroinvertebrate Community Index*. Prepared for the Ministry for the Environment. Cawthron Report No. 1166.58, except for sites in deposited sediment classes 1, 5 and 11, which require use of the soft-sediment sensitivity scores and taxonomic resolution defined n Table A1.1 in Clapcott et al. 2017.		

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Value	Ecosystem health
Freshwater body type	Wadeable rivers and streams
Attribute group	Additional proposed national compulsory attribute requiring an action plan
Attribute name	Macroinvertebrates
Attribute unit	Macroinvertebrate Average Score Per Metric (ASPM)
Attribute band and description	**Numeric Attribute State**
	ASPM score
A Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions.	≥0.6
B Macroinvertebrate communities have mild-to-moderate loss of ecological integrity.	<0.6 and ≥0.4
C Macroinvertebrate communities have moderate-to-severe loss of ecological integrity.	<0.4 and ≥0.3
Proposed national bottom line	**0.3**
D Macroinvertebrate communities have severe loss of ecological integrity.	<0.3
ASPM scores to be determined using annual samples taken between December and March (inclusive) with either fixed counts with at least 200 individuals, or full counts, and with current state calculated as the fiver-year rolling average score. All sites in Deposited Sediment Classes 1, 5, and 11 are to use soft-sediment sensitivity scores and taxonomic resolution is defined in Table A1.1 in Clapcott et al. 2017 *Macroinvertebrate metrics for the National Policy Statement for Freshwater Management*. Cawthron: Nelson, New Zealand. When normalising scores for the ASPM, use the following minimums and maximums: %EPT-abundance (0-100), EPT-richness (0-29), MCI (0-200). Collier, K. J. (2008). *Average score per metric: an alternative metric aggregation method for assessing Wadeable stream health*. New Zealand Journal of Marine and Freshwater Research, 42(4), 367-378.	

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Value	Ecosystem health
Freshwater body type	Wadeable rivers and streams
Attribute group	Additional proposed national compulsory attribute requiring an action plan
Attribute name	Fish
Attribute unit	Fish Index of Biotic Integrity (F-IBI)
Attribute band and description	**Numeric Attribute State**
	Average
A High integrity of fish community. Habitat and migratory access have minimal degradation.	≥34
B Moderate integrity of fish community. Habitat and/or migratory access are reduced and show some signs of stress.	<34 and ≥28
C Low integrity of fish community. Habitat and/or migratory access is considerably impairing and stressing the community.	<28 and ≥18
Proposed national bottom line	**18**
D Severe loss of fish community integrity. There is substantial loss of habitat and/or migratory access, causing a high level of stress on the community.	<18
Sampling is to occur at least annually between December and March (inclusive) following the protocols for at least one of the backpack electrofishing method, spotlighting method, or trapping method in Joy M, David B, and Lake M. 2013. *New Zealand Freshwater Fish Sampling Protocols (Part 1): Wadeable rivers and streams*. Palmerston North, New Zealand: Massey University. The F-IBI score is to be calculated using the general method defined by Joy M. K., & Death, R. G (2004). *Application of the Index of Biotic Integrity Methodology to New Zealand Freshwater Fish Communities*. Environmental Management, 34(3), 415-428. but will exclude salmonids.	

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above for F-IBI but without setting any national bottom line at the C/D band threshold.

Value	Ecosystem health	
Freshwater body type	Rivers and streams	
Attribute group	Additional proposed national compulsory attribute requiring an action plan	
Attribute name	Dissolved oxygen	
Attribute unit	mg/L (milligrams per litre)	
Attribute band and description	**Numeric attribute state**	
	7-day mean minimum	1-day mean minimum
A No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.	≥8.0	≥7.5
B Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.	≥7.0 and <8.0	≥5.0 and <7.5
C Moderate stress on a number of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.	≥5.0 and <7.0	≥4.0 and <5.0
Proposed national bottom line	**5.0**	**4.0**
D Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.	<5.0	<4.0
Seven-day continuous dissolved oxygen monitoring to be collected at least once during summer (December to March inclusive). Objectives apply year-round.		

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Value	Ecosystem health
Freshwater body type	Rivers and streams
Attribute group	Additional proposed national compulsory attribute requiring an action plan
Attribute name	Ecosystem metabolism (Both Gross Primary Production and Ecosystem Respiration)
Attribute unit	$gO_2m^{-2}d^{-1}$ (grams of dissolved oxygen per square metre per day)
Derived from at least seven days of continuous dissolved oxygen monitoring to be collected at least once during summer (December to March inclusive), using the method of Young R.G., Clapcott, J. E., Simon, K. 2016. Ecosystem functions and stream health. Advances in New Zealand Freshwater Science. NZ Freshwater Sciences Society, NZ Hydrological Society.	

Note: Councils are to monitor, and develop an action plan to respond to deteriorating trends.

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Appendix 3: Lake Attribute State Option Tables

Value	**Ecosystem health**	
Freshwater body type	Lakes	
Attribute group	National compulsory attribute	
Attribute name	Phytoplankton	
Attribute unit	mg chl-*a*/m^3 (milligrams chlorophyll-*a* per cubic metre)	
Attribute band and description	**Numeric attribute state**	
	Annual median	Annual maximum
A Lake ecological communities are healthy and resilient, similar to natural reference conditions.	≤2	≤10
B Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.	>2 and ≤5	>10 and ≤25
C Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions. Reduced water clarity is likely to affect habitat available for native macrophytes.	>5 and ≤12	>25 and ≤60
National bottom line	**12**	**60**
D Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte / seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.	>12	>60
Recommended minimum data requirements are 3 years of monthly sampling (n=36). For lakes and lagoons that are intermittently open to the sea, monitoring data should be analysed separately for closed periods and open periods.		

Value	Ecosystem health
Freshwater body type	Lakes
Attribute group	National compulsory attribute
Attribute name	Total phosphorus
Attribute unit	mg/m^3 (milligrams per cubic metre)
Attribute band and description	**Numeric attribute state**
	Annual median
A Lake ecological communities are healthy and resilient, similar to natural reference conditions.	≤10
B Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrient levels that are elevated above natural reference conditions.	>10 and ≤20
C Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions.	>20 and ≤50
National bottom line	**50**
D Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.	>50
Recommended minimum data requirements are 3 years of monthly sampling (n=36). For lakes and lagoons that are intermittently open to the sea, monitoring data should be analysed separately for closed periods and open periods.	

Value	Ecosystem health	
Freshwater body type	Lakes	
Attribute group	National compulsory attribute	
Attribute name	Total nitrogen	
Attribute unit	mg/m^3 (milligrams per cubic metre)	
Attribute band and description	**Numeric attribute state**	
	Annual median	Annual median
	Seasonally Stratified and Brackish	Polymictic
A Lake ecological communities are healthy and resilient, similar to natural reference conditions.	≤160	≤300
B Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.	>160 and ≤350	>300 and ≤500
C Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions. Reduced water clarity is likely to affect habitat available for native macrophytes.	>350 and ≤750	>500 and ≤800
National bottom line	**750**	**800**
D Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte / seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.	>750	>800
Recommended minimum data requirements are 3 years of monthly sampling (n=36). For lakes and lagoons that are intermittently open to the sea, monitoring data should be analysed separately for closed periods and open periods.		

Value	Ecosystem health	
Freshwater body type	Lakes and rivers	
Attribute group	National compulsory attribute	
Attribute name	Ammonia toxicity	
Attribute unit	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)	
Attribute band and description	**Numeric attribute state**	
	Annual median	Annual maximum
A 99% species protection level: No observed effect on any species tested.	≤0.03	≤0.05
B 95% species protection level: Starts impacting occasionally on the 5% most sensitive species.	>0.03 and ≤0.24	>0.05 and ≤0.40
C 80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).	>0.24 and ≤1.30	>0.40 and ≤2.20
National bottom line[1]	**1.30[1]**	**2.20[1]**
D Starts approaching acute impact level (i.e. risk of death) for sensitive species	>1.30	>2.20
Based on pH 8 and temperature of 20°C and recommended minimum data requirements of 3 years of monthly sampling (n=36). Where a sample is missed the state may be determined over a longer time period. Compliance with the numerical attribute states should be undertaken after pH adjustment		

[1] Note the NPSFM (2020) revised the national bottom line for ammonia toxicity in rivers and lakes upwards to the B/C threshold

Value	Ecosystem health
Freshwater body type	Lakes and lake-fed rivers
Attribute group	National compulsory attribute
Attribute name	Cyanobacteria (planktonic)
Attribute unit	Biovolume – mm^3/L (cubic millimetres per litre)
Attribute band and description	**Numeric attribute state**
	80^{th} percentile
A Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with fresh water).	≤0.5 mm^3/L biovolume equivalent for the combined total of all cyanobacteria
B Low risk of health effects from exposure to cyanobacteria (from any contact with fresh water).	>0.5 and ≤1.0 mm^3/L biovolume equivalent for the combined total of all cyanobacteria
C Moderate risk of health effects from exposure to cyanobacteria (from any contact with freshwater).	>1.0 and ≤1.8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR >1.0 and ≤10 mm^3/L total biovolume of all cyanobacteria
National bottom line	**1.8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR** **10 mm^3/L total biovolume of all cyanobacteria**
D High health risks (e.g. respiratory, irrigation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with fresh water).	>1.8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR >10 mm^3/L total biovolume of all cyanobacteria
Recommended data requirements are 30 samples over 3 years with a minimum requirement of 12 samples over 3 years.	

Value	Human health for recreation			
Freshwater body type	Lakes and rivers			
Attribute group	National compulsory attribute			
Attribute name	*Escherichia coli* (*E. coli*)			
Attribute unit	*E. coli*/100 mL (number of *E. coli* per hundred millilitres)			
Attribute band and description	**Numeric attribute state**			
	% exceedances over 540 cfu/100 mL	% exceedances over 260 cfu/100 mL	Median concentration (cfu/100 mL)	95th percentile of *E.coli*/100 mL
A For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 1%*.	<5%	<20%	≤130	≤540
B For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 2%*.	5 to 10%	20 to 30%	≤130	≤1,000
C For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 3%*.	10 to 20%	20 to 34%	≤130	≤1,200
D 20 to 30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >3%*.	20 to 30%	>34%	>130	>1,200
E For more than 30% of the time the estimate risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is 7%*.	>30%	>50%	>260	>1,200

* The predicted average infection risk is the overall average infection to swimmers based on a random exposure on a random day, ignoring any possibility of not swimming during high flows or when a surveillance advisory is in place (assuming that the *E. coli* concentration follows a lognormal distribution). Actual risk will generally be less if a person does not swim during high flows.

[1] Attribute state should be determined by using a minimum of 60 samples over a maximum of 5 years, collected on a regular basis regardless of weather and flow conditions. However, where a sample has been missed due to adverse weather or error, attribute state may be determined using samples over a longer timeframe.

[2] Attribute state must be determined by satisfying all numeric attribute states.

Recommended minimum data requirements are 5 years of monthly sampling (n=60). Where a sample is missed the state may be determined over a longer time period.

Value	Human health for recreation
Freshwater body type	Primary contact in lakes and rivers
Attribute group	Southland attribute
Attribute name	*Escherichia coli* (*E. coli*) at popular bathing sites
Attribute unit	*E. coli*/100 mL (number of *E. coli* per hundred millimetres)
Attribute band and description	**Numeric attribute state**
	95th percentile during the bathing season
A Estimated risk of Campylobacter infection has a <0.1% occurrence, 95% of the time.	≤ 130
B Estimated risk of Campylobacter infection has a 0.1 – 1.0% occurrence, 95% of the time.	> 130 and ≤ 260
C Estimated risk of Campylobacter infection has a 1 - 5% occurrence, 95% of the time.	> 260 and ≤ 540
National guideline for primary contact*	**540**
D Estimated risk of Campylobacter infection has a >5% occurrence, 95% of the time.	> 540
The narrative attribute state description assumes "% of time" equals "% of samples" *National bottom line proposed in the Essential Freshwater Package (September 2019) amendments to the NSPFM	

Notes:
This attribute table is derived from the *E. coli* table for primary contact sites in the draft NPSFM released for public consultation with Government's Essential Freshwater Package (September 2019). It is noted this attribute table has subsequently been included in the new NPSFM (2020) and the C/D threshold shown has become a "national bottom line" (i.e., 540 E. coli/100 mL)

Value	Ecosystem health
Freshwater body type	Lakes
Attribute group	Southland attribute
Attribute name	Trophic state (TLI)
Attribute unit	Trophic Level Index (TLI) score (as either TLI3* or TLI4)
Attribute band and description	**Numeric attribute state**
	3-year mean (of annual TLI score)
A+ Microtrophic: The lake is clear with very low levels of nutrients and algae.	≤2
A Oligotrophic: The lake is clear with low levels of nutrients and algae.	≤3
B Mesotrophic: The lake has moderate levels of nutrients and algae.	>3 and ≤4
C Eutrophic: The lake is green and murky, with high amounts of nutrients and algae.	>4 and ≤5
Proposed minimum acceptable state	**5**
D Supertrophic: The lake is saturated in nutrients, excess algae and poor water clarity.	>5

Recommended minimum data requirements are 3 years of monthly sampling

* TLI3 is used in preference to TLI4 when there are no reliable clarity measures e.g. where a mixture of horizontal and vertical secchi depth is used.

Value	Ecosystem health
Freshwater body type	Lakes
Attribute group	Southland attribute
Attribute name	Macrophytes
Attribute unit	% cover (percentage cover of available habitat)
Attribute band and description	**Numeric attribute state**
	Annual maximum
A Macrophyte communities are healthy and resilient, similar to natural conditions.	≥70%
B Macrophyte and ecological communities are slightly impacted from natural conditions.	≥50 and <70%
C Ecological communities are moderately impacted from natural conditions.	≥20 and <50%
Proposed minimum acceptable state	**20**
D Ecological communities significantly impacted by reduced macrophyte over due to loss of habitat, food sources and less sediment stabilisation. Macrophytes have limited ability to buffer nutrient loads and there is a high risk of a regime shift to a persistent, degraded state.	<20%
Numeric attribute state to be based on a survey during the period of likely maximum annual biomass. Available habitat to be determined based on morphological, hydrological and substrate conditions. Some clarity will need to be developed around the term "available habitat" and a consistent method specified.	

Value	Ecosystem health
Freshwater body type	Lakes
Attribute group	Southland attribute
Attribute name	Trophic state (LakeSPI)
Attribute unit	LakeSPI Index (%)
Attribute band and description	**Numeric attribute state**
	LakeSPI Index (% of maximum potential score)
A+ Excellent ecological health and high value.	≥90
A High ecological health.	≥75 and <90
B Good ecological health.	≥50 and <75
C Moderate ecological health.	≥20 and <50
Proposed minimum acceptable state	**20**
D Poor ecological health or non-vegetated (0%)	<20
Numeric attribute state to be calculated annually following the method described in Clayton J, and Edwards T. 2006. *LakeSPI: A method for monitoring ecological condition in New Zealand Lakes.* User Manual Version 2. Hamilton, New Zealand: National Institute of Water & Atmospheric Research Ltd.	

Value	Ecosystem health	
Freshwater body type	Lakes	
Attribute group	Southland attribute	
Attribute name	Nitrate toxicity	
Attribute unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)	
Attribute band and description	**Numeric attribute state**	
	Annual median	Annual 95th percentile
A High conservation value system. Unlikely to be effects even on sensitive species.	≤1.0	≤1.5
B Some growth effect on up to 5% of species.	>1.0 and ≤2.4	>1.5 and ≤3.5
C Some growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.	>2.4 and ≤6.9	>3.5 and ≤9.8
Proposed minimum acceptable state[1]	**6.9[1]**	**9.8[1]**
D Impacts on growth of multiple species, and starts approaching acute impact level (i.e. risk of death) for sensitive species at high concentrations.	>6.9	>9.8
Recommended minimum data requirements are 3 years of monthly sampling (n=36).		

[1] Note the NPSFM (2020) revised the national bottom line for nitrate toxicity in rivers and lakes upwards to the B/C threshold

Value	Ecosystem health
Freshwater body type	Lakes
Attribute group	Additional proposed national compulsory attribute requiring an action plan
Attribute name	Submerged plants (natives)
Attribute unit	LakeSPI (native condition index) (%)
Attribute band and description	**Numeric attribute state**
	LakeSPI (native condition index) (% of maximum potential score)
A Excellent ecological condition. Native submerged plant communities are almost completely intact.	>75
B High ecological condition. Native submerged plant communities are largely intact.	>50 and ≤75
C Moderate ecological condition. Native submerged plant communities are moderately impacted.	≥20% and ≤50
Proposed national bottom line	**20**
D Poor ecological condition. Native submerged plant communities are largely degraded or absent.	<20

Monitoring to be conducted at least once every three years, following the method described in Clayton J, and Edwards T. 2006. *LakeSPI: A method for monitoring ecological condition in New Zealand Lakes.* User Manual Version 2. Hamilton, New Zealand: National Institute of Water & Atmospheric Research Ltd p57.

Scores are reported as a percentage of maximum potential score (%) of the Native Condition Index, and lakes in a devegetated state receive scores of 0.

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Value	Ecosystem health
Freshwater body type	Lakes
Attribute group	Additional proposed national compulsory attribute requiring an action plan
Attribute name	Submerged plants (invasive species) (%)
Attribute unit	LakeSPI (invasive impact index)
Attribute band and description	**Numeric attribute state**
	LakeSPI (invasive impact index) (% of maximum potential score)
A No invasive plants present in the lake. Native plant communities remain intact.	0
B Invasive plants having only a minor impact on native vegetation. Invasive plants will be patchy in nature co-existing with native vegetation. Often major weed species not present or in early stages of invasion.	≥1 and ≤25
C Invasive plants having a moderate to high impact on native vegetation. Native plant communities likely displaces by invasive wee beds particularly in the 2 – 8 m depth range.	≥26 and ≤90
Proposed national bottom line	**90**
D Tall dense weed beds exclude native vegetation and dominate entire depth range of plant growth. Species concerned likely hornwort and Egeria.	>90
Numeric attribute state to be calculated annually following the method described in Clayton J, and Edwards T. 2006. *LakeSPI: A method for monitoring ecological condition in New Zealand Lakes.* User Manual Version 2. Hamilton, New Zealand: National Institute of Water & Atmospheric Research Ltd p57.	

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Value	**Ecosystem health**
Freshwater body type	Lakes
Attribute group	Additional proposed national compulsory attribute requiring an action plan
Attribute name	Dissolved oxygen (lake bottom)
Attribute unit	mg/L (milligrams per litre)
Attribute band and description	**Numeric attribute state**
	Measured or estimated annual minimum
A No risk from bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.	≥7.5
B Minimal risk from bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.	≥2.0 and <7.5
C Risk from bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.	≥0.5 and <2.0
Proposed national bottom line	**0.5**
D Likelihood from bottom dissolved oxygen of biogeochemical conditions resulting in nutrient release from sediments.	<0.5
To be measured less than 1m above sediment surface at the deepest part of the lake using either continuous monitoring sensors or discrete DO profiles Recommended minimum data requirements for numeric attribute state are 3 years of monthly sampling (n=36)	

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Value	Ecosystem health
Freshwater body type	Seasonally stratifying lakes
Attribute group	Additional proposed national compulsory attribute requiring an action plan
Attribute name	Dissolved oxygen (mid-hypolimnetic)
Attribute unit	mg/L (milligrams per litre)
Attribute band and description	**Numeric attribute state**
	Measured or estimated annual minimum
A No stress cause to any fish species by low dissolved oxygen.	≥7.5
B Minor stress on sensitive fish seeking thermal refuge in the hypolimnion. Minor risk of reduced abundance of sensitive fish and macroinvertebrate species.	≥2.0 and <7.5
C Moderate stress on sensitive fish seeking thermal refuge in the hypolimnion. Risk of sensitive fish species being lost.	≥0.5 and <2.0
Proposed national bottom line	**0.5**
D Significant stress on a range of fish seeking thermal refuge in the hypolimnion. Likelihood of local extinctions of fish species and loss of ecological integrity.	<0.5
Numeric attribute state to be measured using either continuously monitoring sensors or discrete dissolve oxygen profiles. Recommended minimum data requirements for numeric attribute state are 3 years of monthly sampling (n=36)	

Note: the attribute table above is sourced from the Draft NPSFM released as part of Government's Essential Freshwater Package (September 2019). Since then the new NPSFM (2020) has been released and has included this same attribute table as shown above.

Appendix 4: Estuary Attribute State Option Tables

Value	**Ecosystem health**		
Freshwater body type	Estuaries and open coast		
Attribute group	Southland attribute		
Attribute name	Phytoplankton		
Attribute unit	mg chl-*a*/m^3 (milligrams chlorophyll-*a* per cubic metre)*		
Attribute band and description	**Numeric attribute state**		
	Coastal waters[1]	Estuaries (saline)[1]	Estuaries (less saline)[1]
	90th percentile[2]		
A Estuary ecological communities are healthy and resilient, similar to natural reference conditions.	≤3.5	≤4	≤8
B Estuary ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.	>3.5 and ≤7.0	>4 and ≤8	>8 and ≤12
C Estuary ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions. Reduced water clarity is likely to affect habitat available for native macrophytes.	>7.0 and ≤10.5	>8 and ≤12	>12 and ≤16
Proposed minimum acceptable state	**10.5**	**12**	**16**
D Estuary ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte / seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters.	>10.5	>12	>16

*Chlorophyll *a* from representative sites of estuary water column.

[1] Coastal waters and saline estuaries are defined by having salinity >30 ppt and less saline estuaries <30 ppt salinity.

[2] based on monthly measurements over 3 years.

Value	Ecosystem health
Freshwater body type	Estuaries and open coast
Attribute group	Southland attribute
Attribute name	Toxicants in sediment
Attribute unit	mg/kg (milligrams per kilogram dry weight)
Attribute band and description	**Numeric attribute state**
	Median[1]
A Very low risk of harm to aquatic species.	≤25% of DGV
B Low risk of harm to aquatic species.	>25 and ≤50% of DGV
C <10% probability of harm to aquatic species.	>50 and ≤100% of DGV
Proposed minimum acceptable state	**100% of DGV**
D >10% probability of harm to aquatic species.	>100% of DGV

The numeric attribute state is based on the ANZECC interim Default Guideline Value (DGV) and in the sediment quality guidelines (2018): https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/sediment-quality-toxicants

As at October 2019, the DGV for toxicants in sediment are:

- Antimony DGV is 2.0 mg/kg
- Arsenic DGV is 20 mg/kg
- Cadmium DGV is 1.5 mg/kg
- Chromium DGV is 80 mg/kg
- Copper DGV is 65 mg/kg
- Lead DGV is 50 mg/kg
- Nickel DGV is 21 mg/kg
- Silver DGV is 1.0 mg/kg
- Zinc DGV is 200 mg/kg

[1]Up to three years of data. Note that background concentrations may be naturally elevated in some areas due to geology.

Value	Ecosystem health
Freshwater Body Type	Tidal lagoon estuaries (SIDES) and tidal river estuaries (SSRTRE)
Attribute group	Southland attribute
Attribute name	Mud content
Attribute unit	% mud content*
Attribute band and description	**Numeric Attribute State**
	3-year median[1]
A Little to no stress on aquatic organisms and seagrass beds. Ecological communities are healthy and resilient	≤5
B Minor stress on aquatic organisms, particularly sensitive species.	5 and ≤15
C Moderate stress on a number of aquatic organisms and risk of some species being lost.	>15 and ≤25
Proposed minimum acceptable state	**25**
D Significant, persistent stress on a range of macroinvertebrates. A likelihood of local extinctions of keystone species and loss of ecological integrity.	>25

*Measurement applies to individual sites within an estuary. Criteria to ensure monitored sites are adequately representative of the estuary are to be developed.

[1] To be based on an annual monitoring regime.

Value	Ecosystem health
Freshwater Body Type	Tidal lagoon estuaries (SIDES) and tidal river estuaries (SSRTRE)
Attribute group	Additional attribute
Attribute name	Mud extent
Attribute unit	m^2 of intertidal area
Attribute band and description	**Numeric Attribute State**
	Comparison to baseline monitoring
Pass No likely further deterioration of ecology due to increased mud cover.	Decrease or no change[1]
Fail Likely deterioration of ecology due to increased mud cover.	Increase
Muddiness is defined as having >25% mud content. [1] Change is calculated from earliest available monitoring assessment.	

Note that no bottom line has been proposed as it is difficult to establish the spatial coverage of mud that is excessive along with reference conditions. Therefore, this attribute may be more suited as a narrative or for the formation of a target.

Value	Ecosystem health
Freshwater Body Type	Tidal lagoon estuaries (SIDES) and tidal river estuaries (SSRTRE)
Attribute group	Southland attribute
Attribute name	Sedimentation rate
Attribute unit	mm/year (millimetres per year)
Attribute band and description	**Numeric Attribute State**
	Slope[1]
Pass No discernible effect on ecology.	≤2 + NSR[2]
Fail Significant adverse effects on ecology.	>2 + NSR[2]
[1]Trend slope tested to determine if statistically significantly different (90%) from 2 mm/y + natural state rate. Slope determined from all plate data points for the site. Minimum of 5 years to be used to determine slope. Sites are >25% mud content. Rate may be calculated from post significant erosion events and periods. [2]Natural State rate; for SSTRE 0.2mm/yr and SIDES 1mm/yr.	

Note that Townsend and Lohrer (2015) propose a default guideline value of 2mm per year above the natural sedimentation rate. This is based on evidence that shows adverse effects on ecology. One of the supporting studies (Lohrer et al. 2004a) assessed the effects of the thickness of mud deposit on the invertebrate community and found negative impacts from increasing deposited mud thickness on diversity (number of taxa) and number of individuals. This would suggest that the attribute proposed may be towards the top of any banding. The Lohrer et al. (2004a) study experimented with deposits up to 7mm in thickness, thus the lowest banding is not likely to be more than 10mm/yr for SIDEs or SSTREs. It is also worth noting that there will be multi-stressors (such as pH, nutrient concentration and organic matter content) having an effect. In the absence of a banding system this attribute may be more suited as a narrative and should be considered further.

Value	Ecosystem health
Freshwater body type	Tidal lagoon estuaries (SIDES) and tidal river estuaries (SSRTRE)
Attribute group	Southland attribute
Attribute name	Sediment oxygen levels
Attribute unit	aRPD mm (depth of apparent Redox Potential Discontinuity in millimetres)
Attribute band and description	**Numeric attribute state**
	Median[1]
A+ Little to no stress on aquatic organisms and seagrass beds. Ecological communities are healthy and resilient, similar to natural reference conditions.	≥30
A Minor stress on aquatic organisms and seagrass.	≥20 and <30
B Moderate stress on a number of aquatic organisms exceeding preference levels for some species. A moderate risk of losing sensitive macroinvertebrate species due to oxygen stress.	≥10 and <20
C Significant, persistent stress on a range of macroinvertebrates. A likelihood of local extinctions of keystone species and loss of ecological integrity.	≥5 and <10
Proposed minimum acceptable state	**5**
D Severe loss of macroinvertebrates, a shift in the community structure and reduction in available habitat, loss of ecological integrity in addition to a fundamental shift in biogeochemical processes.	<5

[1] Measurement applies to individual sites within an estuary with a minimum of 10 measurements per site.

Measurements should be taken by skilled and experienced personnel. aRPD is a variable measure between providers and care is needed when analysing data from more than provider.

Value	Ecosystem health	
Freshwater Body Type	Tidal lagoon estuaries (SIDES) and tidal river estuaries (SSRTRE)	
Attribute group	Southland attribute	
Attribute name	Gross eutrophic zone	
Attribute unit	GEZ[1]	
Attribute band and description	**Numeric Attribute State**	
	% cover across intertidal area	Area (ha)
A Within zones high stress on aquatic organisms and loss of habitat. Minimal impact on aquatic organisms outside these zones.	≤1	≤0.5
B Within zones high stress on aquatic organisms and loss of habitat. Minor impact on aquatic organisms outside these zones.	>1 and ≤5	>0.5 and ≤5
C Within zones high stress on aquatic organisms and loss of habitat. Moderate impact on aquatic organisms outside these zones. High risk of GEZ areas expanding and becoming self-reinforcing.	>5 and ≤10	>5 and ≤20
Proposed minimum acceptable state	**10**	**20**
D Within zones high stress on aquatic organisms and loss of habitat. Significant impact on aquatic organisms outside these zones. GEZ areas expanding and becoming self-reinforcing with severe loss of ecological integrity for whole estuary.	>10	>20

[1] GEZ is defined as areas consisting of >25% muddiness and aRPD depth of <1cm and 'high (>50%)' macroalgae cover. This definition may be reviewed if substantial areas of hydrogen sulphide toxicity prohibit macroalgae growth.

The numeric bands proposed in this table are not based on literature thresholds. Nominal values have been proposed based on premise that any GEZ area in an estuary constitutes degradation.

Value	Ecosystem health
Freshwater Body Type	Tidal lagoon estuaries (SIDES) and tidal river estuaries (SSRTRE)
Attribute group	Southland attribute
Attribute name	Macroalgae cover and biomass
Attribute unit	EQR (Ecological Quality Rating)
Attribute band and description	**Numeric Attribute State**
	Index[1]
A Ecological communities are healthy and resilient. Algal growth of opportunistic species low.	≥0.8
B Ecological communities are slightly impacted. Algal growth of opportunistic species limited.	≥0.6 and <0.8
C Ecological communities are strongly impacted. Algal growth of opportunistic species high.	≥0.4 and <0.6
Proposed minimum acceptable state	**0.4**
D Ecological communities are strongly impacted. Algal growth of opportunistic species very high.	<0.4
[1] Described and explained by Estuary Trophic Index Tool 2 (Robertson et al. 2016).	

Value	Human health for recreation			
Freshwater body type	Estuaries and open coast			
Attribute group	Southland attribute			
Attribute name	*Escherichia coli* (*E. coli*)			
Attribute unit	*E. coli*/100 mL (number of *E. coli* per hundred millilitres)			
Attribute band and description	**Numeric attribute state [2, 3]**			
	% exceedances over 540 cfu/100 mL	% exceedances over 260 cfu/100 mL	Median concentration (cfu/100 mL)	95th percentile of *E. coli*/100 mL
A For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 1%[1].	<5%	<20%	≤130	≤540
B For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 2%[1].	5 to 10%	20 to 30%	≤130	≤1,000
C For at least half the time, the estimated risk is <1 in 1,000 (<0.1% risk). The predicted average infection risk is 3%[1].	10 to 20%	20 to 34%	≤130	≤1,200
D 20 to 30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >3%[1].	20 to 30%	>34%	>130	>1,200
E For more than 30% of the time the estimate risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is 7%[1].	>30%	>50%	>260	>1,200

[1] The predicted average infection risk is the overall average infection to swimmers based on a random exposure on a random day, ignoring any possibility of not swimming during high flows or when a surveillance advisory is in place (assuming that the *E. coli* concentration follows a lognormal distribution). Actual risk will generally be less if a person does not swim during high flows.

[2] Attribute state should be determined by using a minimum of 60 samples over a maximum of 5 years, collected on a regular basis regardless of weather and flow conditions. However, where a sample has been missed due to adverse weather or error, attribute state may be determined using samples over a longer timeframe.

[3] Attribute state must be determined by satisfying all numeric attribute states.

Value	Human health for recreation
Freshwater body type	Primary contact in estuaries and open coast
Attribute group	Southland attribute
Attribute name	*Escherichia coli* (*E. coli*) at popular bathing sites
Attribute unit	*E. coli*/100 mL (number of *E. coli* per hundred millilitres)
Attribute band and description	**Numeric Attribute State**
	95^{th} percentile during the bathing season[1]
A <0.1% risk of Campylobacter infection. Risk of less than one case of Camplylobacter infection in every 1,000 exposures.	≤ 130
B 0.1 to 1% risk of Campylobacter infection. Risk of up to one case of Campylobacter infection in every 100 exposures.	> 130 and ≤ 260
C 1 to 5% risk of Campylobacter infection. Risk of up to one to five cases of Campylobacter infection in every 100 exposures.	> 260 and ≤ 540
National guideline for primary contact*	**540**
D >5% risk of Campylobacter infection. Risk of at least one case of Campylobacter infection in every 20 exposures.	> 540
The narrative attribute state description assumes "% of time" equals "% of samples" [1]Using weekly monitoring data [2]National bottom line proposed in the Essential Freshwater Package (September 2019) draft NSPFM September 2019	

Notes:
This attribute table is derived from the *E. coli* table for primary contact sites in lakes and rivers in the draft NPSFM released for public consultation with Government's Essential Freshwater Package (September 2019). It is noted this attribute table has subsequently been included for lakes and rivers in the new NPSFM (2020) and the C/D threshold shown has become a "national bottom line" (i.e., 540 E. coli/100 mL)

Value	Human health for recreation	
Freshwater body type	Estuaries and open coast	
Attribute group	Southland attribute	
Attribute name	Enterococci	
Attribute unit	Enterococci/100 mL (number of enterococci per hundred millilitres)	
Attribute band and description	**Numeric Attribute State**	
	95th percentile (MPN/100 mL)[1]	% exceedances over 280 MPN/100 mL[1]
A Estimated GI risk is <1% and AFRI is <0.3% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% less than 5% of the time.	≤40	≤5
B Estimated GI risk is 1 - 5% and AFRI is 0.3 - 2% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% between 5 and 10% of the time.	>40 and ≤200	>5 and ≤10
C Estimated GI risk is 5 - 10% and AFRI is 2 - 4% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% between 10 and 20% of the time.	>200 and ≤500	>10 and ≤20
Proposed minimum acceptable state	**500**	**20**
D Estimated GI risk is >10% and AFRI is >4% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% more than 20% of the time.	>500	>20
[1]Using monthly monitoring data GI is gastrointestinal illness and AFRI is acute febrile respiratory illness		

Value	Human health for recreation
Freshwater body type	Primary contact in estuaries and open coast
Attribute group	Southland attribute
Attribute name	Enterococci at popular bathing sites
Attribute unit	Enterococci/100 mL (number of enterococci per hundred millilitres)
Attribute band and description	**Numeric Attribute State**
	95th percentile (MPN/100 mL) during the bathing season[1]
A Estimated GI risk is <1% and AFRI is <0.3% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% less than 5% of the time.	≤40
B Estimated GI risk is 1 - 5% and AFRI is 0.3 - 2% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% between 5 and 10% of the time.	>40 and ≤200
C Estimated GI risk is 5 - 10% and AFRI is 2 - 4% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% between 10 and 20% of the time.	>200 and ≤500
Proposed minimum acceptable state	**500**
D Estimated GI risk is >10% and AFRI is >4% from a single exposure. The estimated GI risk is >10% and AFRI risk is >4% more than 20% of the time.	>500
[1]Using weekly summer monitoring data GI is gastrointestinal illness and AFRI is acute febrile respiratory illness	

Appendix 5: Details of the data and analyses used

The general method was described in section 0. Further detail of the method used to gather and analyse state data is provided in the supporting technical memorandums for groundwater (Rodway 2020), rivers (Hodson 2020), lakes (Roberts and Ward 2020) and estuaries (Ward and Roberts 2020). This appendix below contains some of that detail specific to the individual assessments.

Groundwater analytical details

Notable additions and exceptions to the general method include:

- Data from seven sites in the National Groundwater Monitoring Programme (NGMP) were assembled in addition to the 1,753 groundwater sites from Environment Southland's SOE, investigations and compliance monitoring data.
- In the case of nitrate-nitrite nitrogen (NNN), where NNN data was not present then nitrate data was used as a representative measure.
- *E. coli* has been commonly measured and reported in two different units, most probable number (MPN/100ml) and coliform forming units (CFU/100ml). Given that in this assessment the *E. coli* data is used simply for a presence/absence test these measures were combined to create a larger dataset for analysis.
- Nitrate-nitrite nitrogen (NNN) was assessed under two identified values (ecosystem health and water supply [human health]). The ecosystem health assessment required calculation of a 5 year mean NNN value for each site (Norton and Wilson, 2019). The site must have 10 samples and at least one sample from 4 of the 5 years. The water supply (human health) value required calculation of a 5 year mean with the same criteria as above and in addition the 5 year maximum value (Norton and Wilson, 2019).
- *E. coli* was assessed under one identified value (water supply [human health]). The water supply (human health) assessment required calculation of an annual maximum *E. coli* value for each site (Norton and Wilson, 2019). The minimum number of samples required to make this assessment is one (Norton and Wilson, 2019).

Rivers analytical details

This report used a selection of outputs from river analyses performed by Aquanet Consulting Limited that are reported separately in full in (Greer 2019). Some key analytical details from Greer (2019) are provided below.

Key attributes

Nitrate Metrics

- Median nitrate-nitrite nitrogen (NNN) concentration; and
- 95th percentile NNN percentile concentration.

Ammonia Metrics

- Median pH adjusted total ammoniacal nitrogen (NH$_4$-N) concentration; and
- Maximum pH adjusted NH$_4$-N concentration.

Dissolved inorganic nitrogen (DIN) Metrics

- Median concentration; and
- 95th percentile concentration.

Dissolved reactive phosphorus (DRP) Metrics

- Median concentration; and
- 95th percentile concentration.

Dissolved oxygen (DO) Metrics

- 7-day mean minimum concentration; and
- 1-day minimum concentration.

Temperature Metrics

- Cox-Rutherford Index (CRI)[13], averaged over the five hottest days of summer; and
- Maximum winter[14] temperature.

Escherichia coli (E. coli) Metrics

- Median concentration;
- 95th percentile concentration;
- Percentage of time above 260 colony-forming units (CFU)/100ml; and
- Percentage of time above 540 CFU/100ml.

Water clarity Metrics

- Median horizontal black disc viewing distance at flows below the median (m).

Deposited fine sediment Metrics

- Mean deposited fine sediment cover as a percentage of stream bed area; and
- Maximum suspendible inorganic sediment (SIS) measured using the Quorer method (Clapcott *et al.*, 2011).

Periphyton Metrics

- 92nd/ 83rd percentile periphyton biomass;
- Maximum cover of long filamentous periphyton as a percentage of stream bed area; and
- Maximum cover of thick mat periphyton as a percentage of stream bed area.

Benthic cyanobacteria Metrics

- Maximum benthic cyanobacteria cover as a percentage of stream bed area.

Macroinvertebrate Metrics

- Mean MCI.

Fish Metrics

- Mean IBI.

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[13] The average of the daily mean and maximum temperature.
[14] May – September.

River data sources

All data were sourced from ES's Rivers State of Environment (SoE) monitoring network datasets. Specifically[15]:

- Discrete monthly water quality data (i.e. nutrient concentrations, faecal containment levels and visual clarity) were available for 77 sites across the Southland Region;
- Continuous temperature data were available for 42 sites across the region;
- Continuous dissolved oxygen data were available for 28 sites across the region;
- Monthly deposited fine sediment cover data were available for 35 sites across the region;
- Monthly suspendible sediment (measured using the Quorer method) data were available for 102 sites across the region;
- Monthly periphyton biomass data were available for 30 sites across the region;
- Monthly periphyton (including benthic cyanobacteria) cover data were available for 35 sites across the region;
- Annual macroinvertebrate monitoring data were available for 120 sites across the region; and
- Annual fish monitoring data were available for 59 sites across the region.

Lakes analytical details

The state of ecosystem health, habitat and water quality attributes at a site, lake, lake type or FMU, at a given baseline year (2010, 2016 and 2019) was assessed using data from the preceding three hydrological years (hereafter referred to as years), unless a different assessment period has been specified (e.g. where 3 years of data is not available or the minimum statistic is a 5 year period for example *E.coli*). Not all attributes have been assessed for each site, lake, lake type or FMU and for every baseline, as:

- Lake Vincent, The Reservoir, Lake George were not monitored pre-2015.
- Waiau (Te Waewae) Lagoon monitoring programme began in late 2016.
- There was a gap in the monitoring data due to budget constraints in the glacial lakes programme between 2014 and 2017.
- Lakes that are currently not covered in the water quality monitoring programme (Lake Brunton, Mavora Lakes and Lake Hauroko) have previously been assessed for macrophyte cover and Lake SPI, these have been included in the presentation of state for the lake level of analysis.
- Lake Sheila, Lake Calder and Lake Brunton were assessed in 2012 in a study by Cawthron to provide an indicative state the report values have been shown in the proceeding report but these do not meet the minimum statistical requirement for the attribute.
- For some attributes the analysis was not undertaken by Environment Southland and the data presented is directly from an existing monitoring report (e.g. Lake SPI and macrophyte cover). In these instances the data may not directly align with the proposed baseline years 2010, 2016 and 2019. Data sources are acknowledged.

[15] Note, not all sites have been monitored at the specified frequency for the entire assessment period.

The analysis has been completed at four different levels:

1. **Site:** Each individual site within a lake was analysed for state in 2010, 2016 and 2019 using the preferred statistic outlined in the table below. In some instances the frequency of sampling did not meet the minimum statistical requirement for the attribute, in these cases state is reported as a best estimate and should be viewed with caution. State has been tabulated for the baseline period (2010 and 2016) and current (2019) in addition to the percentage reduction needed to meet the minimum requirement of the draft FWO, known as the 'gap'. Where no draft FWO has been reported the percentage reduction as not been presented.

2. **Lake:** For ecosystem health the data was screened for site sets within a lake, where all lake sites were not monitored on a given date the date was removed from the analysis to prevent bias toward a particular lake site. Human Health attributes (e.g. *E. coli*) are associated with a health risk factor, as such a precautionary approach was taken and the individual site with the poorest grading within the lake was reported. Note attributes such as macrophyte cover and Lake SPI are only reported for the whole 'Lake' because these attributes are not applicable to individual sites. State has been tabulated for the baseline period (2010 and 2016) and current (2019) in addition to the percentage reduction needed to meet the minimum requirement of the draft FWO, known as the 'gap'. Where no draft FWO has been reported the percentage reduction as not been presented.

3. **Lake Type:** The analysis for lake type used the site level statistics as the basis for assessing the number of sites that fit within each banding for each lake type. The lakes programme is small compared to the river network and therefore box and whisker plots were not a suitable representation of the data, instead the graphical representation of the data represents the numerical value used for the assessment at the site level against the attribute banding. The table includes the proportion of sites within each banding for all lake types, including natural state, for 2010, 2016 and 2019. Furthermore the proportion of sites where, one, two and three state improvement would be needed to meet the FWO is presented.

4. **Regional Summary:** summarises the information used at the FMU scale to present a regional picture for lakes.

Data was analysed using Time Trends (v.6.30, 2017) for metrics such as mean, median, 95th percentile, maximum and minimum. Microsoft Excel (2016) was used where additional analysis was required such as the % exceedances for *E. coli* or basic plotting.

Where numerical values were below the limit of detection a general rule was applied; the below detect was replaced with a numerical value equivalent to a half fraction of the detection limit. Studies have shown that the application of this rule is not suitable particularly for regression and correlation analysis (Helsel, 2006), however the purpose of this report was not to assess trends but to report on state. To do this summary statistics were compared against a defined A-D banding system for each attribute. Non-detects generally fall within the A-band and therefore even though this is not the preferred approach it can be applied in the assessment of state in this context. The approach was applied for the two baseline years (2010 and 2016) and current state (2019).

Attribute	Statistic	Minimum Requirements	Additional Conditions
Phytoplankton	Annual Median Annual Maximum	3 years of monthly sampling, n = 36	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods.
TP	Annual Median	3 years of monthly sampling, n = 36	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods.
TN	Annual Median	3 years of monthly sampling, n = 36	Assessment must consider whether the lake is seasonally stratified or polymictic. Brackish lakes are grouped with seasonally stratified lakes. Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods
Ammonia Toxicity	Annual Median Annual Maximum	3 years of monthly sampling, n = 36	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods.
Cyanobacteria	80^{th} percentile	3 years of monthly sampling, n = 36.	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods NPS-FM recommends 30 samples over 3 years with a minimum of 12 samples over 3 years accepted.
TLI3	Annual Mean	3 years of monthly sampling, n = 36.	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods.
Nitrate Toxicity	Annual Median, 95^{th} percentile	3 years of monthly sampling, n = 36	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods.

Attribute	Statistic	Minimum Requirements	Additional Conditions
E. coli	Median, 95th percentile % exceedances over 540 *E. coli*/100mL % exceedances over 260 *E. coli*/ 100mL	5 years of monthly sampling, n = 60	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods *NPS-FM recommends a minimum of 60 samples over 5 years, where a sample is missed the state may be determined over a longer timeframe.*
Lake Bottom Dissolved Oxygen	Annual Minimum	3 years of monthly sampling, n = 36	Lakes and Lagoons intermittently open to the sea, data is analysed separately for open/ closed periods.
Mid-Hypolimnetic Dissolved Oxygen	Annual Minimum	3 years of monthly sampling, n = 36	Attribute only applies to seasonally stratified lakes
Macrophyte Cover	Total % cover of available habitat	Assessment based on the likely maximum annual biomass in a one year period. Attribute applies to the available macrophyte habitat determined by morphological, hydrological and substrate conditions.	The total percentage cover is weighted with % cover across the polygon transect and the coverage across the whole lake. E.g. **Total % cover = Sum(% cover x polygon area)/ total area of available habitat x 100** Sum(% cover x polygon area): % cover is estimated across lake transects that represent particular areas of the lake, these are extrapolated to the whole polygon area and then all polygons are summed to represent the total available habitat within the lake.
LakeSPI	Lake SPI Score (%) and % Reduction in score Native Condition Index (%) Invasive Impact Index (%)	Assessment based on the likely maximum annual biomass in a one year period.	Numeric attribute state to be calculated annual following the method described in Clayton and Edwards (2006).

Estuary and coastal analytical details

The state of ecosystem health, habitat and water quality attributes at a site, estuary, estuary class or FMU, at a given baseline year (2010, 2016 and 2019) was assessed using data from the preceding three years.

Details of specific statistical requirements and data periods used to represent the different attributes are shown in the tables below.

Most of the data is collected on an annual basis so is not monthly or weekly except that of phytoplankton for New River Estuary and microbiological data. Minimum statistics have been specified but not stringently adhered to otherwise much of the data would be excluded. For some periods there is no data available so the closest preceding time period was used.

It is important to note the following:

1. Not all attributes have been assessed for each site, estuary, estuary class or FMU and for every baseline, as the number and frequency of monitoring needed to cover estuaries in Southland is unfeasible. Focus has therefore been on high risk (highly modified/developed land use in catchment and high sensitivity) estuaries.
2. There was a hiatus in most of the estuarine monitoring from 2013 to 2016.
3. Waiau estuary (not lagoon which is classed within Lakes and lagoons) has no available data.
4. Some attributes are at a site scale and some at an estuarine scale.
5. EQR is a measure of macroalgal response and therefore can theoretically detect responses in the estuarine system to increased pressures. GEZ/GNA measures detect the condition of a system once it has exceeded its assimilative capacity, taking into account sediment oxygen state and algal cover. Measures for EQR and GEZ/GNA should therefore be considered as fundamentally different, but also as tools to use in a gradient of deteriorating state.
6. For microbial data values which were below the limit of detection a general rule was applied; the below detect was replaced with a numerical value equivalent to a half fraction of the detection limit. Studies have shown that the application of this rule is not suitable particularly for regression and correlation analysis (Helsel, 2006), however the purpose of this report was not to assess trends but to report on state.
7. Analysis for phytoplankton has yet to be done for the periods of 2010 and 2016.
8. For microbial coastal/marine sites there is a decline in WQ using cfu measures up to 2007. Following this the method was changed to MPN; however, no cross over time for the methods exists. The measure of cfu was re-established in 2014. Therefore, only one period may be calculated using the data.
9. For a small period both *E. coli* cfu and enterococci cfu were measured at popular bathing sites (summer weekly). For sites that displayed little or no issues sampling was ceased or not started for *E. coli*. These are Colac Bay at Colac Bay Road opposite Marae, Monkey Island at Frentz Road, Oreti Beach at Dunns Road, Riverton Rocks at Mitchells Bay North, Halfmoon Bay at Bathing Beach, Halfmoon Bay at Elgin Terrace, Porpoise Bay at Camping Ground, Awarua Bay at Tiwai Pumphouse. Those sites which showed some pollution were retained and continued to be sampled for both enterococci and *E. coli*: Bluff Harbour at Morrison Beach, Jacobs River Estuary d/s Railway Br East, New River Estuary

at Water Ski Club and New River Estuary at Omaui. Note that *E. coli* will therefore have less data available for the ongoing sites due to the more recent introduction.

10. The main analyte for use against guidelines is Faecal coliforms but *E. coli* can be measured at the same time for no additional cost. For a small period both E. coli cfu and enterococci cfu have been measured at shellfish gathering waters (monthly data). Enterococci has been not measured or ceased (due to low detected levels) at select sites: Riverton Rocks at Mitchells Bay. Some sites continue to be measured for both *E. coli* and enterococci: Bluff Harbour at Ocean Beach, Monkey Island at Frentz Road, Colac Bay at Bungalow Hill Road, Jacobs River Estuary d/s Fish co-op, New River Estuary at Whalers Bay, New River Estuary at Mokomoko Inlet, Toetoes Harbour at Fortrose.

Scale	Attribute	Statistic	Minimum Requirements	Additional Conditions
Site	**Mud content (% mud)**	Annual Median	Up to 3 years of annual sampling n = 3 composite samples /yr	Sampling is conducted according to the estuary protocol by taking 3 composite samples for a site.
Site	**aRPD (cm below surface)**	Annual median	Annual data (n=10)	Sampling is conducted according to the estuary protocol by taking 10 measures in conjunction with macrofaunal samples.
Site	**Toxicants in sediment (As, Cd, Cr, Cu, Pb, Ni) (mg/Kg)**	Annual Median	Up to 3 years of annual sampling n = 3 composite samples /yr	Sampling is conducted according to the estuary protocol by taking 3 composite samples for a site.
Site	**Sediment rate (mm/yr)**	>2mm or <2mm if pass trend significance test (90%).	Filter sites according to if muddy or not (>25% mud content). Use all available annual data, 4 plates per site. Slope calculated using all individual data points to determine slope. Rate may be calculated from post significant erosion events and periods.	Slope characteristics used to run two criteria, slope significance test and test if <2mm/yr rate. Model coefficient was compare against threshold (2mm) using t-test; using R-Script. Not significant (significance test above) = IN (Indeterminate). If Significant (significance test above) and be <2mm to PASS; and be >2mm to FAIL.
Estuary	**Mud extent (m^2 of intertidal area)**	Area >25% mud content has increased/decreased	Annual assessment for the estuary.	Change is calculated from most recent and current assessment.

Site	**Phytoplankton in water (mg chlorophyll-a /m^3)**	90th percentile	Twice a Month data, minimum 5 years. Sites are identified as >30ppt or <30ppt salinity using median conductivity for the data used.	Chl-a measure done at ICC lab: Acetone extraction. Fluorometer. In line with APHA 10200. ICC lab is a non-accredited lab. 90th percentile was calculated using excel. Data has not been filtered according to low and high flow, one of each has been recorded per month.
Estuary	**EQR**	Dimensionless number based on biomass and cover of macroalgae.	Annual assessment for the estuary.	Refer to the New Zealand Estuary Trophic Index (Wriggle Coastal Management Ltd and NIWA, 2015) for guidance on how to calculate EQR.
Estuary	**GEZ**	% cover and Area (Ha) of the estuary	Annual assessment for the estuary.	GEZ is defined as areas consisting of >25% muddiness and aRPD depth of 0 cm and 'high' macroalgae cover. This definition may be reviewed if substantial areas of hydrogen sulphide toxicity prohibit macroalgae growth.
Site	***E. coli*** ***(cfu/100ml)***	Median, 95th percentile % exceedances over 540 E. coli/100mL % exceedances over 260 E. coli/ 100mL	5 years of monthly sampling, ideally n = 60 Some sites have less data available.	NPS-FM recommends a minimum of 60 samples over 5 years, where a sample is missed the state may be determined over a longer timeframe. Calculations were done via R-Script. Using the hazen method to calculate the 95th percentile.
Site	***E. coli* at popular bathing sites** ***(cfu/100ml)***	95th percentile	5 years (seasons) of weekly data over the summer, ideally n = 80 to 85. Some sites have less data available.	The Proposed NPS-FM (2019) has no recommends for minimum data used. However, the Microbial guidelines recommend using 5 years' worth of data. Calculations were done via R-Script. Using the hazen method to calculate the 95th percentile.
Site	**enterococci** ***(cfu/100ml)***	95th percentile % exceedances over 260 E. coli/ 100mL	5 years of monthly sampling, ideally n = 60 Some sites have less data available.	NPS-FM recommends a minimum of 60 samples over 5 years for E. coli. The same principles have been applied. Calculations were done via R-Script. Using the hazen

				method to calculate the 95th percentile.
Site	**enterococci at popular bathing sites** ***(cfu/100ml)***	95th percentile	5 years (seasons) of weekly data over the summer, ideally n = 80 to 85. Some sites have less data available.	The Microbial guidelines recommend using 5 years' worth of data. Calculations were done via R-Script. Using the hazen method to calculate the 95th percentile.

Estuaries: Data used for site scale analysis

Site	As			Cd			Cr			Cu			Pb		
	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Awarua Bay Estuary Site A															
Awarua Bay Estuary Site B															
Bluff Harbour Site A															
Bluff Harbour Site B															
Fortrose Estuary Site A			2018 2019 (6)			2018 2019 (6)	2009 (3)		2018 2019 (6)	2009 (3)		2018 2019 (6)	2009 (3)		2018 2019 (6)
Fortrose Estuary Site B			2018 2019 (6)	2009 (3)		2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)
Freshwater Estuary Site A				2009 2010 (6)			2009 2010 (6)			2009 2010 (6)					
Freshwater Estuary Site B				2009 2010 (6)	2015 (10)		2009 2010 (6)	2015 (10)		2009 2010 (6)	2015 (10)			2015 (10)	
Freshwater Estuary Site C					2015 (10)			2015 (10)			2015 (10)			2015 (10)	
Haldane Estuary Site A1			2019 (3)	2009 2010 (6)		2019 (3)	2009 2010 (6)		2019 (3)	2009 2010 (6)		2019 (3)			2019 (3)
Haldane Estuary Site B			2019 (3)		2015 (10)	2019 (3)		2015 (10)	2019 (3)		2015 (10)	2019 (3)		2015 (10)	2019 (3)
Haldane Estuary Site C					2015 (10)			2015 (10)			2015 (10)			2015 (10)	
Jacobs River Estuary Site A			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)
Jacobs River Estuary Site B			2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)
Jacobs River Estuary Site C			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)
Jacobs River Estuary Site D			2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)
Jacobs River Estuary Site E			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)
New River Estuary Site B			2018 2019 (6)	2010 (3)	2015 (10)	2018 2019 (6)	2010 (3)	2015 (10)	2018 2019 (6)	2010 (3)	2015 (10)	2018 2019 (6)	2010 (3)	2015 (10)	2018 2019 (6)
New River Estuary Site C			2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)
New River Estuary Site D			2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)
New River Estuary Site E			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)
New River Estuary Site F			2018 2019 (6)		2015 (13)	2018 2019 (6)		2015 (13)	2018 2019 (6)		2015 (13)	2018 2019 (6)		2015 (13)	2018 2019 (6)
Waikawa Estuary Site A			2019 (3)	2008 (3)		2019 (3)	2008 (3)		2019 (3)	2008 (3)		2019 (3)	2008 (3)		2019 (3)
Waikawa Estuary Site B			2019 (3)	2008 (3)	2015 (10)	2019 (3)	2008 (3)	2015 (10)	2019 (3)	2008 (3)	2015 (10)	2019 (3)	2008 (3)	2015 (10)	2019 (3)
Waikawa Estuary Site C					2015 (10)			2015 (10)			2015 (10)			2015 (10)	
Waimatuku Estuary Site D			2018(1)			2018(1)			2018(1)			2018(1)			2018(1)
Waimatuku Estuary Site E			2018(1)			2018(1)			2018(1)			2018(1)			2018(1)
Waimatuku Estuary Site G			2018(1)			2018(1)			2018(1)			2018(1)			2018(1)

Site	Hg			Ni			Zn			% mud			aRPD		
	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
Awarua Bay Estuary Site A															
Awarua Bay Estuary Site B															
Bluff Harbour Site A															
Bluff Harbour Site B															
Fortrose Estuary Site A			2018 2019 (6)	2009 (3)		2018 2019 (6)	2009 (3)		2018 2019 (6)			2018 2019 (6)			2019(10)
Fortrose Estuary Site B			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)	2009(3)		2018 2019 (6)	2009(10)		2019(10)
Freshwater Estuary Site A				2009 2010 (6)			2009 2010 (6)			2009 2010 (6)			2010(10)		
Freshwater Estuary Site B		2015 (10)		2009 2010 (6)	2015 (10)		2009 2010 (6)	2015 (10)		2009 2010 (6)			2010(10)	2015(10)	
Freshwater Estuary Site C		2015 (10)			2015 (10)			2015 (10)						2015(10)	
Haldane Estuary Site A1			2019 (3)	2009 2010 (6)		2019 (3)	2009 2010 (6)		2019 (3)	2009 2010 (6)		2019 (3)			2019(10)
Haldane Estuary Site B		2015 (10)	2019 (3)		2015 (10)	2019 (3)		2015 (10)	2019 (3)			2019 (3)		2015(10)	2019(10)
Haldane Estuary Site C		2015 (10)			2015 (10)			2015 (10)						2015(10)	
Jacobs River Estuary Site A			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2019(10)
Jacobs River Estuary Site B		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)			2018 2019 (6)		2015(10)	2019(10)
Jacobs River Estuary Site C			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2019(10)
Jacobs River Estuary Site D		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)		2015 (10)	2018 2019 (6)			2018 2019 (6)		2015(10)	2019(10)
Jacobs River Estuary Site E			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2019(10)
New River Estuary Site B		2015 (10)	2018 2019 (6)	2010 (3)	2015 (10)	2018 2019 (6)	2010 (3)	2015 (10)	2018 2019 (6)	2010 (3)		2018 2019 (6)	2010(10)	2015(10)	2019(10)
New River Estuary Site C			2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010(10)		2019(10)
New River Estuary Site D			2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010 (3)		2018 2019 (6)	2010(10)		2019(10)
New River Estuary Site E			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2018 2019 (6)			2019(10)
New River Estuary Site F		2015 (13)	2018 2019 (6)		2015 (13)	2018 2019 (6)		2015 (13)	2018 2019 (6)		2016 (3)	2018 2019 (6)		2015(10)	2019(10)
Waikawa Estuary Site A			2019 (3)	2008 (3)		2019 (3)	2008 (3)		2019 (3)			2019 (3)	2008(10)		2019(10)
Waikawa Estuary Site B		2015 (10)	2019 (3)	2008 (3)	2015 (10)	2019 (3)	2008 (3)	2015 (10)	2019 (3)			2019 (3)	2008(10)	2015(10)	2019(10)
Waikawa Estuary Site C		2015 (10)			2015 (10)			2015 (10)						2015(10)	2019(10)
Waimatuku Estuary Site D			2018(1)			2018(1)			2018(1)	2018(1)		2018(1)			2008(1)
Waimatuku Estuary Site E			2018(1)			2018(1)			2018(1)	2018(1)		2018(1)			2008(1)
Waimatuku Estuary Site G			2018(1)			2018(1)			2018(1)	2018(1)		2018(1)			2008(1)

Site	Phytoplankton (Chlorophyll-a)			*E.coli*			*E.coli* at popular bathing sites			enterococci			enterococci at popular bathing sites		
	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019	2010	2016	2019
New River Estuary Omaui Beach	To be done	To be done	Jun 2016-Jul 2019 (74)												
New River Estuary Awarua Farm	To be done	To be done	Jun 2016-Jul 2019 (68)												
New River Estuary Lagoon tip outlet	To be done	To be done	Jun 2016-Jul 2019 (73)												
New River Estuary Stead Street	To be done	To be done	Jun 2016-Jul 2019 (74)												
New River Estuary Dunns Road	To be done	To be done	Jun 2016-Jul 2019 (74)												
Oreti Beach	To be done	To be done	Jun 2016-Jul 2019 (73)												
New River Estuary Ski club	To be done	To be done	Jun 2016-Jul 2019 (74)												
New River Estuary Mcoys Beach	To be done	To be done	Jun 2016-Jul 2019 (70)												
Bluff Harbour at Ocean Beach						2016 – 2019 (42)						2014 – 2019 (63)			
Colac Bay at Bungalow Hill Road						2015 – 2019 (56)						2014 – 2019 (63)			
Jacobs River Estuary d/s Fish Co-op						2014 – 2019 (59)						2014 – 2019 (63)			
Monkey Island at Frentz Road (south)						2016 – 2019 (41)						2014 – 2019 (63)			
New River Estuary at Mokomoko Inlet						2016 – 2019 (42)						2014 – 2019 (63)			
New River Estuary at Whalers Bay						2016 – 2019 (42)						2014 – 2019 (63)			
Riverton Rocks at Mitchells Bay						2016 – 2019 (34)						2014 – 2017 (43)			
Toetoes Harbour at Fortrose						2016 – 2019 (42)						2014 – 2019 (63)			
Awarua Bay at Tiwai pumphouse															2013 – 2019 (54)
Bluff Harbour at Morrison Beach									2015 – 2019 (55)						2013 – 2019 (102)
Colac Bay at Colac Bay Road opp marae									2015 – 2017 (21)						2013 – 2019 (102)
Halfmoon Bay at bathing beach															2013 – 2019 (96)
Halfmoon Bay at Elgin Terrace															2013 – 2019 (97)
Jacobs River Estuary d/s Railway Br East									2015 – 2019 (55)						2013 – 2019 (101)
Kawakaputa Bay at Wakapatu Road															2013 – 2019 (101)
Monkey Island at Frentz Road									2015 – 2017 (20)						2013 – 2019 (101)
New River Estuary at Omaui									2015 – 2019 (55)						2013 – 2019 (102)
New River Estuary at Water Ski Club									2015 – 2019 (55)						2013 – 2019 (101)
Oreti Beach at Dunns Road									2015 – 2017 (21)						2013 – 2019 (93)
Porpoise Bay at camping ground															2013 – 2019 (54)
Riverton Rocks at Mitchells Bay North									2015 – 2017 (21)						2013 – 2019 (102)

Estuaries: Data used for estuary scale analysis

Estuary	Macroalgae (EQR)			GEZ			Muddiness of intertidal area		
	2010	2016	2019	2010	2016	2019	2010	2016	2019
Fortrose Estuary	2013	2016	2018	2013	2016	2018	2003 compare 2013	2013 compare 2016	2016 compare 2018
Freshwater Estuary									
Haldane Estuary	2004	2016		2004	2016			2004 compare 2016	
Jacobs River Estuary		2016	2018	2008	2016	2018	2003 compare 2008	2013 compare 2016	2016 compare 2018
New River Estuary	2007	2016	2018	2007	2016	2018	2007 compare 2012	2013 compare 2016	2016 compare 2018
Waikawa Estuary	2008	2016		2009	2016		2004 compare 2009	2009 compare 2016	

Appendix 6: State summary tables for rivers and streams

Streams and rivers state: Waiau FMU 2010

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

	Pass
	Fail

Streams and rivers state: Waiau FMU 2010	Natural State				Lowland soft bed					Hill						Lake fed							Spring fed
	Eglington River at McKay Creek Confluence	McKay Creek at Milford Road	Pig Creek at Borland Lodge	Thicket Burn at Lake Hauroko Road	Lill Burn at Lill Burn-Monowai Road	Rowallan Burn East at Rowallan Road	Thicket Burn u/s Lill Burn Confluence	Camp Creek at State Highway 99	Orauea River at Orawia Pukemaori Road	Mararoa River at The Key	Mararoa River at Weir Road	Mararoa River at Mararoa Road Bridge	Upukerora River at Te Anau Milford Road	Wairaki River at Blackmount Road	Whitestone River d/s Manapouri-Hillside	Mararoa River at South Mavora Lake	Mararoa River at Kiwiburn	Mararoa River at Mavora Lake	Waiau River at Duncraigen Road	Waiau River at Sunnyside	Waiau River 100m u/s Clifden Bridge	Waiau River at Tuatapere	Home Creek at Manapouri
National compulsory attributes																							
Nitrate toxicity (mg/L)									A	A	A		A		A	A			A	A		A	
Ammonia toxicity (mg/L)									B	A	A		A		A	A			A	A		A	
E. coli (*E. coli*/100 mL)									E	C	D		B		B	A			B	A		D	
Southland attributes																							
Macroinvertebrates (MCI, wadable rivers only)	A	B	A	B	B	B	B				B	B	B	B			C	B	B		B	C	B
Temperature - summer (°C, Dec - Mar)																				C			
Temperature - winter (°C, May - Sep)																				Fail			
E. coli at popular bathing sites (*E. coli*/100 mL)																						D	
Clarity (visible distance, m)									C	A	A		A		A				A	A		B	
Suspendend fine sediment (turbidity, FNU)									B	A	C		A		A	A			C	C		D	
National compulsory attributes requiring an action plan																							
Dissolved Reactive Phosphorus (mg/L)									C	A	A		B		B	A			A	A		B	
Fish (IBI)								C															
Additional attributes for information																							
Dissolved inorganic nitrogen (mg/L)									C	A	B		A		B	A			B	A		A	

Streams and rivers state: Aparima FMU 2010	Lowland soft bed	Lowland hard bed														Hill					
	Opouriki Stream at Tweedie Road	Aparima River at Otautau	Aparima River at Thornbury	Aparima River at Wreys Bush	Cascade Stream at Pourakino Valley Road	Hillpoint Stream at Waikana Road	Otautau Stream at Otautau-Tuatapere Road	Otautau Stream at Waikouro	Pourakino River at Ermedale Road	Pourakino River at Traill Road	Pourakino River at Pourakino Valley	Pourakino River at Jubilee Hill Road	Waimatuku Stream at Lorneville Riverton Hwy	Waimatuku Stream d/s Bayswater Bog	Waimeamea River at Young Road	Aparima River at Dunrobin	Aparima River u/s Dunrobin	Hamilton Burn at Goodall Road	North Etal Creek u/s Dunrobin Valley Rd	Taringatura Creek at Taromaunga	Hamilton Burn at Goodall Road
National compulsory attributes																					
Nitrate toxicity (mg/L)	B	A	B		A		B	B	A	A			C	B		A					
Ammonia toxicity (mg/L)	B	A	B		A		B	B	A	A			A	B		A					
E. coli (*E. coli*/100 mL)	E	D	E		B		E	E	D	E			E	E		B					
Southland attributes																					
Macroinvertebrates (MCI, wadable rivers only)			B	B	A	B	C		A			A	D		B		A	B	A	B	
Temperature - summer (°C, Dec - Mar)			C								A					C					
Temperature - winter (°C, May - Sep)			Fail								Fail					Fail					
E. coli at popular bathing sites (*E. coli*/100 mL)			D																		
Clarity (visible distance, m)	C	A	B		B		D	D	C	D			D	D		A					
Suspendend fine sediment (turbidity, FNU)	D	B	C		A		D	D	D	D			D	D		A					
National compulsory attributes requiring an action plan																					
Dissolved Reactive Phosphorus (mg/L)	C	B	B		A		D	D	B	A			D	D		B					
Fish (IBI)											C										B
Additional attributes for information																					
Dissolved inorganic nitrogen (mg/L)	D	C	C		A		D	D	A	A			D	D		A					

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

	Pass
	Fail

Streams and rivers state: Ōreti FMU 2010

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)
or	
	Pass
	Fail

Streams and rivers state: Ōreti FMU 2010	Natural state		Lowland soft bed										Lowland hard bed													Hill						Mountain	Spring fed	
	Dunsdale Stream at Dunsdale Reserve	Mokotua Stream at Awarua	Makarewa River at King Road	Makarewa River at Lora Gorge Road	Makarewa River at Winton - Hedgehope Hwy	Makarewa River at Counsell Road	Makarewa River at Wallacetown	Otepuni Creek at Nith Street	Silver Stream at Lora Gorge Road	Trenders Creek at Hall Road	Waianiwa Creek 1 at Lornville Riverton Highway	Tussock Creek at Cooper Road	Bog Burn d/s Hundred Line Road	Dipton Stream at South Hillend-Dipton Road	Oreti River at Wallacetown	Otapiri Stream at Otapiri Gorge	Otapiri Stream at Anderson Road	Waihopai River u/s Queens Drive	Waihopai River at Waihopai Dam	Waihopai River at Kennington	Waikiwi Stream at North Road	Winton Stream at Lochiel	Winton Stream at Benmore - Otapiri Road	Winton Stream at Winton Substation Road	Winton Stream d/s Winton Dam	Cromel Stream at Selbie Road	Irthing Stream at Ellis Road	Oreti River at Benmore	Oreti River at Centre Bush	Oreti River at Lumsden Bridge	Oreti River at Three Kings	Oreti River at McKellars Flat	Murray Creek at Castlerock Road	Murray Creek at Double Road
National compulsory attributes																																		
Nitrate toxicity (mg/L)	A	A		A			B	B				C	B			B		C			C	C			A	A	B		B	A	A			
E. coli (*E. coli*/100 mL)	B	A		E			E	E				E	E		D	E		E			E	E			E	A	D		D	B	A			
Ammonia toxicity (mg/L)	A	B		B			C	C				C	B			A		B			B	B			A	A	A		A	A	A			
Southland attributes																																		
Macroinvertebrates (MCI, wadable rivers only)	A	C	B		D		D	D	B	B	D			B	C		D	D	D		D	D	C			A	A	B		A		B	D	D
Temperature - summer (°C, Dec - Mar)						C									C	B				C							B			B	B			
Temperature - winter (°C, May - Sep)						Fail									Fail	Fail				Fail							Fail			Fail	Fail			
E. coli at popular bathing sites (*E. coli*/100 mL)															D																			
Clarity (visible distance, m)	B			D			D	D				D	D		C	D		C			D	D			D	A	A		A	A	A			
Deposited fine sediment (% cover)																																		
Suspendend fine sediment (turbidity, FNU)	A	A		C			C	C				B	D		A	D		D			D	D			D	A	D		D	B	A			
National compulsory attributes requiring an action plan																																		
Dissolved Reactive Phosphorus (mg/L)	C	B		C			D	C				D	D			C		B			C	D			C	A	B		B		A			
Fish (IBI)	C		C																B					C								B		
Additional attributes for information																																		
Dissolved inorganic nitrogen (mg/L)	A	A		C			D	D				D	D		A	C		D			D	D			C	A	D		C	A	A			

Streams and rivers state: Mataura FMU 2010

Legend	
A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)
or	
	Pass
	Fail

Lowland soft bed

Attribute	Mimihau Stream at Wyndham	Mimihau Stream at Mimihau School Road	Mokoreta River at Egremont Road	Mokoreta River at Wyndham River Road	Otamita Stream at Mandeville	Oteramika Stream at Seaward Downs	Tokanui River at Fortrose Otara Road	Waikaka Stream at Gore	Waikawa River at Progress Valley	Waikawa River at Bigger Road	Waikaka Stream at Willowbank	Waikopikopiko Stream at Haldane Curio Bay	Waituna Creek at Marshall Road[1]	Waituna Creek 1m u/s Waituna Road[1]
National compulsory attributes														
Nitrate toxicity (mg/L)	B			B	B	C	B	B	A			A	C	C
Ammonia toxicity (mg/L)	A			B	A	B	B	B	B			A	B	B
E. coli (*E. coli*/100 mL)[2]	E			E	E	E	E	E	E			D	E	E
Southland attributes														
Macroinvertebrates (MCI, wadable rivers only)		B	B	B	B	D		C	B			B	D	
Temperature - summer (°C, Dec - Mar)											C			
Temperature - winter (°C, May - Sep)											Fail			
E. coli at popular bathing sites (*E. coli*/100 mL)														
Clarity (visible distance, m)	D			B	C	D	D	D	D			D	D	D
Suspendend fine sediment (turbidity, FNU)	D			D	C	D	D	D	D			D	D	B
Additional national compulsory attributes requiring an action plan														
Dissolved Reactive Phosphorus (mg/L)	C			C	C	D	C	D	C			B	C	B
Fish (IBI)										C				
Additional attributes for information														
Dissolved inorganic nitrogen (mg/L)	C			D	C	D	C	D	C			A	D	D

Lowland hard bed

Attribute	Carran Creek at Waituna Lagoon Road[1]	Carran Creek Trib at Waituna Lagoon Rd[1]	East Branch Waikaka Stream at Greenvale Rd	Longridge Stream at Sandstone	Mataura River at Gorge Road	Mataura River at Keowns Road Bridge	Mataura River at Mataura Island Bridge	Mataura River at Seaward Downs	Moffat Creek at Moffat Road[2]	North Peak Stream at Waimea Valley Road	Sandstone Stream at Kingston Crossing Rd	Waimea Stream at Mandeville	Waimea Stream at Murphy Road	Waimea Stream at Nine Mile Road	Waimea Stream at Old Balfour Road	Waimea Stream at Pahiwi - Balfour Road	Waimea Tributary at McCale Road
National compulsory attributes																	
Nitrate toxicity (mg/L)	B	A		C	B				B	B	D	C	C	C	B	C	B
Ammonia toxicity (mg/L)	B	A		B	B				B	B	B	B	A	B	A	B	B
E. coli (*E. coli*/100 mL)[2]	E	C		E	E		E		E	E	E	E	E	E	E	E	E
Southland attributes																	
Macroinvertebrates (MCI, wadable rivers only)						A	C		D			C					
Temperature - summer (°C, Dec - Mar)								C				C					
Temperature - winter (°C, May - Sep)								Fail				Fail					
E. coli at popular bathing sites (*E. coli*/100 mL)																	
Clarity (visible distance, m)		D	D	C	D		C		D	D	D	D	C	D	D	C	D
Suspendend fine sediment (turbidity, FNU)	D	A		D	D		D		D	D	D	D	D	D	D	D	D
Additional national compulsory attributes requiring an action plan																	
Dissolved Reactive Phosphorus (mg/L)	D	D		D	C				D	C	D	D	C	D	B	C	B
Fish (IBI)									B								
Additional attributes for information																	
Dissolved inorganic nitrogen (mg/L)	C	A		D	C		A		C	D	D	D	D	D	C	D	C

Hill / Mountain / Spring fed

Attribute	Hill: Mataura River 200m d/s Mataura Bridge	Hill: Mataura River at Garston	Hill: Mataura River at Gore	Hill: Mataura River at Otamita Bridge	Hill: Mataura River at Parawa	Hill: Mataura River d/s Robert Creek Confluence	Hill: Mimihau Stream South at Venlaw Forest	Hill: Mimihau Stream Tributary at Venlaw Forest	Hill: Waikaia River at Waikaia	Hill: Waikaia River at Waipounamu Bridge Road	Mountain: Waikaia River at Piano Flat	Mountain: Waikaia River u/s Piano Flat	Spring fed: Brightwater Spring West at Garston Kings	Spring fed: Meadow Burn at Round Hill Road
National compulsory attributes														
Nitrate toxicity (mg/L)	B		A	A				A	A	A		A		
Ammonia toxicity (mg/L)	B		B	A				A	A	A		B		
E. coli (*E. coli*/100 mL)[2]	E		E	D	D			A	D	D		B		
Southland attributes														
Macroinvertebrates (MCI, wadable rivers only)	C		B	B	A	A	B	B		A		A	C	D
Temperature - summer (°C, Dec - Mar)			C								C			
Temperature - winter (°C, May - Sep)			Fail								Fail			
E. coli at popular bathing sites (*E. coli*/100 mL)			D						D					
Clarity (visible distance, m)	C		B	B	A			C	B	B		A		
Suspendend fine sediment (turbidity, FNU)	D		D	D	C			A	D	D		A		
Additional national compulsory attributes requiring an action plan														
Dissolved Reactive Phosphorus (mg/L)	C		B	B				C	B	B		A		
Fish (IBI)														C
Additional attributes for information														
Dissolved inorganic nitrogen (mg/L)	C	A	C	C	A			B	A	B		A		

Footnotes: 1. Sites which fall within the proposed Waituna FMU discussed in the Environment Court Interim Decision on the proposed SWLP

Streams and rivers state: Waiau FMU 2016	Natural state			Lowland soft bed							Lowland hard bed		Hill							Lake fed							Spring fed
A = Very good; B = Good; C = Fair; D = Poor; E = Very poor (*E. coli* only); *or* Pass; Fail	Eglington River at McKay Creek Confluence	McKay Creek at Milford Road	Thicket Burn at Lake Hauroko Road	Camp Creek at State Highway 99	Excelsior Creek at Weir Rd	Lill Burn at Hindley Road	Lill Burn at Lill Burn-Monowai Road	Orauea River at Orawia Pukemaori Road	Thicket Burn u/s Lill Burn Confluence	Waimotu Creek at Waiau Lagoon	Chartres Property at Te Anau Downs	Ellis Creek Tributary at Happy Valley Rd	Mararoa River at The Key	Mararoa River at Mararoa Road Bridge	Mararoa River at Weir Road	Upukerora River at Te Anau Milford Road	Wairaki River at Blackmount Road	Wairaki River d/s Blackmount Road	Whitestone River d/s Manapouri-Hillside	Boundary Creek at Waiau Confluence	Mararoa River at Kiwiburn	Mararoa River at South Mavora Lake	Waiau River 100m u/s Clifden Bridge	Waiau River at Duncraigen Road	Waiau River at Sunnyside	Waiau River at Tuatapere	Home Creek at Manapouri
National compulsory attributes																											
Nitrate toxicity (mg/L)							A	A					A		A	A		A	A			A		A	A	A	
Ammonia toxicity (mg/L)							A	B					A		A	A		A	A			A		A	A	A	
E. coli (*E. coli*/100 mL)							D	E					B		A	A		B	A			A		B	A	D	
Southland attributes																											
Macroinvertebrates (MCI, wadable rivers only)	A	B	A			B	B	C	B					B	B	B	B		B		B		D	B	B	C	B
Temperature - winter (°C, May - Sep)																									Fail		
E. coli at popular bathing sites (*E. coli*/100 mL)																										D	
Clarity (visible distance, m)							B	C					A		A	A		A	A					A	A	A	
Deposited fine sediment (% cover)							A	A							A	A		A	A							A	
Suspendend fine sediment (turbidity, FNU)							D	B					A		A	A		A	A			A		A	A	D	
Benthic cyanobacteria (% cover)							A	A							A	D		A	C							B	
Filamentous periphyton (% cover)							Fail	Pass							Fail	Pass		Pass	Fail							Fail	
Diatoms and cyanobacteria (% cover)							Pass	Fail							Fail	Pass		Pass	Pass							Fail	
Additional national compulsory attributes requiring an action plan																											

Dissolved Reactive Phosphorus (mg/L)	
Fish (IBI)	
Additional attributes for information	
Dissolved inorganic nitrogen (mg/L)	
Deposited fine sediment (% cover)	
Deposited fine sediment (Quorer method)	

Streams and rivers state: Fiordland & Islands FMU 2016	Natural state	
A Very good; B Good; C Fair; D Poor; E Very poor (*E. coli* only); *or* Pass; Fail	Caroline Burn above Lake Hauroko	Lake Hauroko Tributary at Carpark
Southland attributes		
Macroinvertebrates (MCI, wadable rivers only)		
Additional national compulsory attributes requiring an action plan		
Fish (IBI)		

Streams and rivers state: Aparima FMU 2016

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

Pass	Pass
Fail	Fail

	Natural state	Lowland soft bed		Lowland hard bed																				Hill						
	Gorge Stream at Cascade Road	Opouriki Stream at Tweedie Road	Waimatuku at Fairfax Isla bank Rd	Aparima River at Otautau	Aparima River at Thornbury	Cascade Stream at Pourakino Valley Road	Cascade Stream at Cascade Road	Hamilton Burn at Affleck Road	Hillpoint Stream at Waikana Road	Kenny Creek	Otautau Stream at Otautau	Otautau Stream at Otautau-Tuatapere Road	Otautau Stream at Waikouro	Pourakino River at Pourakino Valley	Pourakino River at Ermedale Road	Pourakino River at Jubilee Hill Road	Pourakino River at Traill Road	Waimatuku Stream at Lorneville Riverton Hwy	Waimatuku Stream at Rance Road	Waimatuku Stream at Waimatuku Township Rd	Waimatuku Stream d/s Bayswater Bog	Waimeamea River at Young Road	Wairio Stream at Dahlenburg Rd	Aparima River at Dunrobin	Aparima River d/s Dunrobin Bridge	Aparima River at Etalvale	Centre Burn at Goodall Rd	Hamilton Burn at Goodall Road	Taringatura Creek at Taromaunga	North Etal Creek u/s Dunrobin Valley Rd
National compulsory attributes																														
Nitrate toxicity (mg/L)		B		A	B	A		B				B	B		A		A	C			B			A						
Ammonia toxicity (mg/L)		B		A	A	A		B				B	B		A		A	B			B			A						
E. coli (*E. coli*/100 mL)		E		D	E	D		D				E	E		D		E	E			E			B						
Southland attributes																														
Macroinvertebrates (MCI, wadable rivers only)		D		B	C	A		B	C	D	C	C	C		B	A		D	D			A		B	B	A		B	B	A
Temperature - summer (°C, Dec - Mar)					C									A	D					B				C						
Temperature - winter (°C, May - Sep)					Fail									Fail	Fail									Fail						
E. coli at popular bathing sites (*E. coli*/100 mL)					D																									
Clarity (visible distance, m)		D		A	B	B		A				D	D		B		D	D			D			A						
Deposited fine sediment (% cover)					A			A				A								A										
Suspendend fine sediment (turbidity, FNU)		C		A	A	A		A				D	D		D		D	D			D			A						
Benthic cyanobacteria (% cover)					A			A				A								A										
Filamentous periphyton (% cover)					Fail			Pass				Fail									Fail									
Diatoms and cyanobacteria (% cover)					Pass			Pass				Pass								Pass										
Additional national compulsory attributes requiring an action plan																														
Dissolved Reactive Phosphorus (mg/L)		C		A	B	A		A				D	D		A		A	D			D			A						
Fish (IBI)	D		B			B	C	A												D			C				C			
Additional attributes for information																														
Dissolved inorganic nitrogen (mg/L)		D		C	C	A		C				D	D		A		A	D			D			A						
Deposited fine sediment (% cover)					Pass			Pass				Pass								Pass										
Deposited fine sediment (Quorer method)				Pass	Pass	Pass		Fail	Fail		Fail	Pass	Fail		Pass	Pass		Pass	Pass					Fail		Pass		Fail		Fail

Streams and rivers state: Ōreti FMU 2016 (table 1 of 2)

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

Pass	Pass
Fail	Fail

	Natural state		Lowland soft bed										
	Dunsdale Stream at Dunsdale Reserve	Mokotua Stream at Awarua	Hedgehope Stream 20m u/s Makarewa Confl	Makarewa River at Counsell Road	Makarewa River at Lora Gorge Road	Makarewa River at Wallacetown	Makarewa River u/s Hedgehope Confluence	Otepuni Creek at Nith Street	Silver Stream at Lora Gorge Road	Trenders Creek at Hall Road	Tussock Creek at Cooper Road	Tussock Creek at Horton Road	Waianiwa Creek 1 at Lornville Riverton Highway
National compulsory attributes													
Nitrate toxicity (mg/L)	A	A	A		A	B		B			B		
Ammonia toxicity (mg/L)	A	B	B		A	B		B			C		
E. coli (*E. coli*/100 mL)	B	A	E		E	E		E			E		
Southland attributes													
Macroinvertebrates (MCI, wadable rivers only)	A	C	D		C	D	C	D	B	B	D	D	D
Temperature - summer (°C, Dec - Mar)				C									
Temperature - winter (°C, May - Sep)				Fail									
E. coli at popular bathing sites (*E. coli*/100 mL)													
Clarity (visible distance, m)	B		D		D	D		D			C		
Deposited fine sediment (% cover)	A		A	A									
Suspendend fine sediment (turbidity, FNU)	A	A	D		C	C		C			A		
Benthic cyanobacteria (% cover)	A		A	A									
Filamentous periphyton (% cover)	Pass		Fail	Fail									
Diatoms and cyanobacteria (% cover)	Pass		Pass	Pass									
Additional national compulsory attributes requiring an action plan													
Dissolved Reactive Phosphorus (mg/L)	B	A	C		C			C	C		D		
Fish (IBI)	C		B						C	C			
Additional attributes for information													
Dissolved inorganic nitrogen (mg/L)	A	A	C		C	D		D			D		
Deposited fine sediment (% cover)	Pass		Pass	Pass									
Deposited fine sediment (Quorer method)	Pass		Fail		Fail	Fail	Fail		Fail		Fail		Fail

	Lowland hard bed																			
	Bog Burn at Hundred Line Road	Bog Burn at Winton-Wreys Bush Hwy	Bog Burn d/s Hundred Line Road	Dipton Stream at Lang Road	Dipton Stream at South Hillend-Dipton Road	Myross Tributary at Mill Road	Oreti River at Branxholme	Oreti River at Wallacetown	Otapiri Stream at Anderson Road	Otapiri Stream at Otapiri Gorge	Waihopai River at Waihopai Dam	Waihopai River at Dacre	Waihopai River at Kennington	Waihopai River at Kennington Road	Waihopai River u/s Queens Drive	Waikiwi Stream at North Road	Winton Stream at Centre Bush Otapiri Rd	Winton Stream at Benmore - Otapiri Road	Winton Stream at Lochiel	Winton Stream d/s Winton Dam
National compulsory attributes																				
Nitrate toxicity (mg/L)			C		B			B		B					C	C			C	B
Ammonia toxicity (mg/L)			B		A			A		B					B	B			B	A
E. coli (*E. coli*/100 mL)			E		E			D		E					E	E			E	E
Southland attributes																				
Macroinvertebrates (MCI, wadable rivers only)			C		C			C	C	B	D			D	D	D		C	D	
Temperature - summer (°C, Dec - Mar)							C			C			C							
Temperature - winter (°C, May - Sep)								Fail		Fail										
E. coli at popular bathing sites (*E. coli*/100 mL)								D												
Clarity (visible distance, m)			D		C			B		D					C	D	D			D
Deposited fine sediment (% cover)					A		A													
Suspendend fine sediment (turbidity, FNU)			D		D			B		D					D	D			D	C
Benthic cyanobacteria (% cover)					D		A													
Filamentous periphyton (% cover)					Fail		Fail													
Diatoms and cyanobacteria (% cover)					Pass		Pass													
Additional national compulsory attributes requiring an action plan																				
Dissolved Reactive Phosphorus (mg/L)			D		D			B		C					B	C			D	C
Fish (IBI)	B	B		B		B						B					B			
Additional attributes for information																				
Dissolved inorganic nitrogen (mg/L)			D		D			C		C					D	D			D	C
Deposited fine sediment (% cover)					Pass		Pass													
Deposited fine sediment (Quorer method)			Fail		Fail			Fail	Fail	Fail	Fail				Pass				Fail	

	Hill									
	Cromel Stream at Selbie Road	Dipton Stream Tributary at Castle Downs Forest	Irthing Stream at Ellis Road	Irthing Tributary at East Dome Station Road	Oreti River at Benmore	Oreti River at Centre Bush	Oreti River at Lumsden Bridge	Oreti River at Mossburn	Oreti River at Ram Hill	Oreti River at Three Kings
National compulsory attributes										
Nitrate toxicity (mg/L)	A		B			A	A			A
Ammonia toxicity (mg/L)	A		B			B	A			A
E. coli (*E. coli*/100 mL)	A		D			C	B			A
Southland attributes										
Macroinvertebrates (MCI, wadable rivers only)	A		A		B		B	B	B	A
Temperature - summer (°C, Dec - Mar)			C				B			B
Temperature - winter (°C, May - Sep)			Fail				Fail			Fail
E. coli at popular bathing sites (*E. coli*/100 mL)										
Clarity (visible distance, m)	A		A			A	A			A
Deposited fine sediment (% cover)	A		A							A
Suspendend fine sediment (turbidity, FNU)	A		B			B	A			A
Benthic cyanobacteria (% cover)	A		A							A
Filamentous periphyton (% cover)	Pass		Pass							Pass
Diatoms and cyanobacteria (% cover)	Pass		Pass							Fail
Additional national compulsory attributes requiring an action plan										
Dissolved Reactive Phosphorus (mg/L)	A		A			A	A			A
Fish (IBI)	B	A		B						
Additional attributes for information										
Dissolved inorganic nitrogen (mg/L)	A		D			C	B			A
Deposited fine sediment (% cover)	Pass		Pass							Pass
Deposited fine sediment (Quorer method)	Pass		Fail		Pass		Fail	Pass	Pass	Pass

Streams and rivers state: Ōreti FMU 2016 (table 2 of 2)	Mountain	Spring fed	
	Ōreti River at McKellars Flat	Murray Creek at Casetlerock	Murray Creek at Double Road
National compulsory attributes			
Nitrate toxicity (mg/L)			
Ammonia toxicity (mg/L)			
E. coli (*E. coli*/100 mL)			
Southland attributes			
Macroinvertebrates (MCI, wadable rivers only)			
Temperature - summer (°C, Dec - Mar)			
Temperature - winter (°C, May - Sep)			
E. coli at popular bathing sites (*E. coli*/100 mL)			
Clarity (visible distance, m)			
Deposited fine sediment (% cover)			
Suspendend fine sediment (turbidity, FNU)			
Benthic cyanobacteria (% cover)			
Filamentous periphyton (% cover)			
Diatoms and cyanobacteria (% cover)			
Additional national compulsory attributes requiring an action plan			
Dissolved Reactive Phosphorus (mg/L)			
Fish (IBI)			
Additional attributes for information			
Dissolved inorganic nitrogen (mg/L)			
Deposited fine sediment (% cover)			
Deposited fine sediment (Quorer method)			

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

	Pass
	Fail

Streams and rivers state:
Mataura FMU 2016 (Table 1 of 2)

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

Pass	
Fail	

	Lowland soft bed																			
	Cook Creek at Haldane Curio Bay Rd	Jordan Creek at Leigh plantation	Koneburn at Bushy Park Road	Mimihau Stream at Wyndham	Mokoreta River at Egremont Road	Mokoreta River at Wyndham River Road	Otamita Stream at Mandeville	Oteramika Stream at Seaward Downs	Tokanui River at Fortrose Otara Road	Waikaka Stream at Gore	Waikaka Stream at Hamilton Park	Waikaka Stream at Willowbank	Waikawa Harbour Tributary at Bell Road	Waikawa River at Biggar Road	Waikawa River at Progress Valley	Waikopikopiko Stream at Haldane Curio Bay	Waionepu Creek at Haldane-Curio Bay Road	Waipapa River at Haldane-Otara Hwy	Waituna Creek at Marshall Road[1]	Waituna Creek 1m u/s Waituna Road[1]
National compulsory attributes																				
Nitrate toxicity (mg/L)				A		B	B	C	B	B					A	A			B	C
Ammonia toxicity (mg/L)				A		A	A	C	B	B					A	A			B	B
E. coli (*E. coli*/100 mL)				E		E	E	E	E	E					E	D			E	E
Southland attributes																				
Macroinvertebrates (MCI, wadable rivers only)				C	B	B	B	D	D	D	C				B	A			D	
Temperature - summer (°C, Dec - Mar)											C	C		B					C	
Temperature - winter (°C, May - Sep)												Fail								
E. coli at popular bathing sites (*E. coli*/100 mL)																				
Clarity (visible distance, m)				D		C	C	D	D	D					D	D			D	C
Deposited fine sediment (% cover)				A			A			A					A				A	
Suspendend fine sediment (turbidity, FNU)				D		D	C	D	D	D					D	D			D	A
Benthic cyanobacteria (% cover)				A			A			A					A				A	
Filamentous periphyton (% cover)				Fail			Pass			Fail					Pass				Pass	
Diatoms and cyanobacteria (% cover)				Pass			Pass			Pass					Pass				Pass	
Additional national compulsory attributes requiring an action plan																				
Dissolved Reactive Phosphorus (mg/L)				C		B	B	D	D	D					C	B			C	B
Fish (IBI)	A	A	B				C	B		C			A		B		B	B	C	
Additional attributes for information																				
Dissolved inorganic nitrogen (mg/L)				C		D	C	D	D	D					C	A			D	D
Deposited fine sediment (% cover)				Pass			Pass			Pass					Fail				Pass	
Deposited fine sediment (Quorer method)				Fail	Fail	Pass	Fail	Fail		Fail	Fail				Fail	Fail			Fail	

	Lowland hard bed																				
	Carran Creek at Waituna Lagoon Road[1]	Carran Creek Trib at Waituna Lagoon Rd[1]	East Branch Waikaka Stream at Greenvale Rd	Longridge Stream at Sandstone	Longridge Stream at Sandstone-Kingston Crossing Rd	Mataura River at Gorge Road	Mataura River at Wyndham	Mataura River at Mataura Island Bridge	Mataura River at Seaward Downs	Moffat Creek at Moffat Road[2]	North Peak Stream at Waimea Valley Road	Sandstone Stream at Kingston Crossing Rd	Sandstone Stream at Mandeville Kingston	Sandstone Stream u/s Waimea Confluence	Waimea Stream at Mandeville	Waimea Stream at Murphy Road	Waimea Stream at Nine Mile Road	Waimea Stream at Old Balfour Road	Waimea Stream at Pahiwi - Balfour Road	Waimea Tributary at McCale Road	Waimea Tributary at Fairplace Farm
National compulsory attributes																					
Nitrate toxicity (mg/L)	B	A		C		B		A		B	B	C			C	C	C	A	C	A	
Ammonia toxicity (mg/L)	B	A		C		A		A		B	C	C			A	A	A	A	A	A	
E. coli (*E. coli*/100 mL)	E	C		E		E		E		E	E	E			E	D	E	E	D	D	
Southland attributes																					
Macroinvertebrates (MCI, wadable rivers only)	D			D				C		D		D		D	D						
Temperature - summer (°C, Dec - Mar)							D		D						D						
Temperature - winter (°C, May - Sep)							Fail		Fail						Fail						
E. coli at popular bathing sites (*E. coli*/100 mL)																					
Clarity (visible distance, m)	D	D		C		D		B		D	D	D			C	C	C	B	C	D	
Deposited fine sediment (% cover)				A				A							A						
Suspendend fine sediment (turbidity, FNU)	D	A		D		D		D		D	D	D			D	D	C	D	B	D	
Benthic cyanobacteria (% cover)				A				A							A						
Filamentous periphyton (% cover)				Fail				Fail							Pass						
Diatoms and cyanobacteria (% cover)				Pass				Pass							Pass						
Additional national compulsory attributes requiring an action plan																					
Dissolved Reactive Phosphorus (mg/L)	D	D		D		C		B		D	C	D			C	C	D	B	C	B	
Fish (IBI)			B		A					B			C		B						C
Additional attributes for information																					
Dissolved inorganic nitrogen (mg/L)	C	A		D		D		C		C	C	D			D	D	D	C	D	C	
Deposited fine sediment (% cover)				Pass				Pass							Pass						
Deposited fine sediment (Quorer method)				Fail				Fail		Fail		Fail			Pass						

Footnotes: 1. Sites which fall within the proposed Waituna FMU discussed in the Environment Court Interim Decision on the proposed SWLP

Streams and rivers state:
Mataura FMU 2016 (Table 2 of 2)

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)
or	
Pass	Pass
Fail	Fail

	Hill												Mountain		Spring fed		
	Eyre Creek at Athol	Mataura River 200m d/s Mataura Bridge	Mataura River d/s Robert Creek Confluence	Mataura River at Garston	Mataura River at Gore	Mataura River at Otamita Bridge	Mataura River at Parawa	Mataura River at Pyramid Bridge	Mimihau Stream Tributary at Venlaw Forest	Waikaia River at Waikaia	Waikaia River at Waipounamu Bridge Road	Waikaka Tributary at Bryant Road	Waikaia River u/s Piano Flat	Waikaia River at Piano Flat	Brightwater Spring West at Garston Kings	Meadow Burn at Round Hill Road	Waimea Stream Tributary at Kingsbury Road
National compulsory attributes																	
Nitrate toxicity (mg/L)		A		A	A	A	A		A	A	A		A				
Ammonia toxicity (mg/L)		B		A	A	A	A		A	A	A		A				
E. coli (*E. coli*/100 mL)		E		A	E	B	D		A	D	D		A				
Southland attributes																	
Macroinvertebrates (MCI, wadable rivers only)	A	B	B	B	C		A	B	A	A	B		A		C	D	
Temperature - summer (°C, Dec - Mar)					C									B			
Temperature - winter (°C, May - Sep)					Fail									Fail			
E. coli at popular bathing sites (*E. coli*/100 mL)					D					D							
Clarity (visible distance, m)		B		A	B	B	A		C	B	B		A				
Deposited fine sediment (% cover)					A					A				A			
Suspendend fine sediment (turbidity, FNU)		D		A	D	D	D		A	D	D			A			
Benthic cyanobacteria (% cover)					A					D			D				
Filamentous periphyton (% cover)					Pass					Pass			Fail				
Diatoms and cyanobacteria (% cover)					Pass					Pass			Pass				
Additional national compulsory attributes requiring an action plan																	
Dissolved Reactive Phosphorus (mg/L)		C		A	B	B	A		C	A	B		A				
Fish (IBI)									D			B					B
Additional attributes for information																	
Dissolved inorganic nitrogen (mg/L)		C		A	C	C	B		A	A	C		A				
Deposited fine sediment (% cover)					Pass					Pass			Pass				
Deposited fine sediment (Quorer method)				Fail	Fail		Fail	Fail	Pass	Pass	Pass		Pass				

Footnotes: 1. Sites which fall within the proposed Waituna FMU discussed in the Environment Court Interim Decision on the proposed SWLP

Streams and rivers state: Waiau FMU 2019

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

Pass	Pass
Fail	Fail

Attribute	Natural state					Lowland soft bed					Hill							Lake fed								Spring fed
	Eglington River at McKay Creek Confluence	McKay Creek at Milford Road	Pig Creek at Borland Lodge	Thicket Burn at Lake Hauroko Road	Upper Waiau River at Queens Reach	Lill Burn at Hindley Road	Lill Burn at Lill Burn-Monowai Road	Orauea River at Orawia Pukemaori Road	Thicket Burn u/s Lill Burn Confluence	Rowallan Burn East at Rowallan Road	Mararoa River at Mararoa Road Bridge	Mararoa River at The Key	Mararoa River at Weir Road	Upukerora River at Te Anau Milford Road	Upukerora River off Sinclair Rd	Wairaki River d/s Blackmount Road	Whitestone River d/s Manapouri-Hillside	Boundary Creek at Waiau Confluence	Mararoa River at Kiwiburn	Mararoa River at South Mavora Lake	Waiau River 100m u/s Clifden Bridge	Waiau River at Duncraigen Road	Waiau River at Sunnyside	Waiau River at Tuatapere	Waiau River u/s Excelsior Creek	Home Creek at Manapouri
National compulsory attributes																										
Periphyton (Chl-*a* mg/m²)							B	B					B	B		A	B							C		
Nitrate toxicity (mg/L)							A	A				A	A	A		A	A			A			A	A		
Ammonia toxicity (mg/L)							A	B				A	A	A		A	A			A			A	A		
Dissolved oxygen (mg/L)[1]							C	B					C	A		A								C		
E. coli (*E. coli*/100 mL)							D	E				D	D	D		D	D			A			B	D		
Southland attributes																										
Macroinvertebrates (MCI, wadable rivers only)	A	A	A	A		B	C	C	B	B	B		B	B	B	B	B		C		C	C	B	C		B
Temperature - summer (°C Dec - Mar)							C	B					A	A		B							C	D		
Temperature - winter (°C, May-Sep)																							Fail			
E. coli at popular bathing sites (*E. coli*/100 mL)																								D		
Clarity (visible distance, m)							B	C				A	A	A		A	A						A	A		
Deposited fine sediment (% cover)					A		A	A					A	A		A	A				A		A	A	A	
Suspendend fine sediment (turbidity, FNU)							B	A				A	A	A		A	A			A			A	D		
Benthic cyanobacteria (% cover)					A		A	A					C	D		A	C				A		A	B	A	
Filamentous periphyton (% cover)					Pass		Fail	Fail					Fail	Pass		Pass	Fail				Fail		Pass	Pass	Pass	
Diatoms and cyanobacteria (% cover)					Pass		Fail	Fail					Fail	Pass		Pass	Pass				Pass		Pass	Fail	Pass	

National compulsory attributes requiring an action plan	
Dissolved Reactive Phosphorus (mg/L)	
Fish (IBI)	
Additional attributes for information	
Dissolved inorganic nitrogen (mg/L)	
Deposited fine sediment (% cover)	
Deposited fine sediment (Quorer method)	

Footnotes:
1. This is a national complusory attribute below point source discharges and a Southland attribute elsewhere

Streams and rivers state: Fiordland and Islands FMU 2019	Natural State
	Caroline Burn above Lake Hauroko
Southland attributes	
Macroinvertebrates (MCI, wadable rivers only)	

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

	Pass
	Fail

Streams and rivers state: Aparima FMU 2019

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (*E. coli* only)

or

	Pass
	Fail

Streams and rivers state: Aparima FMU 2019	Lowland soft bed	Lowland hard bed																		Hill				
	Opouriki Stream at Tweedie Road	Aparima River at Otautau	Aparima River at Thornbury	Cascade Stream at Cascade Rd	Cascade Stream at Pourakino Valley Road	Hamilton Burn at Affleck Road	Hillpoint Stream at Waikana Road	Kenny Creek	Otautau Stream at Otautau	Otautau Stream at Otautau-Tuatapere Road	Otautau Stream at Waikouro	Pourakino River at Pourakino Valley	Pourakino River at Ermedale Road	Pourakino River at Jubilee Hill Road	Pourakino River at Traill Road	Waimatuku Stream at Lorneville Riverton Hwy	Waimatuku Stream at Rance Road	Waimatuku Stream at Waimatuku Township Road	Waimeamea River at Young Road	Aparima River at Dunrobin	Aparima River at Etalvale	Hamilton Burn at Goodall Road	Taringatura Creek at Taromaunga	North Etal Creek u/s Dunrobin Valley Rd
National compulsory attributes																								
Periphyton (Chl-*a* mg/m^2)			D			B				C								B						
Nitrate toxicity (mg/L)	B		B		A	B				B	B				A	C				A				
Ammonia toxicity (mg/L)	B		A		A	B				B	B				A	B				A				
Dissolved oxygen (mg/L)[1]			B			C				D						C								
E. coli (*E. coli*/100 mL)	E		D		D	D				E	E				E	E				D				
Southland attributes																								
Macroinvertebrates (MCI, wadable rivers only)	D	B	C		B	C	B	D	C	C	B		B	A		D	D	D	B	A	A	B	B	A
Temperature - summer (°C, Dec - Mar)			D			B				B		B	D							D				
Temperature - winter (°C, May - Sep)			Fail									Fail	Fail					Fail		Fail				
E. coli at popular bathing sites (*E. coli*/100 mL)			D																					
Clarity (visible distance, m)	C		B		B	B				D	D				D	C				A				
Deposited fine sediment (% cover)			A			A				A								A						
Suspendend fine sediment (turbidity, FNU)	B		A		A	A				D	D				D	C				A				
Benthic cyanobacteria (% cover)			C			A				A								A						

Filamentous periphyton (% cover)																								
Diatoms and cyanobacteria (% cover)																								
Additional national compulsory attributes requiring an action plan																								
Dissolved Reactive Phosphorus (mg/L)																								
Fish (IBI)																								
Additional attributes for information																								
Dissolved inorganic nitrogen (mg/L)																								
Deposited fine sediment (% cover)																								
Deposited fine sediment (Quorer method)																								

Footnotes:

1. This is a national complusory attribute below point source discharges and a Southland attribute elsewhere

Streams and rivers state: Ōreti FMU 2019	Natural state		Lowland soft bed													Lowland hard bed															Hill								Mountain	Spring fed	
A Very good; B Good; C Fair; D Poor; E Very poor (*E. coli* only) *or* Pass; Fail	Dunsdale Stream at Dunsdale Reserve	Mokotua Stream at Awarua	Hedgehope Stream 20m u/s Makarewa Confl	Hedgehope Stream at Block Road	Makarewa River at Counsell Road	Makarewa River at King Road	Makarewa River at Lora Gorge Road	Makarewa River at Wallacetown	Makarewa River at Winton - Hedgehope Hwy	Makarewa River u/s Hedgehope Confluence	Otepuni Creek at Nith Street	Silver Stream at Lora Gorge Road	Trenders Creek at Hall Road	Tussock Creek at Cooper Road	Waianiwa Creek 1 at Lornville Riverton Highway	Bog Burn d/s Hundred Line Road	Dipton Stream at South Hillend-Dipton Road	Oreti River at Branxholme	Oreti River at Wallacetown	Otapiri Stream at Anderson Road	Otapiri Stream at Otapiri Gorge	Waihopai River at Dacre	Waihopai River at Kennington	Waihopai River at Kennington Road	Waihopai River at Waihopai Dam	Waihopai River u/s Queens Drive	Waikiwi Stream at North Road	Winton Stream at Benmore - Otapiri Road	Winton Stream at Lochiel	Winton Stream at Winton Substation Road	Cromel Stream at Selbie Road	Irthing Stream at Ellis Road	Oreti River at Benmore	Oreti River at Lumsden Bridge	Oreti River at Mossburn	Oreti River at Winton Bridge	Oreti River at Ram Hill	Oreti River at Three Kings	Oreti River at McKellars Flat	Murray Creek at Cumming Road	Murray Creek at Double Road
National compulsory attributes																																									
Periphyton (Chl-*a* mg/m²)	A		A		B												D	B													A	A						B			
Nitrate toxicity (mg/L)	A	A	B				A	B			B			B		B	B		B		A					C	C		C		A	B		A				A			
Ammonia toxicity (mg/L)	A	A	B				A	B			B			B		B	B		A		A					B	B		C		A	A		A				A			
Dissolved oxygen (mg/L)[1]	A		B		C												C	A													A	B						A			
E. coli (*E. coli*/100 mL)	B	A	E				E	E			E			E		E	E		D		E					E	E		E		A	D		C				A			
Southland attributes																																									
Macroinvertebrates (MCI, wadable rivers only)	A	D	D	B	D	D	C	D	D	C	D	B	C	D	D	C	C		C	D	B			D	D	D	D	D	D		B	A	B	B	B		B	B	B	D	D
Temperature - summer (°C, Dec-Mar)	A		B		D												B	D			C		D								C	D		C				C			
Temperature - winter (°C, May-Sep)	Pass				Fail																Fail		Fail									Fail		Fail				Fail			
E. coli at popular bathing sites (*E. coli*/100 mL)																			D																	D					
Clarity (visible distance, m)	C		D				D	D			D			D		D	B		B		D					C	D		D		A	A		A				A			
Deposited fine sediment (% cover)	A		A		A												A	A													A	A						A			
Suspendend fine sediment (turbidity, FNU)	A	A	C				C	D			C			A		D	D		A		C					C	D		D		A	A		A				A			
Benthic cyanobacteria (% cover)	A		A		A												D	A													A	A						A			
Filamentous periphyton (% cover)	Pass		Fail		Fail												Fail	Fail													Fail	Pass						Pass			
Diatoms and cyanobacteria (% cover)	Pass		Pass		Pass												Pass	Pass													Pass	Pass						Fail			
National compulsory attributes requiring an action plan																																									
Dissolved Reactive Phosphorus (mg/L)	B	A	C				C	C			C			D		D	C		B		C					B	B		D		A	A		A				A			
Fish (IBI)	C		B									D										A								B	B								A		
Additional attributes for information																																									
Dissolved inorganic nitrogen (mg/L)	A	A	C				C	D			D			D		D	D		D		C					D	D		D		A	D		C				A			
Deposited fine sediment (% cover)	Pass		Pass		Pass												Pass	Pass													Pass	Pass						Pass			
Deposited fine sediment (Quorer method)	Fail		Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail		Fail	Fail	Fail			Fail	Pass	Fail	Fail	Fail	Pass		Pass	Pass	Fail	Fail	Fail

Footnotes:

1. This is a national complusory attribute below point source discharges and a Southland attribute elsewhere

Streams and rivers state: Mataura FMU 2019	Lowland soft bed													Lowland hard bed												Hill									Mountain	Spring fed
	Mimihau Stream at Wyndham	Mokoreta River at Egremont Road	Mokoreta River at Wyndham River Road	Otamita Stream at Mandeville	Oteramika Stream at Seaward Downs	Tokanui River at Fortrose Otara Road	Waikaka Stream at Gore	Waikaka Stream at Hamilton Park	Waikawa River at Progress Valley	Waikopikopiko Stream at Haldane Curio Bay	Waituna Creek at Marshall Road[2]	Waikawa River at Biggar Road	Waikaka Stream at Willowbank	Carran Creek at Waituna Lagoon Road[2]	Longridge Stream at Sandstone	Longridge Stream at Sandstone-Kingston Crossing Rd	Mataura River at Keowns Road Bridge	Mataura River at Mataura Island Bridge	Moffat Creek at Moffat Road[2]	North Peak Stream at Waimea Valley Road	Sandstone Stream at Kingston Crossing Rd	Sandstone Stream u/s Waimea Confluence	Waimea Stream at Mandeville	Mataura River at Seaward Downs	Mataura River at Wyndham	Mataura River 200m d/s Mataura Bridge	Mataura River at Garston	Mataura River at Gore	Mataura River at Parawa	Mataura River at Riversdale	Mataura River at Pyramid Bridge	Mimihau Stream Tributary at Venlaw Forest	Waikaia River at Waikaia	Waikaia River at Waipounamu Bridge Road	Waikaia River u/s Piano Flat	Meadow Burn 500m ds Fingerpost-Pyramid
National compulsory attributes																																				
Periphyton (Chl-*a* mg/m^2)																																				
Nitrate toxicity (mg/L)																																				
Ammonia toxicity (mg/L)																																				
Dissolved oxygen (mg/L)[1]																																				
E. coli (*E. coli*/100 mL)																																				
Southland attributes																																				
Macroinvertebrates (MCI, wadable rivers only)																																				
Temperature - summer (°C, Dec - Mar)																																				
Temperature - winter (°C, May - Sep)																																				
E. coli at popular bathing sites (*E. coli*/100 mL)																																				
Clarity (visible distance, m)																																				
Deposited fine sediment (% cover)																																				
Suspendend fine sediment (turbidity, FNU)																																				
Benthic cyanobacteria (% cover)																																				
Filamentous periphyton (% cover)																																				
Diatoms and cyanobacteria (% cover)																																				
National compulsory attributes requiring an action plan																																				
Dissolved Reactive Phosphorus (mg/L)																																				
Fish (IBI)																																				
Additional attributes for information																																				
Dissolved inorganic nitrogen (mg/L)																																				
Deposited fine sediment (% cover)																																				
Deposited fine sediment (Quorer method)																																				

Footnotes:

1. This is a national complusory attribute below point source discharges and a Southland attribute elsewhere
2. Sites which fall within the Waituna FMU contained within the Environment Court Interim Decision on the proposed SWLP

Appendix 7: State summary tables for lakes

Lakes State 2010	Natural state[1]										Deep lakes			Brackish lakes & lagoons						
A = Very good; B = Good; C = Fair; D = Poor; E = Very poor (for *E.coli* only)	Lake Te Anau (whole lake)	Lake Te Anau at Blue Gum Point	Lake Te Anau at South Fiord	Lake Manapōuri (whole lake)	Lake Manapōuri at Pomona Island	Lake Manapōuri at Stony Point	Lake Manapōuri near Frazers Beach	Lake Hauroko	Lake Sheila	Lake Calder	Lake Hauroko	North Mavora Lake	South Mavora Lake	Waiau Lagoon (whole lake)	Waituna Lagoon (closed, whole lake)	Waituna Lagoon at Lagoon Centre (closed)	Waituna Lagoon at Lagoon East (closed)	Waituna Lagoon at Lagoon South (closed)	Waituna Lagoon at Lagoon West (closed)	Lake Brunton
National compulsory attributes																				
Phytoplankton (Chl-*a* mg/m²)		A	A		A	A	A		A	A						C	B	C	D	A
Total phosphorus (mg/m³)		A 3	A 3		A 3	A 3	A 3		A	A						C	C	C	C	C
Total nitrogen (mg/m³)		A 3	A 3		A 3	A 3	A 3		A	A						D	D	C	D	C
Ammonia toxicity (mg/L)		A	A		A	A	A		A	A						B	B	B	B	A
Southland attributes																				
Trophic state (TLI)		A 3	A 3		A 3	A 3	A		A	A						C	C	C	C	B
Macrophytes (% cover)									B	C				C	B 2					D
Trophic state (LakeSPI)	B			C							B	B	B							
Nitrate toxicity (mg/L)		A	A		A	A	A		A	A						B	B	B	B	A
Additional national compulsory attributes requiring an action plan																				
Submerged plants (LakeSPI native condition index)	C			C				C				B	B							
Submerged plants (LakeSPI invasive impact index)	B			C				B				C	C							

Footnotes:

1. Lakes Manapōuri, Te Anau and Hauroko are represented in both the Natural State and Deep Lakes classes in the report, but only shown in Natural State in this table
2. For 'Waituna Lagoon' based on average % cover rather than weighted % cover.
3. 'A+' band result ('Excellent')

Lakes State 2016	Natural state[1]		Lowland shallow lakes										Deep lakes	Brackish lakes & lagoons					
	Lake Te Anau	Lake Manapōuri	Lake George (whole lake)	Lake George NE	Lake George SW	Lake Vincent (whole lake)	Lake Vincent centre	Lake Vincent north	The Reservoir (whole lake)	The Reservoir centre	The Reservoir west	Lake Murihiku	Lake Hauroko	Waituna Lagoon (closed, whole lake)	Waituna Lagoon at Lagoon Centre (closed)	Waituna Lagoon at Lagoon East (closed)	Waituna Lagoon at Lagoon South (closed)	Waituna Lagoon at Lagoon West (closed)	Lake Brunton
National compulsory attributes																			
Phytoplankton (Chl-*a* mg/m²)				B	B		B	B		D	D				C	B	C	C	
Total phosphorus (mg/m³)				C	C		C	C		C	C				C	C	C	C	
Total nitrogen (mg/m³)				B	C		D	D		C	C				D	D	D	D	
Ammonia toxicity (mg/L)				A	A		B	B		A	A				A	A	A	A	
Southland attributes																			
Trophic state (TLI)				C	C		C	C		C	C				C	C	C	C	
Macrophytes (% cover)			C			A			C			C		B (2)					D
Trophic state (LakeSPI)	C	C	A (3)			B			B				B						
Nitrate toxicity (mg/L)				A	A		A	A		A	A				A	A	A	A	
Additional national compulsory attributes requiring an action plan																			
Submerged plants (LakeSPI native condition index)	C	C	A			B			B				C						
Submerged plants (LakeSPI invasive impact index)	C	C	A			C			B				B						
Dissolved oxygen (lake bottom, mg/L)				A	A		A	A		A	A				A	A	A	A	

Legend:

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (for *E.coli* only)

Footnotes:

1. Lakes Manapōuri, Te Anau and Hauroko are represented in both the Natural State and Deep Lakes classes in the report, but only shown in Natural State in this table
2. For 'Waituna Lagoon' based on average % cover rather than weighted % cover.
3. 'A+' band result ('Excellent')

Lakes State 2019	Natural State[1]					Lowland shallow lakes									Brackish lakes & lagoons									
A – Very good; B – Good; C – Fair; D – Poor; E – Very poor (for *E.coli* only)	Lake Te Anau at Blue Gum Point	Lake Te Anau at South Fiord	Lake Manapōuri at Pomona Island	Lake Manapōuri at Stony Point	Lake Manapōuri near Frazers Beach	Lake George (whole lake)	Lake George NE	Lake George SW	Lake Vincent (whole lake)	Lake Vincent centre	Lake Vincent north	The Reservoir (whole lake)	The Reservoir centre	The Reservoir west	Waiau Lagoon (whole lake)	Waiau Lagoon middle	Waiau Lagoon Monitoring Station	Waiau Lagoon opp boat ramp	Waituna Lagoon (closed, whole lake)	Waituna Lagoon at Lagoon Centre (closed)	Waituna Lagoon at Lagoon East (closed)	Waituna Lagoon at Lagoon South (closed)	Waituna Lagoon at Lagoon West (closed)	Lake Brunton
National compulsory attributes																								
Phytoplankton (Chl-*a* mg/m^2)	A	A[6]	A[6]	A[6]	A[6]		D	D		B	B		C	C		B	B	C		C	B	C	C	
Total phosphorus (mg/m^3)	A[6]	A[6]	A[6]	A[6]	A[6]		C	C		C	B		C	C		C	C	C		C	C	C	C	
Total nitrogen (mg/m^3)	A	A	A	A	A		C	C		C	C		C	C		C	C	C		D	D	D	D	
Ammonia toxicity (mg/L)	A	A	A	A	A		A	A		A	A		A	A		B	B	A		A	A	A	B	
E. coli (*E. coli*/100 mL)[3,4]							A	D		A	A		A	A		D	D	D		B	A	A	A	
Cyanobacteria (planktonic, biovolume mm^3/L)	A			A													A			C				
Southland attributes																								
Trophic state (TLI)	A[6]	A[6]	A[6]	A[6]	A[6]		C	C		C	C		C	C		C	C	B		C	C	C	C	
Macrophytes (% cover)						C			A			C				A			B[2]					D
Trophic state (LakeSPI)																								
E. coli at popular bathing sites (*E. coli*/100 mL)[3,4]																								
Nitrate toxicity (mg/L)	A	A	A	A	A		A	A		A	A		A	A		A	A	A		A	A	A	A	
Additional national compulsory attributes requiring an action plan																								
Submerged plants (LakeSPI native condition index)																								
Submerged plants (LakeSPI invasive impact index)																								
Dissolved oxygen (mid-hypolimnetic, mg/L)[5]																								
Dissolved oxygen (lake bottom, mg/L)							A	A		A	A		A	B		B	A	A		A				

Footnotes:

1. Lakes Manapōuri, Te Anau and Hauroko are represented in both the Natural State and Deep Lakes classes in the report, but only shown in Natural State in this table
2. For 'Waituna Lagoon' based on average % cover rather than weighted % cover.
3. There are currently no bathing sites monitored in lakes and no lake sites are identified as popular bathing sites in Appendix G of the proposed pSWLP.
4. This is also a national complusory attribute requiring an action plan in the NPS-FM 2020
5. Analysis not undertaken due to resourcing constraints. Data is only available for Lakes Te Anau and Manapōuri.
6. 'A+' band result ('Excellent')

Appendix 8: State summary tables for estuaries and open coast

Estuaries State 2010	Natural State		Tidal Lagoon Estuaries (SIDEs)										Tidal River Estuaries (SSRTRE)				
	Freshwater Estuary Site A	Freshwater Estuary Site B	Haldane Estuary	Haldane Estuary Site A1	Jacobs River Estuary	New River Estuary	New River Estuary Site B	New River Estuary Site C	New River Estuary Site D	Waikawa Estuary	Waikawa Estuary Site A	Waikawa Estuary Site B	Fortrose Estuary	Fortrose Estuary Site B	Waimatuku Estuary Site D	Waimatuku Estuary Site E	Waimatuku Estuary Site G
Southland Attributes																	
Sediment oxygen levels (aRDP mm)	A (1)	A (1)					A	B	A		A (1)	A (1)		B			
Gross eutrophic zone (% intertidal area)			A		C	D				A			A				
Mud content (% mud at site)	A (1)	A (1)		D			A (1)	A	A (1)		A	A (1)		A (1)	C	A	A (1)
Macroalgae (EQR index)			A			C				A			A				
Cadmium in sediment (mg/kg dry weight)	A	A		A			A	A	A		A	A		A			
Chromium in sediment (mg/kg dry weight)	A	A		A			A	A	A		A	A		A			
Copper in sediment (mg/kg dry weight)	A	A		A			A	A	A		A	A		A			
Lead in sediment (mg/kg dry weight)							A	A	A		A	A		A			
Nickel (mg/kg dry weight)	A	A		A			A	A	A		A	A		A			
Zinc in sediment (mg/kg dry weight)	A	A		A			A	A	A		A	A		A			

A	Very good
B	Good
C	Fair
D	Poor

Footnotes:

1. 'A+' band result ('Excellent')

Estuaries State 2016	Natural State		Tidal Lagoon Estuaries (SIDEs)													Tidal River Estuaries (SSRTRE)	
	Freshwater Estuary Site B	Freshwater Estuary Site C	Haldane Estuary	Haldane Estuary Site B	Haldane Estuary Site C	Jacobs River Estuary	Jacobs River Estuary Site B	Jacobs River Estuary Site C	Jacobs River Estuary Site D	New River Estuary	New River Estuary Site B	New River Estuary Site F	Waikawa Estuary	Waikawa Estuary Site B	Waikawa Estuary Site C	Fortrose Estuary	Fortrose Estuary Site B
Southland Attributes																	
Sediment oxygen levels (aRDP mm)				B	A		A		D		A	D		A 1	B		A 1
Gross eutrophic zone (% intertidal area)			A			D				D			A			B	
Mud content (% mud at site)												D					
Macroalgae (EQR index)			A			D				D			B			C	
Cadmium in sediment (mg/kg dry weight)	A	A		A	A		A		A		A	A		A	A		
Chromium in sediment (mg/kg dry weight)	A	A		A	A		A		A		A	B		A	A		
Copper in sediment (mg/kg dry weight)	A	A		A	A		A		A		A	B		A	A		
Lead in sediment (mg/kg dry weight)	A	A		A	A		A		A		A	B		A	A		
Mercury in sediment (mg/kg dry weight)	A	A		A	A		A		A		A	B		A	A		
Nickel (mg/kg dry weight)	A	A		A	B		B		B		B	D		A	B		
Zinc in sediment (mg/kg dry weight)	A	A		A	A		A		A		A	C		A	A		

A	Very good
B	Good
C	Fair
D	Poor

Footnotes:

1. 'A+' band result ('Excellent')

Estuaries State 2019	Tidal Lagoon Estuaries (SIDE)																																Tidal River Estuaries (SSRTRE)									
	Haldane Estuary Site A1	Haldane Estuary Site B	Jacobs River Estuary	Jacobs River Estuary Site A	Jacobs River Estuary Site B	Jacobs River Estuary Site C	Jacobs River Estuary Site D	Jacobs River Estuary Site E	Jacobs River Estuary d/s Fish Co-op	Jacobs River Estuary d/s Railway Br east	New River Estuary	New River Estuary Awarua Farm	New River Estuary Lagoon tip outlet	New River Estuary Stead Street	New River Estuary Dunns Road	New River Estuary Ski club	New River Estuary Mcoys Beach	New River Estuary Sandy Point	New River Estuary Site B	New River Estuary Site C	New River Estuary Site D	New River Estuary Site E	New River Estuary Site F	New River Estuary Waihopai central	New River Estuary Waihopai upper	New River Estuary at Mokomoko Inlet	New River Estuary at Whalers Bay	New River Estuary at Omaui	Waikawa Estuary Site A	Waikawa Estuary Site B	Waikawa Estuary Site C	Waikawa Estuary upper north	Fortrose Estuary	Fortrose Estuary Site A	Fortrose Estuary Site B	Toetoes Harbour at Fortrose	Waimatuku Estuary Site D	Waimatuku Estuary Site E	Waimatuku Estuary Site G	Oreti Beach	Oreti Beach at Dunns Road	New River Estuary at Omaui Beak
Southland Attributes																																										
Phytoplankton (Chl-*a* mg/m^3)												A	B	D	A	A	A	B																						D		B
Sediment oxygen levels (aRDP mm)	A 1	B		A	B	C	D	D											A	A	A	D	D						C	B	A	A		A 1	A		D	D	D			
Gross eutrophic zone (% intertidal area)			D								D																						B									
Mud content (% mud at site)	D	A		A 1	A	A	D	D											A 1	A	A 1	D	D						C	A 1				A 1	A 1		A	A	B			
Sedimentation rate (mm/year)																								Fail	Fail							Pass										
Macroalgae (EQR index)			D								D																						C									
E. coli (*E. coli*/100 mL)									C																	C	B									D						
E. coli at popular bathing sites (*E. coli*/100 mL) [2]										D						D												D													A	
Enterococci (Enterococci/100 mL)									D																	C	B									C						
Enterococci at popular bathing sites (Enterococci/100 mL)										B						C												D													A	
Arsenic in sediment (mg/kg dry weight)	A	A		A	B	B	B	B											A	B	A	B	B											A	A		A	A	B			
Cadmium in sediment (mg/kg dry weight)	A	A		A	A	A	A	A											A	A	A	A	A											A	A		A	A	A			
Chromium in sediment (mg/kg dry weight)	A	A		A	A	A	A	A											A	A	A	A	B											A	A		A	A	A			
Copper in sediment (mg/kg dry weight)	A	A		B	A	A	B	B											A	A	A	A	B											A	A		A	A	A			
Lead in sediment (mg/kg dry weight)	A	A		A	A	A	A	A											A	A	A	A	B											A	A		A	A	A			
Mercury in sediment (mg/kg dry weight)	A	A		A	A	A	A	A											A	A	A	A	B											A	A		A	A	A			
Nickel (mg/kg dry weight)	B	A		C	B	B	C	C											B	B	B	C	D											A	A		B	B	B			
Zinc in sediment (mg/kg dry weight)	A	A		B	A	A	A	B											A	A	A	A	C											A	A		A	A	A			

A	Very good
B	Good
C	Fair
D	Poor
E	Very poor (for *E. coli* only)
	Pass
	Fail

Footnotes:

1. 'A+' band result ('Excellent')
2. There are currently no bathing sites identified in the pSWLP or RCPS, however, monitoring is undertaken at some sites and shown here.