Memo

Date	30 October 2017
To	OTOP Zone Committee
CC	
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Pathways to achieving LWRP water quality outcomes

Background

In previous workshops, the zone committee has been asked to consider options for addressing water quality issues including nitrate hotspots in the Orari and Levels Plains area, Waitarakao/Washdyke Lagoon and urban waterway issues, and to establish water quality objectives for the zone. The zone committee have indicated general support for the Land and Water Regional Plan (LWRP) water quality outcomes tables (Tables 1a and 1b) and their timelines for achievement (2030). This paper briefly summarises the current state of waterways in the OTOP zone in relation to the LWRP water quality outcomes, and likely pathways for achieving the outcomes where they are currently not being met.

Purpose

The purpose of this paper is to:

a. Summarise the current state of water quality in relation to the outcomes in the LWRP
b. Assess likelihood that provisions in PC5/LWRP will achieve LWRP water quality outcomes
c. Provide options for additional measures to achieve the water quality outcomes

How well do waterways in the zone meet the LWRP outcomes?

A summary of the current state of monitoring sites in relation to the LWRP Table 1a and 1b outcomes is provided in Appendices 1 and 2. This summary is based on detailed analysis of the current state water quality report (Hayward et al., 2016). Additional analysis of data to determine the E. coli attributes states for the National Policy Statement for Freshwater Management (NPS) 2017 is included in Appendix 2.

Rivers

One of the key indicators of aquatic ecological health in rivers is the Quantitative Macroinvertebrate Community Index (QMCI[1]). Under the LWRP, QMCI objectives for hill-fed, lake-fed and alpine river types fall into the 'excellent' water quality class, while spring-fed streams objectives fall into the 'good'

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[1] QMCI – Quantitative Macroinvertebrate Community Index scores the abundance and sensitivity of macroinvertebrate taxa to water and habitat quality. The higher the QMCI score, the greater diversity and abundance of sensitive taxa.

water quality class. However, in the OTOP zone, just under half the alpine/lake/hill fed stream sites monitored meet the LWRP outcomes and only 2 out of 13 spring-fed sites meet the LWRP outcomes (Appendices 1, 3 and 4).

Deposition of excessive amounts of fine sediment is an issue in many spring-fed streams, and occasionally on the lower reaches of hill-fed streams. Fine sediment can smother the stream bed, and result in a highly degraded habitat for instream life. Fine sediment deposits are a key regulator of invertebrate communities. All of the spring-fed stream sites regularly monitored in the OTOP zone exceed the LWRP objective for sedimentation, and often exceed the threshold by a large amount. Over half the hill-fed streams also had maximum cover exceeding the LWRP objective, but this is typically less frequent, and generally hill-fed rivers have much lower amounts of fine sediment deposits compared to spring-fed streams.

Nuisance periphyton cover and high biomass is occasionally an issue in some waterways, where rivers such as the Pareora are prone to development of nuisance periphyton growths during low summer flows. The Opihi River is particularly susceptible to developing blooms of the toxic algae Phormidium.

Hill-fed rivers in OTOP zone are generally suitable for swimming based on microbial risks. However, Phormidium blooms often constrain recreational uses of these rivers. In contrast, spring-fed streams have consistently poorer microbial quality, and are generally unsuitable for swimming. While the NPS swimmability attributes state does not apply to many spring-fed streams because they are generally less than 4th order streams, they are important culturally, particularly for mahinga kai gathering. Their vulnerability to faecal contamination creates a challenge for meeting cultural values and expectations.

From an assessment of the current state of rivers and streams, the following main issues emerge:

1. Spring fed streams have generally poorer ecological health than hill-fed streams in terms of macroinvertebrate communities and sedimentation, and often fail to meet the LWRP outcomes.
2. Spring-fed streams have poorer microbial quality.
3. Lower reaches of hill-fed rivers and their tributaries show lower overall water quality, particularly, poor ecosystem health in some waterways.
4. The upper reaches of hill-fed streams are generally in good condition, and currently meet the LWRP outcomes.

The drivers of poor ecological health are often complex and are an interplay of multiple factors (multiple stressors). Common drivers of poor ecological health in spring-fed streams are excessive amounts of deposited fine sediment which promotes excessive macrophyte growth, which in turn chokes the stream, slows down flow, and causes large daily fluctuations in water chemistry (pH, dissolved oxygen). Alterations to the habitat through channel straightening (loss of habitat heterogeneity) and loss of riparian shading are common additional stressors in spring-fed streams, especially across the plains. Because of their small size and lack of wide berms (compared to braided rivers), spring-fed streams are particularly vulnerable to impacts from land uses in the immediate surrounds. Furthermore, spring-fed streams commonly arise in areas of heavy soils (often historically wetlands) that require extensive drainage networks to enable farming of the land. Open drains can be a be a direct conduit for contaminants from the land into streams (faecal material, nutrients, sediment).

Small tributaries of the main hill fed rivers can be similarly vulnerable to impacts of adjacent land uses, particularly where they have small channels and run through the valleys of rolling hills, which are prone to erosion run-off.

The mainstem hill-fed rivers and their major tributaries show typical patterns of high quality water and good ecological health in their upper reaches where land use is generally less intensive than on the plains, riparian margins often have more intact vegetation, and where streams gradients are steeper and bed substrate is coarser providing better instream habitat. The cumulative effects of nutrient enrichment, fine sediment inputs, constraint and encroachment of river margins and low summertime flows are the main drivers for a decline in ecological health of lower reaches of hill fed rivers compared to upstream reaches. Examples of this gradient in ecological health can be seen in the Pareora, Orari and Waihi rivers where their upper reaches meet the LWRP QMCI outcomes but exhibit declines in QMCI values in their lower reaches (Appendix 1, Appendix 3).

Lakes

The two main lakes in the OTOP zone are Lake Opuha and Waitarakao/Washdyke Lagoon. The zone committee has been provided with information on the state of these waterbodies previously. The key issues are listed below.

- Waitarakao/Washdyke Lagoon currently meets the LWRP Trophic Level Index (TLI) for coastal lagoons but does not meet the NPS national bottom lines for nutrients (TP or TN). The TLI for coastal lagoons in the LWRP was set well before the establishment of the NPS (2014/2017) attribute states and national bottom lines. The TLI outcomes for coastal lagoons in the LWRP are not consistent with the NPS attribute states for lakes. Therefore, subregionsub region section objectives for Waitarakao/Washdyke Lagoon need to be set for at least achieving the national bottom lines for TN and TP over time. Despite high nutrient concentrations in the lagoon, chlorophyll a concentrations (the amount of phytoplankton produced) fall into the Attribute State A (mid beach site) or B (lagoon outlet). This means despite high nutrient status of the lagoon, the productivity of the lagoon is relatively low. One of the likely reasons for this is the short residence time of water in the lagoon because of the permanently flowing outlet.
- Lake Opuha is classified as an On-River Artificial lake, and as such, currently does not meet the LWRP TLI of 3. However, the lake generally falls into the Attribute states A and/or B for chlorophyll a and total phosphorus, and Attribute State C for total nitrogen, indicating slight to moderate enrichment.

Will LWRP/PC5 provisions be sufficient to achieve the water quality outcomes?

LWRP / PC5 Provisions

Achieving the LWRP water quality outcomes was assessed during the scenario testing stage of the heathy catchments process. An assessment was made of whether the key outcomes of the current pathways scenario would likely result in achievement of the LWRP water quality outcomes. The current pathways scenario was based largely on assuming the following LWssssRP/PC5 requirements:

- audited Farm Environment Plans (FEPs) on those properties that would be subject to land use consents
- implementation of the industry agreed good management practices (GMPs)
- stock exclusion rules
- nitrogen GMP baseline controls.

Will these Provisions Achieve Outcomes?

There is considerable uncertainty in making this assessment, not the least of which is the difficulty in quantifying the water quality improvements that might be achieved through widespread implementation of the industry agreed good management practices (GMPs). Furthermore, we do not have a lot of information on current practices on farm, nor do we know precisely which properties need to apply for land use consents under LWRP and/or PC5 (and therefore require FEPs and implement GMPs). In some catchments/streams where water allocation is high and/or minimum flows are low, failure to meet the LWRP outcomes is also linked with low flows. In assessing the effects on the water quality outcomes of the current pathways scenario; the following results are anticipated:

- No change to the risks associated with cyanobacterial growths are anticipated
- Some sites, such as the Te Ana Wai and Opihi at Rockwood, could improve from currently not meeting the LWRP QMCI objective to meeting that objective. This is because these sites are currently very close to the LWRP objective value and small improvements in water quality and flows may be sufficient to achieve the LWRP objective.
- There is likely to be some improvement (reductions) in deposited fine sediment across the zone through the implementation of GMPs, and sites such as the Pareora River at SH1 and Rhodes Stream may meet the LWRP outcomes for sedimentation because they are already close to meeting the outcomes. Other sites which have heavily silted stream beds are unlikely to see significant improvements without other interventions (e.g., sediment removal, stream bank improvements, installation of sediment traps).
- Filamentous algae and total nuisance algae levels are not anticipated to change significantly
- The Trophic levels of Lake Opuha and Waitarakao/Washdyke Lagoon are unlikely to change.

Because of the uncertainty associated with achievement of the water quality outcomes, a multi-step approach may be needed that includes timelines for meeting targets with regulatory consequences if targets are not met, prioritisation of funding for protection and restoration projects and catchment group based ownership and management of relevant issues. The LWRP sets a 2030 timeline for achievement of the outcomes.

In previous papers provided to the ZC, the concepts of FEPs, Good Management Practices, and Baseline GMP Loss Rates have been explained. An overview of the stock exclusion requirements is provided below.

Stock Exclusion

The LWRP requires exclusion of non-intensive and intensively farmed cattle, deer and pigs from lakes, wetlands and rivers, and limits access to waterbodies to stock species that prefer to avoid water (sheep). For the purposes of stock exclusion, a river is defined as a continually or intermittently flowing body of fresh water; and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal). This definition does not capture drains or springheads.

Permitted Access to Waterways:

Non-intensively farmed stock are allowed access to surface waterbodies provided their access does not result in pugging or de-vegetation that exposes bare earth in the bed or banks, and a conspicuous change in clarity or colour of that waterbody.

Consented Access to Waterways:

Intensively farmed stock[2] (cattle, deer and pigs) must be excluded from waterways that are greater than one metre wide, and 10 centimetres deep, and wetlands. If they are not excluded, a resource consent is required for stock access to that waterway. The LWRP considers stock access of this nature to be inappropriate.

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Prohibited Access to Waterways:

Any farmed cattle, deer and pigs are **prohibited** from having access to, and must be excluded from:

a. Waterways with Inanga spawning habitat and salmon spawning sites
b. Waterways with Community Drinking Water Supply Protection Zones
c. Waterways 1000m upstream of a freshwater bathing site
d. The bed or banks of all spring-fed plains rivers (Appendix 4 shows the extent of spring-fed streams)rivers

A key tool for determining if all stock are excluded from waterways with an appropriate setback distance are Farm Environment Plans and Management Plans. An "effective" setback distance for fencing a stream for stock exclusion will depend on the nature of the waterway, how vulnerable it is to contamination due to the surrounding land characteristics and practices, and whether the setback is for bank protection, or nutrient filtering and assimilation. These requirements are determined through the audit of FEPs.

Managing the Overland flow of Contaminants

PC5 seeks to minimise nitrogen, phosphorus, sediment and faecal contamination to waterbodies by ensuring that high risk farming activities will be subject to an FEP, and lower risk farming activities will implement good practice on farm through the preparation of a Management Plan. Critical source areas (CSAs) are a major contributor to the overland flow of contaminants and are generally located in low lying areas on farms, where runoff accumulates and poses a significant threat to waterways. Most farms have CSAs, particularly those farms in hill and rolling country and undulating areas. Identifying and mapping CSAs is important for ensuring investment in the effective control of the overland flow pathways of contaminants. Measures for managing CSAs need to be addressed in FEPs

[2] - Cattle or deer grazed on irrigated land or contained for break-feeding of winter feed crops;
- Dairy cattle, including cows, whether dry or milking, and whether on irrigated land or not;
- Farmed pigs

and may include excluding stock from CSAs at times of high risk for soil saturation and overland flow (eg high rainfall), erosion and sediment controls, management of risks associated with winter grazing and avoiding cultivating land during vulnerable wet periods. Educating landowners on effective CSA management and improving their skills in this area will be a key component to reducing the overland flow pathways of contaminants.

A project has been undertaken in the OTOP zone to identify priority areas for contaminant generation and runoff. The generation and risk maps created by this project can be used to assist on-the-ground staff and auditors to identify areas where FEPs and Management Plans should include CSA management as a priority and where additional resource and education is likely to be most effective. Figure 1 shows CSAs areas in the OTOP zone.

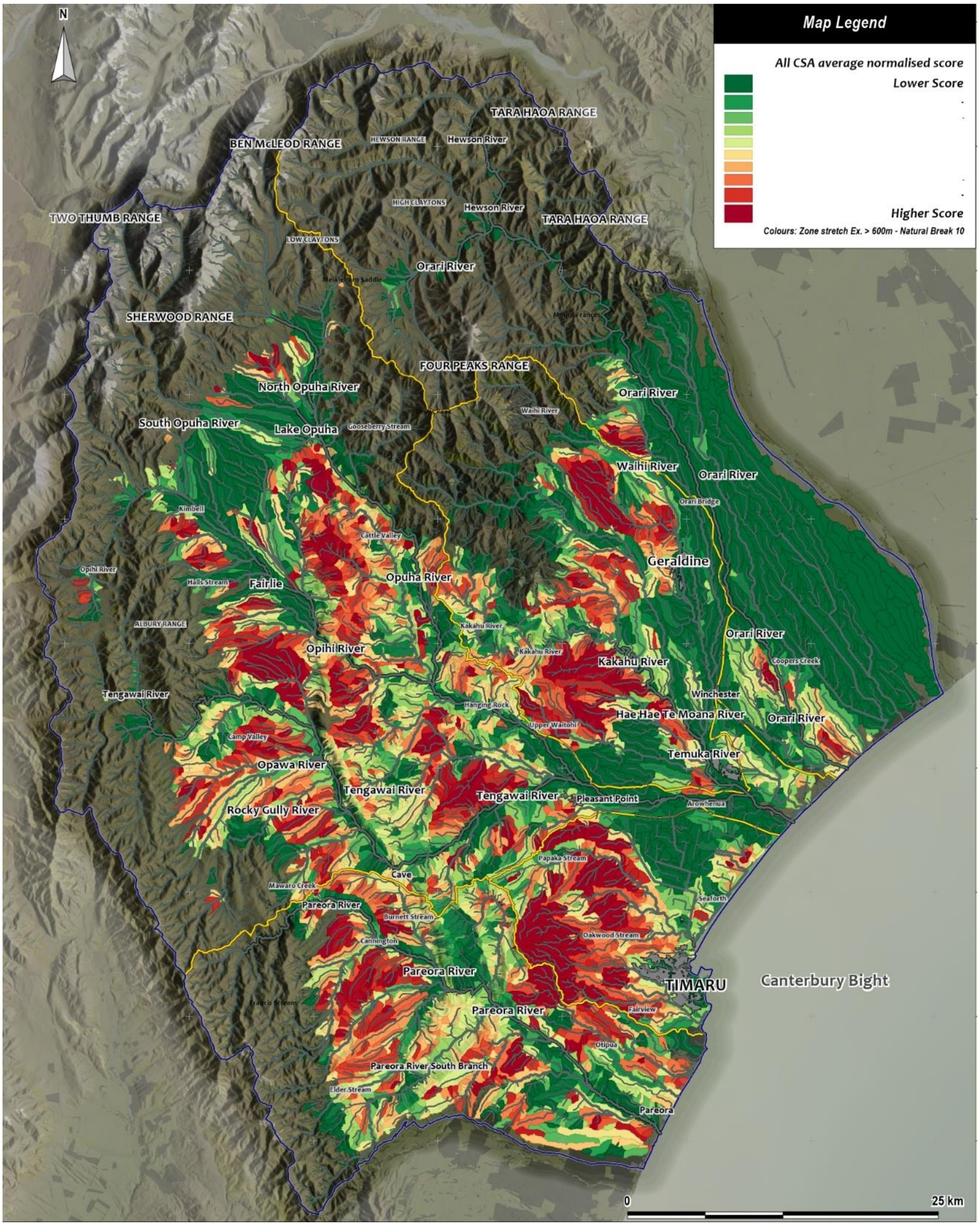


Figure 1 Critical Source Area Management layer which identifies the priority areas for management of contaminant runoff related to land management

While Management Plans for permitted farming activities will require the mapping of critical source areas for phosphorus loss on farm, the farm environment plan process will better ensure the effective management of CSAs for higher risk farming activities. Research has indicated that the fence pacing and wallowing of deer causes soil compaction and is a significant source of soil loss and overland flow of contaminants in catchments containing deer, particularly on sloping land (McDowell, R. W. 2009). Overland flow from deer on winter grazed areas should also be considered an important source of contaminants that have the potential to adversely impact water quality (McDowell, R. W., & Stevens, D. R. 2008).

Many of the farms that include deer in the OTOP zone occur on sloping land and have either a direct connection to surface waterbodies or have potential for overland flow to surface water. It is considered that for these farms the farm environment plan process would better manage the overland flow pathways of contaminants and a consented pathway for deer farms on sloping land may be appropriate in the OTOP zone.

Stock exclusion from waterways and the effective management of critical source areas on farm are the two most effective ways of minimising the overland flow of contaminants to surface water bodies from farming.

Soluble Contaminants via Groundwater

Reducing nitrogen loss to leaching in the FEP process is primarily achieved through better management of irrigation, fertiliser and dairy effluent.

Further solutions for high nitrates in ground water and subsequently in spring fed waterbodies are being investigated in several studies and trials being undertaken in Canterbury and nationally. These include:

- Bioreactors and denitrification trenches
- Macrophyte harvesting
- Augmentation

In future, as these mitigation techniques and how best to integrate them into catchment management plans are better understood, they may be able to support improvements to water quality in priority areas of the zone.

Sediment Accumulation in Waterbodies

To reduce fine sediment inputs to stream beds, sediment sources need to be controlled in both hill fed and spring fed streams, with stock exclusion and riparian management being the most effective strategies. In areas where stream bank slumping and undercutting is occurring, channel and bank stabilisation by contouring and battering may be applicable. In some areas sediment traps, while not preventing the input of sediment, can be used with careful consideration of instream values.

Improved riparian planting provides water quality benefits in the provision of habitat, stream shading, and organic matter inputs, while reducing sediment inputs by stabilising banks and by the interception and filtering of runoff from land.

The effective implementation of the above strategies will require the coordination of resources and effective prioritisation to target the most sensitive and the most influential areas. Improved physical habitat monitoring will also be important to ensure the mitigations are effective and that water quality is improving in response to the measures being implemented.

Pathways to achieving outcomes

While the factors that cause failure to achieve the LWRP water quality outcomes are complex, there are some common issues that arise. These are:

- Excessive inputs of fine sediments, particularly in spring-fed streams, from stock access, run-off from hill slopes and critical source areas
- Reduced flows and freshes addressed in setting minimum flows and allocations
- Excessive plant (periphyton and macrophytes) growth from nutrient inputs and lack of shading
- Faecal contamination of spring-fed streams, stock access to waterways and/or drains, run-off from critical source areas and sloping hills, effluent management.

While we do expect to see improvements across these issues as opportunities to implement GMPs are identified through the FEPs, in some areas GMPs alone may be insufficient to restore degraded waterbodies. Targeted measures for stream restoration may be required.

Option 1: Strengthening the Stock Exclusion Rules to Include Drains and Springheads

As discussed earlier in the paper, spring fed streams in OTOP generally have poorer health in terms of macroinvertebrate communities and sedimentation, and faecal contamination from stock access to waterways. Open drains can also be a direct conduit for these into these streams.

Key Decision Area:
The Zone Committee recommends that for purpose of stock exclusion in OTOP, a river will include all drains, spring heads and watercourses, but exclude irrigation canals, water supply races and canals for the supply of electricity generation, where these races and canals do not connect to a river or surface water body.

Option 2: Regulate High Risk Deer Farming Operations

The identification and management of CSAs is required under Farm Environment Plans (FEPs) to minimise a primary source of sediment, phosphorus and faecal contamination to waterways. The zone committee has previously highlighted the risk that deer pose as major contributors to the overland flow of contaminants due to their fence pacing and wallowing behaviour. This is particularly the case in areas with sloping land and erodible soils. These areas have been mapped as High Runoff Risk Phosphorus Zones for PC5.

Key Decision Area:
The Zone Committee recommends that for deer farms over 10ha in size in the High Runoff Risk Phosphorus Zone this activity be subject to a farm environment plan

Option 3: Identify and prioritise non-statutory mitigations to meet LWRP outcomes in priority areas

Non-statutory measures are likely to be required to meet water quality outcomes in some priority areas. These measures are most likely to be successful if they are supported by the improved prioritisation of funding for protection and restoration projects and catchment group based ownership and management of relevant issues.

Key Decision Area:

The Zone Committee recommends further investigation into non-statutory mitigations, particularly in respect of the generation of fine sediment. Restoration projects should be prioritised in accordance with the attached map (Priority Area Map tabled on 6 November)

References

Hayward, S., Clarke, G., Dynes, K., Barnden, A., Arthur, J., Barbour, S., 2016. *Orari, Temuka, Opihi and Pareora Zone: state and trends in water quality and aquatic ecology.* Environemnt Canterbury Report No. R16/63

McDowell, R. W. (2009a). Maintaining good water and soil quality in catchments containing deer farms. [Article]. *International Journal of River Basin Management, 7*(3), 187-195. doi: 10.1080/15715124.2009.9635382

McDowell, R. W., & Stevens, D. R. (2008). Potential waterway contamination associated with wintering deer on pastures and forage crops. [Article]. *New Zealand Journal of Agricultural Research, 51*(3), 287-290.

Appendix 1 Current state of rivers in relation to ecological outcomes in Table 1a of LWRP

River type	Site	Ecological health/amenity/habitat					
		QMCI Average score (water quality class)	Periphyton - filamentous (average ann. max. % cover)	Periphyton - total nuisance (ORRP only) (average ann. max. % cover)	Periphyton biomass - chlorophyll a (92nd percentile mg/m^2)	Emergent Macrophytes (average ann. max. % cover)	Deposited sediment (average ann. max. % cover)
Alpine upland	South Opuha River at Clayton Rd	5.6 (good)					
Lake fed	Opuha River at Skiptons Bridge (NIWA)	2.3 (poor)					
Hill-fed upland	Stony Stream - Monument Rd	6.5 (excellent)					
	Ribbonwood Creek - Plantation Rd	6.3 (excellent)					
	Station Stream - Clayton Rd	5.7 (good)					
	Orari Gorge/Lochaber Rd	6.2 (excellent)					
Hill-fed lower	Orari River at Parke Rd	4.9 (fair)					
	Pareora R at Cave-Pareora Rd	6.1 (excellent)					
	Pareora R at the Huts	4.2 (fair)					
	Pareora R at Brassells Bridge	6.0 (excellent)					
	Pareora R at SH1	4.2 (fair)					
	Opihi River - SH79	6.4 (excellent)					
	Opihi River - Tondros Rd	6.4 (excellent)					
	Halls Stream	4.3 (fair)					
	Opihi River at Rockwood (NIWA)	5.9 (good)					
	Tengawai River at Tengawai Bridge	5.9 (good)					
	Raincliff Stream - Middle Valley Rd	2.7 (poor)					
	Opihi River - SH1	6.3 (excellent)					
	Opihi River at Grassy Banks	5.3 (good)					
	Temuka River - SH1	4.3 (fair)					
	Hae Hae Te Moana South Branch - Te Moana	4.8 (fair)					
	Hae Hae Te Moana South Branch at Sheep D	6.4 (excellent)					
	Waihi River - Waihi Gorge Rd	7.8 (excellent)					
	Waihi River at Waimarie	7.3 (excellent)					
	Waihi River - Te Awa Rd	4.8 (fair)					
	Kakahu River - Earls Rd	3.1 (poor)					
Hill-fed lower urban	Taitarakihi Creek	2.4 (poor)					
Spring-fed lower basin	Glenfield Stream - SH79	3.9 (poor)					
	Coal Stream	4.4 (fair)					
Spring-fed plains	Orakipaoa Creek at Milford Lagoon Rd	3.6 (poor)					
	Taumatakahu Stream - Maude St	3.0 (poor)					
	Coopers Creek - SH72	4.2 (fair)					
	Ohapi Creek North branch - Guild Rd	5.5 (good)					
	Ohapi Creek - Guild Rd	4.1 (fair)					
	Ohapi Creek South Branch - Guild Rd	4.6 (fair)					
	Ohapi Creek upstream Orari River Confluenc	3.8 (poor)					
	McKinnons Stream at Wallaces Bridge	5.1 (good)					
	Petries Drain - Canal Rd	3.9 (poor)					
	Rhodes Stream - Rolleston Rd	2.8 (poor)					
	Rhodes Stream at Parke Rd	4.7 (fair)					

LWRP outcome generally met — LWRP outcomes generally not met — Bank cell indicates no data available

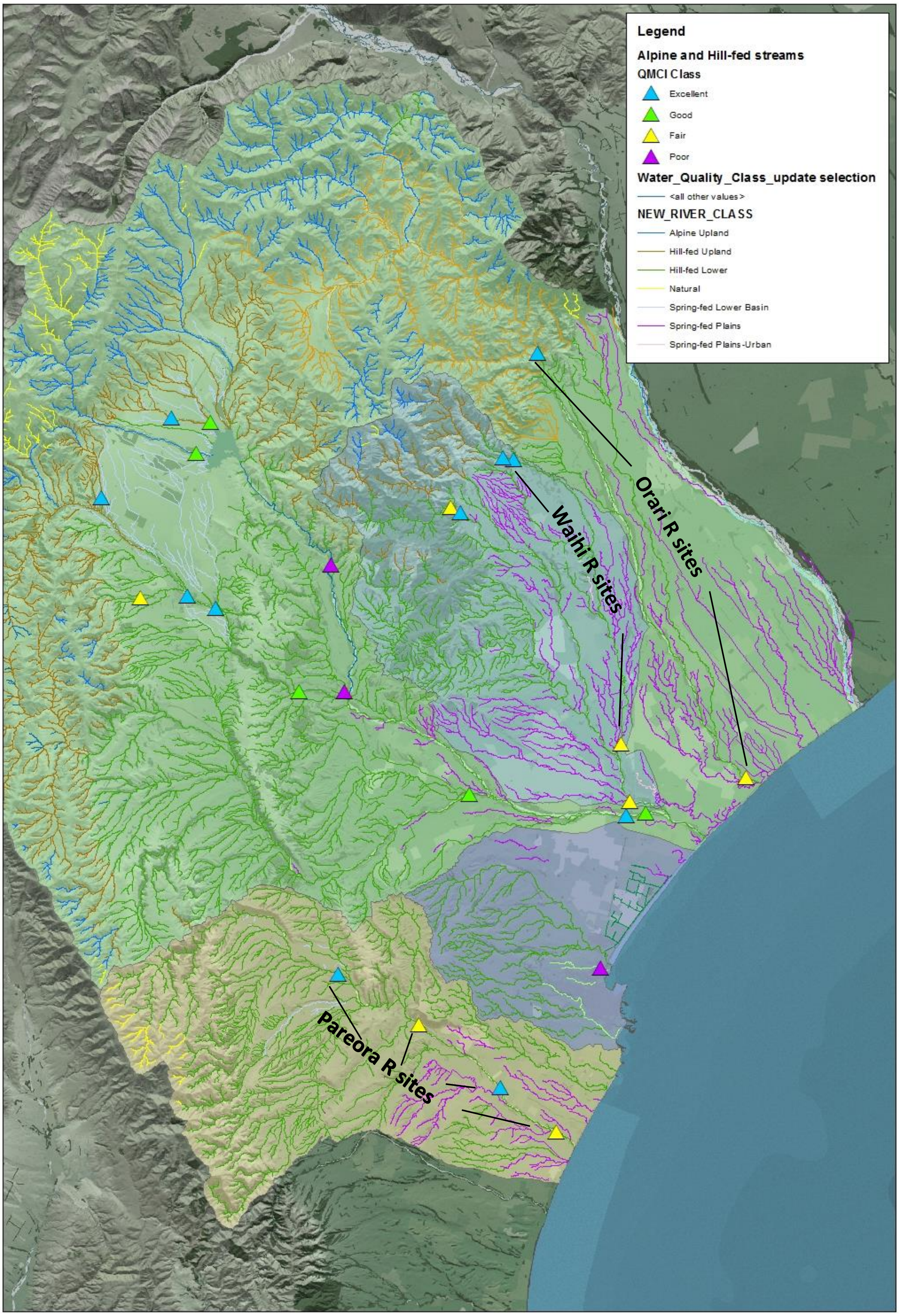
Appendix 2 Current state of rivers in relation to recreational outcomes in Table 1a of LWRP

River type	Site	Human recreation		
		NPS (2017) E. coli attribute states (monthly monitoring - all year data)	Summertime swimming grades for microbial quality (SFRG)	Cyanobacteria cover (max. % cover)
Lake fed	Opuha River at Skiptons Bridge (NIWA)	A		Action
Hill-fed upland	Orari Gorge/Lochaber Rd	A	Fair	
Hill-fed lower	Orari River at Parke Rd	B		
	Pareora R at Evans Crossing		Good	Action
	Pareora R at the Huts	D	Fair	Action
	Pareora R at SH1	C		Action
	Opihi River - SH79			Action
	Opihi River at Rockwood (NIWA)	B		Action
	Tengawai River at Tengawai Bridge	B		Alert
	Opihi River - SH1		Good	Action
	Opihi River at Grassy Banks	A		
	Opihi River at Waipopo		Good	Action
	Hae Hae Te Moana South Branch at Sheep Dip Rd	C	Fair	
	Waihi River - Waihi Gorge Rd		Fair	
	Waihi River at Waimarie	A		
	Waihi River - Te Awa Rd			Action
	Temuka River at Manse Bdg	D	Fair	Action
	Temuka River - SH1			Action
Hill-fed lower urban	Taitarakihi Creek	D		
Spring-fed plains	Raukapuka Creek at Coach Road	E		
	Orakipaoa Creek at Milford Lagoon Rd	E		
	Ohapi Creek upstream Orari River Confluence	E		
	McKinnons Stream at Wallaces Bridge	E		
	Rhodes Stream at Parke Rd	D		

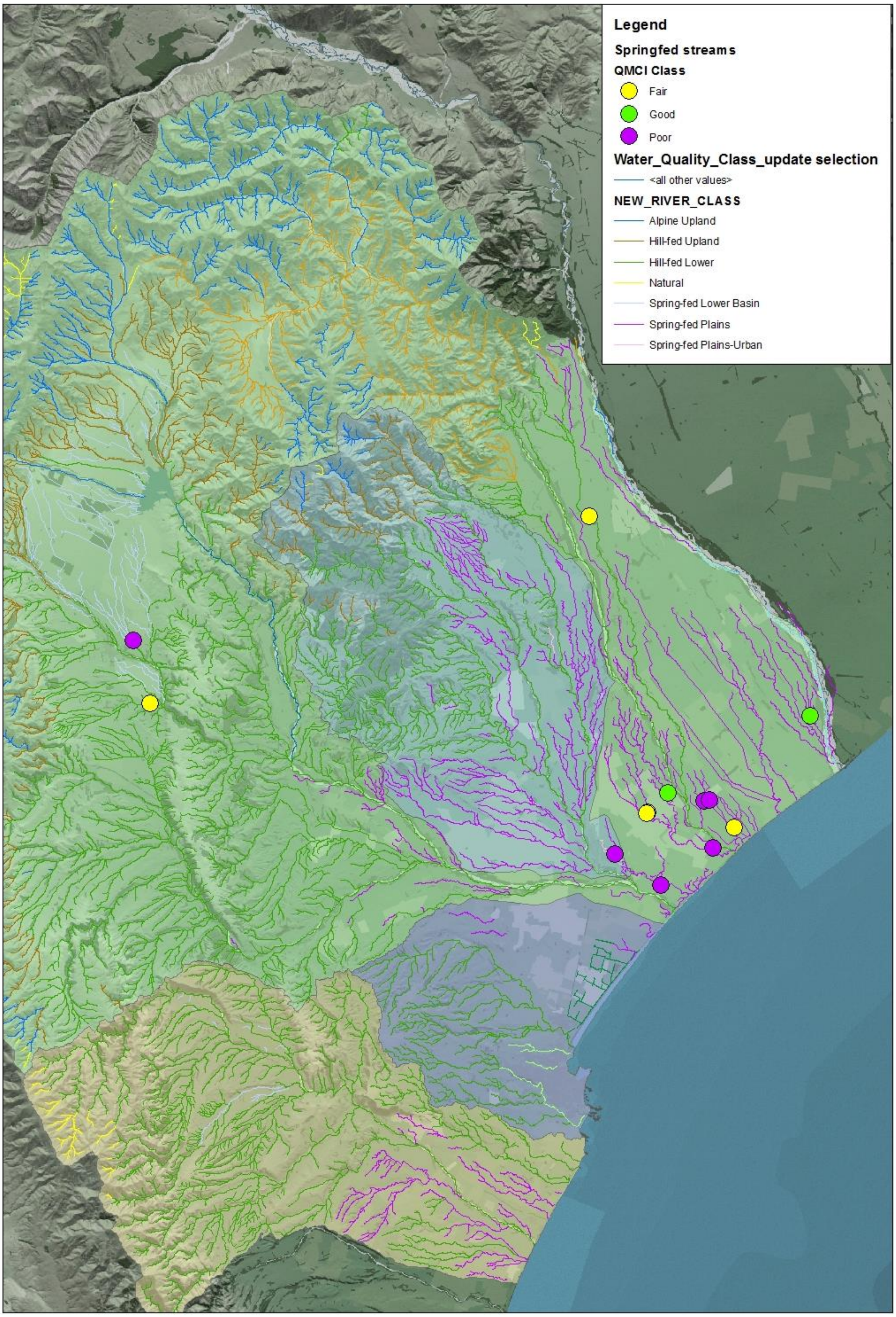
LWRP outcome generally met (green)
LWRP outcomes generally not met (pink)

Note: NPS 2017 Attribute states for E. coli – Attribute States A (blue), B (green) and C (yellow) are considered suitable for primary contact recreation; Attribute States D (orange) and E (red) are not.

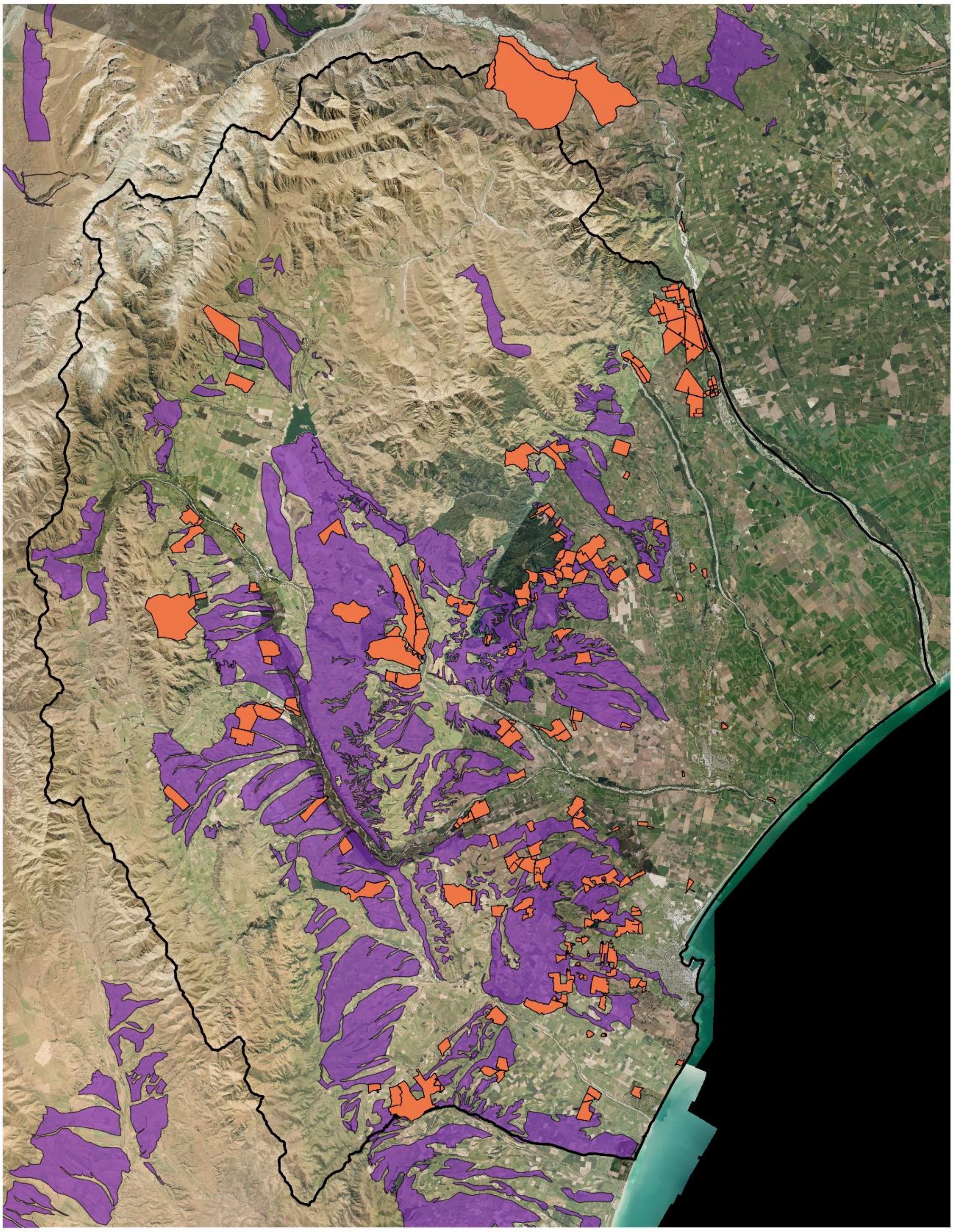
Appendix 3 QMCI classes for hill-fed and alpine fed rivers and streams



Appendix 4 QMCI classes for spring-fed streams



Appendix 5 Properties farming deer in 2016 shown over the High Runoff Risk Phosphorus Zone



Legend

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OTOP BOUNDARY May 2017

Plan Change 5 LWRP High Runoff Risk Phosphorus Zone