

Memo

Date	18/9/2017
To	Hurunui-Waiiau Zone Committee
CC	Ian Whitehouse, Lisa Jenkins, Ned Norton, Graeme Clarke
From	Kimberley Dynes and Jarred Arthur

Hurunui River recreational water quality summary 2016/17

Background

Environment Canterbury's recreational water quality monitoring programme assesses the health risks associated with primary contact recreational activities (e.g. swimming) at popular freshwater and coastal bathing sites. During the summer months, weekly water quality samples are collected from the Hurunui River near the State Highway 1 and State Highway 7 bridges. Samples are laboratory tested for concentrations of *Escherichia coli*, which are compared to MfE & MoH (2003) national guidelines for recreational water quality¹. *E. coli* functions as an indicator organism for the presence of pathogens (e.g., campylobacter) that pose a risk to human health. Suitability for recreation grades (SFRGs) are calculated for swimming sites based on both the concentration of *E. coli* in the water, and an assessment the potential for the waterway to be contaminated by surrounding contaminant sources (Appendix 1). A site graded as 'poor' or 'very poor' is not considered to be suitable for primary contact recreation due to increased risks of swimmers becoming ill.

¹ The MfE & MoH (2003) '[Microbiological water quality guidelines for marine and freshwater recreational areas](#)' provide a comprehensive background to sampling protocols, assessment and grading criteria, and response protocols.

The Hurunui River was generally considered as a suitable site for primary contact recreation up until five years ago /

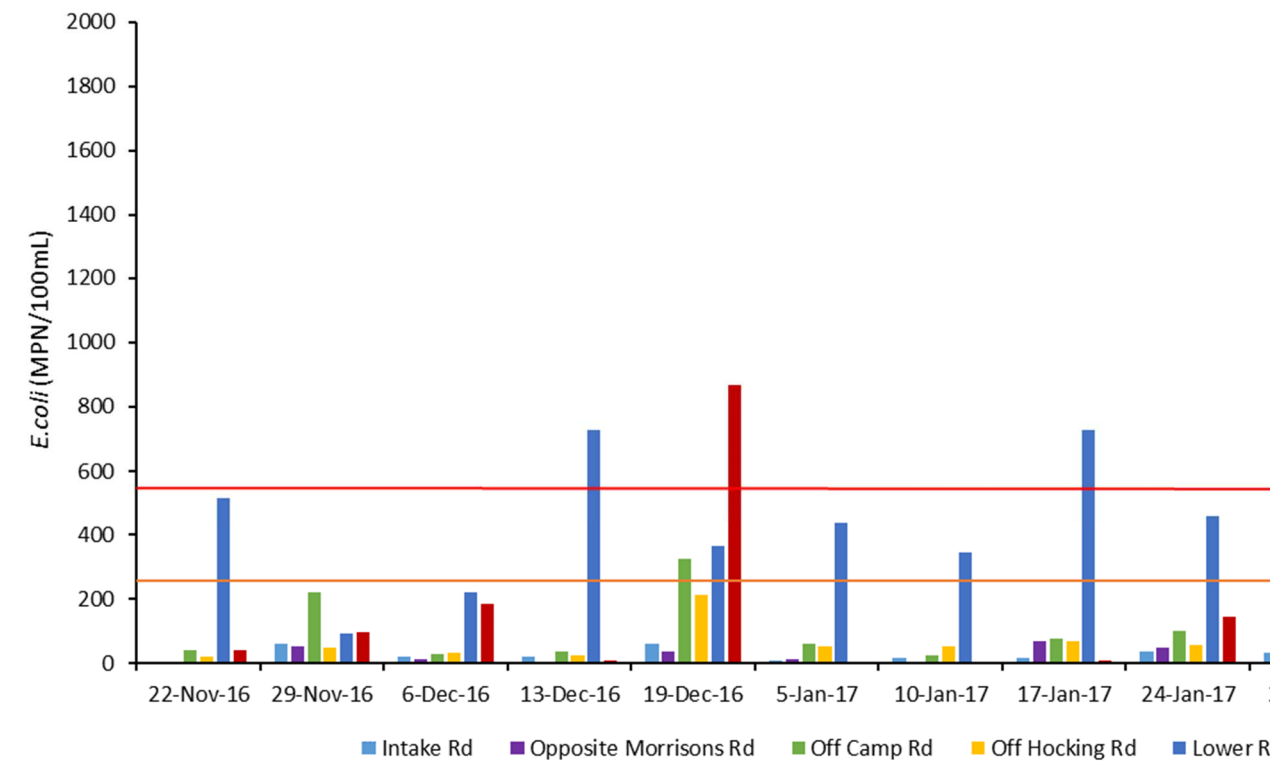


Figure 2: Weekly *E. coli* concentrations measured in the upper Hurunui River during the 2016/17 recreational water quality monitoring season. Horizontal red and orange lines indicate 'Action' (550 *E. coli*/100 mL) and 'Alert' (260 *E. coli*/100 mL) modes respectively, as per the national microbiological water quality guidelines for marine and freshwater recreational areas (Mfe & MoH 2003). Significant rainfall and a high flow event resulted in elevated *E. coli* levels at many sampling sites on the 14th of February 2017.

Table 1). SFRGs indicate that recreational water quality was either 'fair' or 'good' at the sites until the 2012/13 season, when State Highway 1 became graded as 'poor'. The same decline in SFRG occurred at State Highway 7 the following year. Since the 2012/13 monitoring season, each site has changed between either 'poor' or 'fair' gradings (Appendix 2). This has resulted from fluctuating *E. coli* levels entering the river from contaminant sources. Each monitoring site is moderately susceptible to faecal contamination due to the river being a focal point for the drainage of surrounding low-intensity agricultural land (MfE & MoH, 2003).

This memo reports the results of two related studies conducted over the 2016/17 summer:

1. A weekly sample survey for *E. coli* at multiple sites along the Hurunui River above State Highway 7.
2. An investigation of possible animal sources for *E. coli* at State Highway 7 using faecal source tracking (FST) techniques.

2016/17 *E. coli* monitoring of the upper Hurunui River

What we did

The reason behind fluctuating recreational water quality grades in the Hurunui River at State Highway 7 was investigated between November 2016 and March 2017. This investigation examined what the *E. coli* concentrations were along a longitudinal gradient of the river upstream of the State Highway 7 site.

Weekly *E. coli* samples were collected from an additional five sites in the Hurunui River between the Amuri Irrigation Company intake and approximately 1 km upstream of the State Highway 7 bridge (**Error! Reference source not found.**). Each sample was collected at the same time as the routine recreational water quality monitoring was carried out at the State Highway 1 and State Highway 7 bathing sites. Fourteen samples were collected from each site over the entire summer.

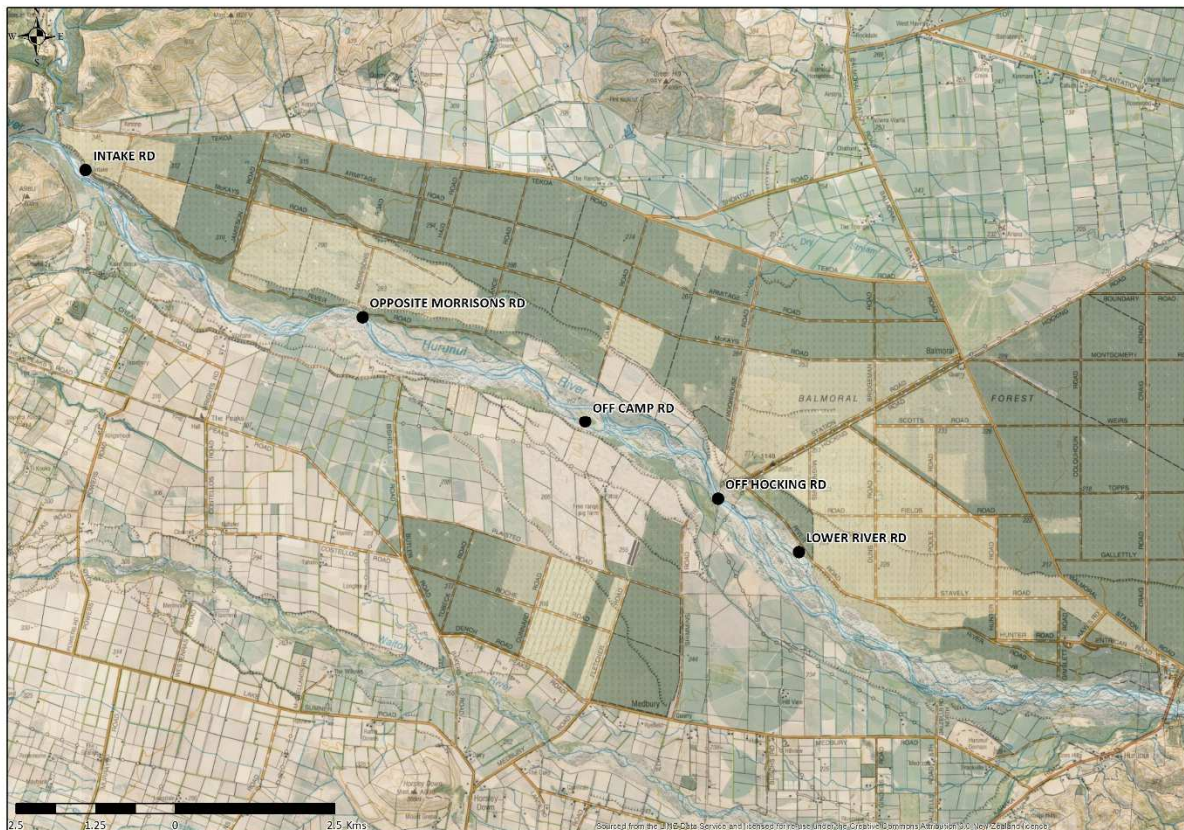


Figure 1: Weekly *E. coli* monitoring sites for the Hurunui River above State Highway 7.

What we found

E. coli concentrations varied across the upper Hurunui River throughout the 2016/17 summer (**Error! Reference source not found.**). The four uppermost sites (Intake Rd, Opposite Morrison's Rd, Off Camp Rd, and Off Hocking Rd) generally contained low concentrations of *E. coli* bacteria. *E. coli* results at all these sites were below 'Alert' guideline levels (260 MPN/100 mL; MfE & MoH, 2003) during base flow conditions. An exception was seen at the Off Camp Rd site when a small spike of

326 MPN/100 mL occurred on the 19th of December. A high flow event on the 14th of February 2017 was the likely cause of very high *E. coli* concentrations on one occasion across several monitoring sites.

E. coli concentrations at the Lower River Rd site were generally greater than those recorded at the four sites located upstream (**Error! Reference source not found.**). Members of the local community have long-suspected that a colony of birds present near the Lower River Rd site could be a considerable source of faecal contamination in the river. This same bird colony was observed on several sampling occasions throughout the study, and FST analyses (see Section below) have confirmed that there was a presence of avian-derived faecal bacteria at State Highway 7 downstream.

E. coli concentrations at Lower River Rd were often greater than those recorded at State Highway 7. This indicates that the attenuation of bacteria occurs downstream of Lower River Rd via dilution, uptake and/or die-off. The presence of avian bacterial signatures at State Highway 7 are a proponent that the diluted levels of *E. coli* at the site could be in-part sourced from the bird colony upstream. The downstream dilution of *E. coli* may occur from mixing with Hurunui River water sourced from side braids, or from mixing with upwelling groundwater. Bacteria die-off is a natural process that may result from consumption by heterotrophic organisms or sterilisation by UV radiation (sunlight). However, die-off rates are affected by multiple environmental factors including dissolved oxygen levels and salinity, but particularly temperature (Blaustein *et al.* 2013). Uptake can occur when bacteria bind to stream bed sediments, periphyton or other surfaces.

The Hurunui River at State Highway 7 recorded three exceedances of the 'Action' guideline value over the summer (**Error! Reference source not found.**). Two of these exceedances occurred during stable flow conditions and indicate that there was an increased risk of becoming ill from swimming on these days. The elevated levels of *E. coli* did not coincide with similarly high concentrations at the Lower River Rd site. This indicates that there are additional sources of contamination between the two sites. The remaining exceedance occurred during high flows when swimming would not be suitable anyway.

It is possible that *E. coli* concentrations were high in the Hurunui River at other times during the summer. However, it is not possible or desirable to sample every day, and *E. coli* concentrations in water can fluctuate tremendously over time. The laboratory processing time for *E. coli* samples is up to 24 hours, and results are not reported until the day after samples are collected. Because results cannot be reported in 'real time', a single SFRG is used to inform the public of the potential human health risk at a swimming site over an entire summer. A monitoring site's SFRG does not change during a summer monitoring season regardless of week-to-week fluctuations in *E. coli* levels. Public health warnings are issued and retesting occurs at sites that are considered suitable for swimming (i.e. a SFRG of 'fair', 'good' or 'poor') when *E. coli* levels exceed the 'Alert' level concentration of 550 MPN/100 mL (MfE & MoH, 2003).

Animal sources of faecal contamination in the Hurunui River

What we did

Faecal source tracking (FST) investigates the animal sources of faecal contamination using a variety of DNA-molecular and chemical techniques. This is a valuable procedure when developing management strategies for protecting recreational water quality and human health. FST was carried out for the Hurunui River at the routine State Highway 1 and State Highway 7 recreational monitoring

sites. Samples at each site were collected weekly under stable flow (i.e. low or sustained receding flow) conditions and sent to ESR (the Institute of Environmental Science and Research) for processing and storage. This involved the collection of separate 1 L and 4 L samples for PCR-marker and sterol analyses respectively. Only samples with sufficiently high *E. coli* levels (i.e. those that exceeded MfE & MoH (2003) 'Action' level guidelines or the "next best thing") were analysed for the presence of animal source PCR-marker and sterol signatures².

What we found

Samples collected at State Highway 1 never exceeded 'Action' level guidelines for *E. coli* (MfE & MoH, 2003). However, two sets of FST samples, that were collected in February and March 2017, did exceed 'Alert' level guidelines for *E. coli* and were therefore analysed for PCR-markers and sterols³. At State Highway 7, two sets of FST samples collected in mid-December and early-February exceeded the 'Action' level guideline and were analysed for PCR-markers and sterols (Table 2).

Both samples collected at State Highway 1 indicate that faecal bacteria were predominantly derived from ruminant sources (**Error! Reference source not found.**). A small trace of avian-derived bacteria was detected in the sample-set collected on the 8th of February. Unfortunately (for the technical purpose of identifying sources using FST), no *E. coli* samples exceeded the "Action" level guideline of 550 MPN/100 mL, which is the MfE & MoH (2003) threshold above which public health risks for primary recreation is deemed 'unacceptable'.

One of two State Highway 7 samples, that were analysed for PCR-marker and sterol signatures, showed a discernible animal source for faecal contamination. On this occasion, bacteria stemming from ruminant sources were the most dominant type of faecal contamination, followed by traces of avian-sourced bacteria. Avian-sourced bacteria at the site may in-part be attributed to a bird colony situated upstream near Lower River Rd (see explanation earlier in memo). However, additional contaminant sources must at times exist between Lower River Rd and State Highway 7, as indicated on occasions when State Highway 7 *E. coli* levels greatly exceeded those recorded at Lower River Rd (Figure 2). While results from the sample-set collected on the 2nd of February were non-conclusive, testing still detected weak signatures of ruminant and avian-derived bacteria (**Error! Reference source not found.**).

Summary

The 2016/17 upper Hurunui River *E. coli* monitoring shows that faecal bacteria levels are commonly high at particularly the Lower River Rd and State Highway 7 sites. This indicates that significant levels of faecal contamination occurs downstream of Hocking Road, which typically recorded low levels of faecal contamination. A colony of birds is often present near the Lower River Rd site and is likely to contribute to high *E. coli* levels in the river. FST analyses confirmed that bird populations are a source of faecal bacteria in the Hurunui River at State Highway 7; however, the impact of birds appears to be

² For more information on FST and its associated methods, visit the ESR FST website <http://www.esr.cri.nz/water-science/our-work/faecal-source-tracking/>.

³ Sterol analyses were inconclusive and are therefore excluded from this memo. For the purpose of this memo, the interpretation of relative faecal source contributions are made solely from PCR-marker analysis results.

less significant than that of ruminant animals such as cattle and sheep. FST monitoring at State Highway 1 also found that ruminant animals are the dominant form of faecal contamination in the Hurunui River.

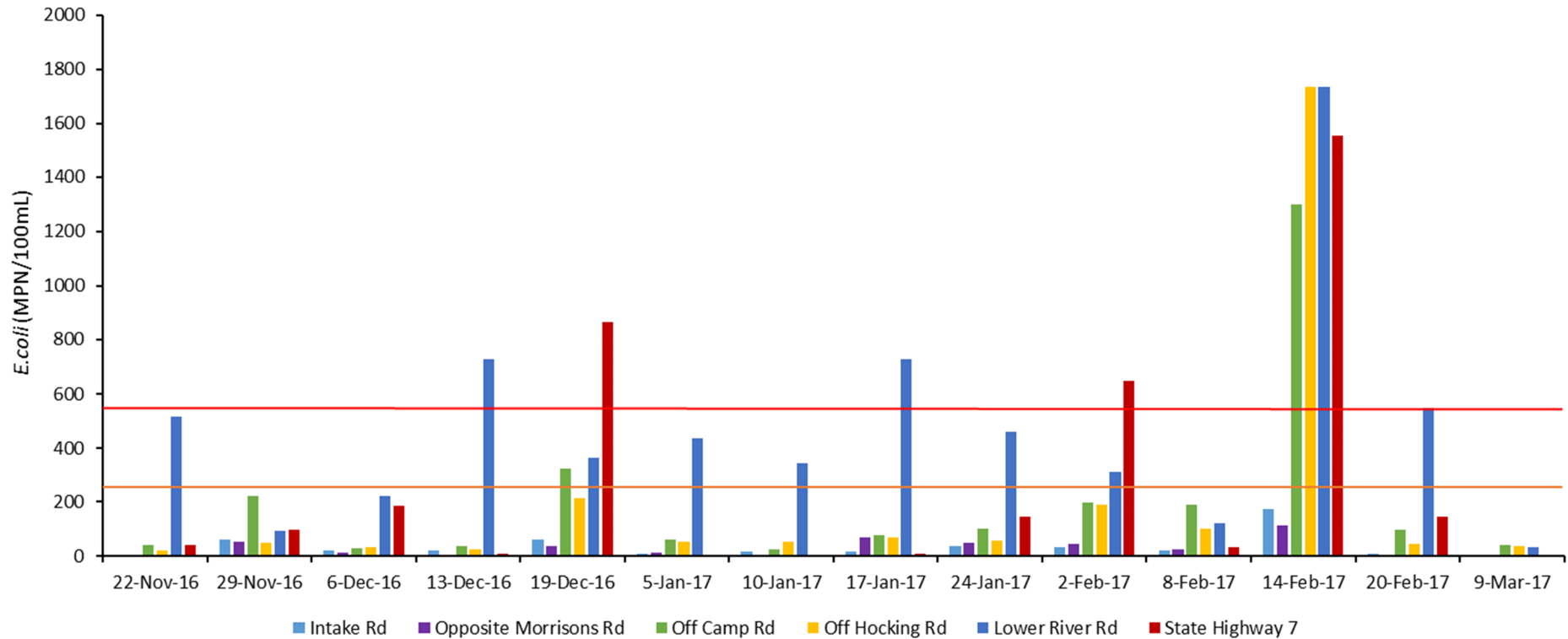


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Table 1: Annual suitability for recreation grades (SFRGs) for the Hurunui River recreational water quality monitoring sites.

Site	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Hurunui River at State Highway 1	Fair *	Fair*	Fair*	Fair*	Fair*	Poor	Poor	Poor	Fair*	Fair*
Hurunui River at State Highway 7	Good	Fair	Fair	Fair	Fair*	Fair*	Poor	Poor	Fair*	Poor

* denotes an SFRG calculated once rainfall affected data is removed (i.e. ignores high flow events)

Table 2: Summary of faecal source tracking (FST) PCR results for the Hurunui River at State Highway 1 and State Highway 7.

Site	Date	<i>E. coli</i> (MPN/100 mL)	General GenBac/100 mL	Human BacH/100 mL	Human BiADO/100 mL	Ruminant BacR/100 mL	Proportion Ruminant	Avian GFD/100 mL	Conclusion
Hurunui at State Highway 1	8/02/2017	313	8100	ND	ND	140	10 - 50%	detected <LOQ	Ruminant source (10-50%)
	15/03/2017	299	3500	ND	ND	76	10 - 50%	ND	Ruminant source (10-50%)
Hurunui at State Highway 7	19/12/2016	866	11000	ND	ND	360	10 - 50%	56	Ruminant source (10-50%) + avian
	2/02/2017	649	3500	ND	ND	detected <LOQ	NC	detected <LOQ	No discernible faecal source

ND: not detected. See <http://www.esr.cri.nz/water-science/our-work/faecal-source-tracking/> for more information on FST analysis techniques .

References

Arthur, J.B., Bolton-Ritchie, L. and Barbour, S. (2017). Canterbury water quality monitoring for recreation: annual summary report 2016/17. Environment Canterbury draft technical report.

Blaustein, R.A., Pachepsky, Y., Hill, R.L., Shelton, D.R. and Whelan, G. (2013). *Escherichia coli* survival in waters: temperature dependence. *Water Research* 47: 569-578.

Ministry for the Environment and Ministry of Health (2003). Microbiological water quality guidelines for marine and freshwater recreational areas. Ministry for the Environment, Wellington.

Appendix 1

Suitability for Recreation Grading System

Environment Canterbury's recreational water quality monitoring programme follows national guidance provided by the *Microbiological water quality guidelines for marine and freshwater recreational areas* (MfE & MoH, 2003). These guidelines address the microbiological quality of waterbodies and associated health risks to water users.

Escherichia coli (*E. coli*) is used as the indicator organism for the presence of harmful pathogens in freshwaters. The MfE & MoH (2003) guidelines use both the measurement of *E. coli* in waterways coupled with a qualitative risk assessment of potential faecal contamination at a recreation site to assess the suitability of a site for contact recreation. More specifically, the two components used for grading a recreation site are known as the:

- *Sanitary Inspection Category* (SIC), which generates a qualitative risk assessment of the susceptibility of a water body to faecal contamination; and,
- *Microbiological Assessment Category* (MAC), which provides a measurement of the actual water quality over time based on historical microbiological results (i.e. the 95th percentile of *E. coli* concentrations using 5 years of data).

The 2003 guidelines combine the SIC and MAC in an assessment matrix, which is then used to calculate a swimming site's *Suitability for Recreation Grade* (SFRG) (Table A1).

Table A1: Suitability for recreation grade (SFRG) matrix for freshwater sites (MfE & MoH, 2003)

		Microbiological Assessment Category (MAC) (95 th percentile of 5 years data)			
		A	B	C	D
Freshwater		≤ 130 <i>E. coli</i> /100 mL	131-260 <i>E. coli</i> /100 mL	261-550 <i>E. coli</i> /100 mL	>550 <i>E. coli</i> /100 mL
Sanitary Inspection Category (SIC)	Very low	Very good	Very good	Follow-up*	Follow-up*
	Low	Very good	Good	Fair	Follow-up*
	Moderate	Follow-up*	Good	Fair	Poor
	High	Follow-up*	Follow-up*	Poor	Very poor
	Very high	Follow-up*	Follow-up*	Follow-up*	Very poor

* Indicates unexpected results requiring investigation (i.e. a reassessment of the SIC and/or MAC)

A SFRG describes the *general condition* of a site at any given time. The risk of becoming ill from swimming at a site increases progressively from sites graded as 'very good' to 'very poor'. Sites graded 'very good', 'good' and 'fair' are considered suitable for contact recreation, however these sites may still be at times not be suitable due to high rainfall and flow events. Such events can result in increased surface runoff and therefore bacterial counts in waterways. Sites graded 'poor' or 'very poor' are generally considered unsuitable for primary contact recreation, and public notification of this through signage and the media is recommended. The MfE & MoH (2003) guidelines provide a detailed interpretation of what each SFRG means.

Appendix 2

Annual recreational water quality summaries for Hurunui River sites

Microbiological Assessment Categories (MACs) and Suitability for Recreation Grades (SFRGs) are calculated based on the preceding five years of weekly summer monitoring data.

Hurunui River at SH1

All weekly data

Year	No. of samples	95%ile	MAC	SIC	SFRG
2012/13	75	1100	D	Moderate	Poor
2013/14	75	1100	D	Moderate	Poor
2014/15	75	854.3	D	Moderate	Poor
2015/16	75	687	D	Moderate	Poor
2016/17	75	644.5	D	Moderate	Poor

Rainfall-affected data removed

Year	No. of samples	95%ile	MAC	SIC	SFRG
2012/13	65	607.5	D	Moderate	Poor
2013/14	66	602	D	Moderate	Poor
2014/15	73	576.9	D	Moderate	Poor
2015/16	70	488	C	Moderate	Fair
2016/17	71	481.7	C	Moderate	Fair

Hurunui River at SH7

All weekly data

Year	No. of samples	95%ile	MAC	SIC	SFRG
2012/13	75	590	D	Moderate	Poor
2013/14	75	640.8	D	Moderate	Poor
2014/15	75	640.8	D	Moderate	Poor
2015/16	75	765.3	D	Moderate	Poor
2016/17	75	774.30	D	Moderate	Poor

Rainfall-affected data removed

Year	No. of samples	95%ile	MAC	SIC	SFRG
2012/13	68	529.3	C	Moderate	Fair
2013/14	70	613	D	Moderate	Poor
2014/15	73	590.2	D	Moderate	Poor
2015/16	73	453.5	C	Moderate	Fair
2016/17	72	597.8	D	Moderate	Poor

Attachments: N/A

File reference: N/A