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Overview of water quality in the Upper Waiau – Te Anau area

For the Te Anau Basin Catchment Group

Prepared For

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QUALITY INFORMATION

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1. Introduction

Thriving Southland has asked Landpro to provide a brief report that provides more background information to explain the summary of information on water quality of the Upper Waiau - Te Anau area provided in an earlier report[1].

The outline information that was included in the original literature report is provided in Appendix A. The report considers river water quality and groundwater only. It does not consider lake water quality. This brief report provides additional background information and context to understand the state and trends of water quality in this area.

The summary information focussed on two water quality indicators, *E. coli* and nitrate nitrogen, because with just two indicators a reasonable understanding can be developed of water quality, the likely pressures on water quality, and the extent of water quality improvement that may be needed to meet current regional and national requirements.

2. Water quality standards

A key water quality consideration is comparing water quality with reference water quality standards. In Southland, the relevant regional plans include a range of water quality standards. However, in September 2020 Central Government released the National Policy Statement Freshwater Management 2020 (NPSFM). This document includes a National Objectives Framework (NOF) that includes detailed Water Quality Attributes with a banding (grading) system (A, B, C, D & E) (See Appendix B) and for most attributes, National Bottom Lines, that are designed to be the lowest acceptable water quality. This highly complex approach effectively sets minimum national water quality standards and regional councils have to develop regional plans that ensure that the national bottom lines are met. The key water quality standards (attributes) are: phytoplankton, periphyton, total nitrogen, total phosphorus, ammonia, nitrate, dissolved oxygen, suspended fine sediment, and *Escherichia coli (E. coli*).

This report focuses specifically on *E. coli* and nitrate nitrogen.

3. River water quality - *E. coli* & water contact recreation

- Indicator of microbial pathogens (disease-causing organisms) – important for water use.
- Microbiological water quality monitoring and reporting are complex and risk-based.
- 'A' is the best grade but surface waters in agricultural catchments will have some level of microbiological contamination.
- Indirect rough indicator of surface run-off contaminants such as sediment and phosphorus.

The summary results that show Mararoa River at the Key having a five-year median grade of 'D" indicates that the water quality has a relatively high risk of infection for swimming or similar water contact recreation. However, this result needs to be interpreted carefully. Sometimes, they can indicate recent poor water quality. These are the current NPSFM somewhat complex definitions:

[1] https://www.thrivingsouthland.co.nz/science-report/

Band	NPSFM Description – for water contact recreation	English translation
A	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 1%*.	Excellent
B	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 2%*.	Good
C	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 3%*.	Fair - depends
D	20-30% of the time, the estimated risk is >=50 in 1000 (>5% risk). The predicted average infection risk is >3%*.	Poor – probably unsuitable
E	For more than 30% of the time, the estimated risk is >=50 in 1000 (>5% risk). The predicted average infection risk is >7%*.	Bad - definitely

Long-term relatively frequent water quality monitoring and an understanding of infection risk is needed to build an understanding of the suitability of water for swimming. Environment Southland (ES) has been carrying monthly microbiological monitoring for over 15 years so a reasonable understanding has developed. Five-year trends can be potentially misleading, or they can indicate recent changes. For example, the reported five-year state and trend data needs to be considered carefully in the context of whether the data indicates a real change occurring or just the timing of sampling and high flows/time of year.

Environment Southland monitoring data is provided to the national LAWA water quality reporting website[2]. Microbiological water quality reporting be challenging to interpret. For example, the data for the Mararoa River at Weir Road is illustrated below and on the following page.

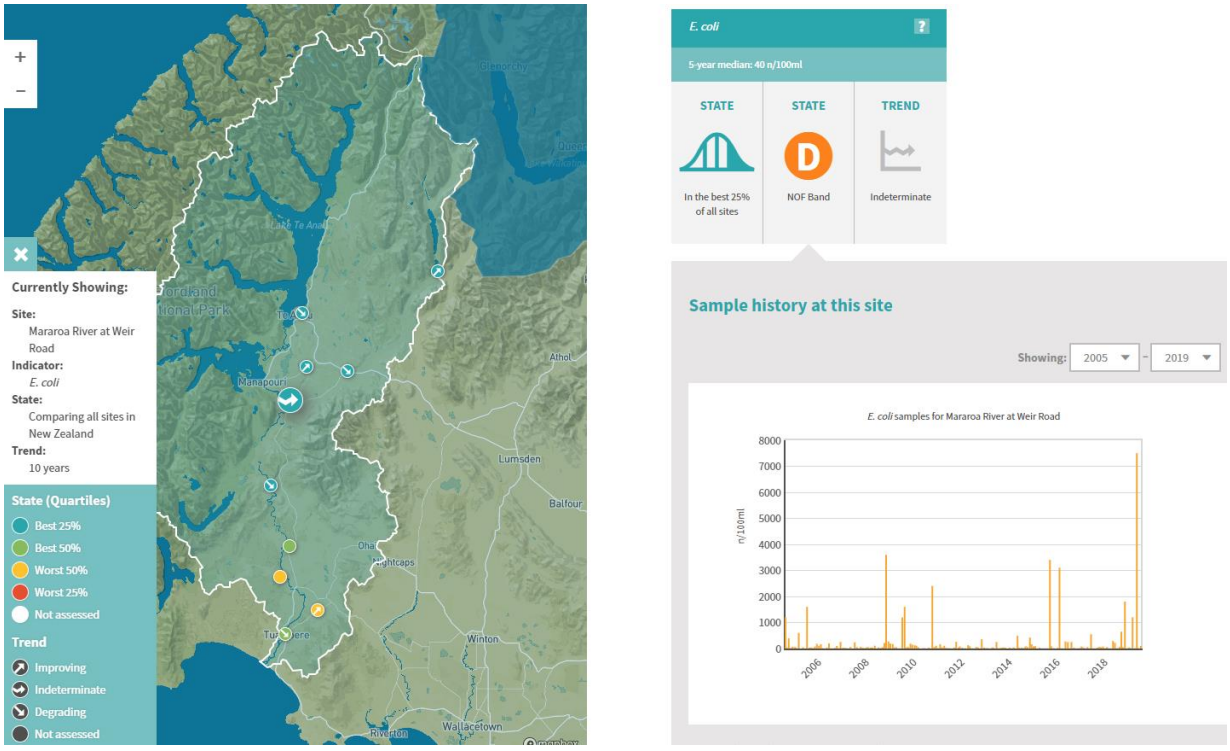


Figure 1. *E. coli* data for Mararoa River at Weir Road (LAWA website, ES data)

[2] www.lawa.org.nz

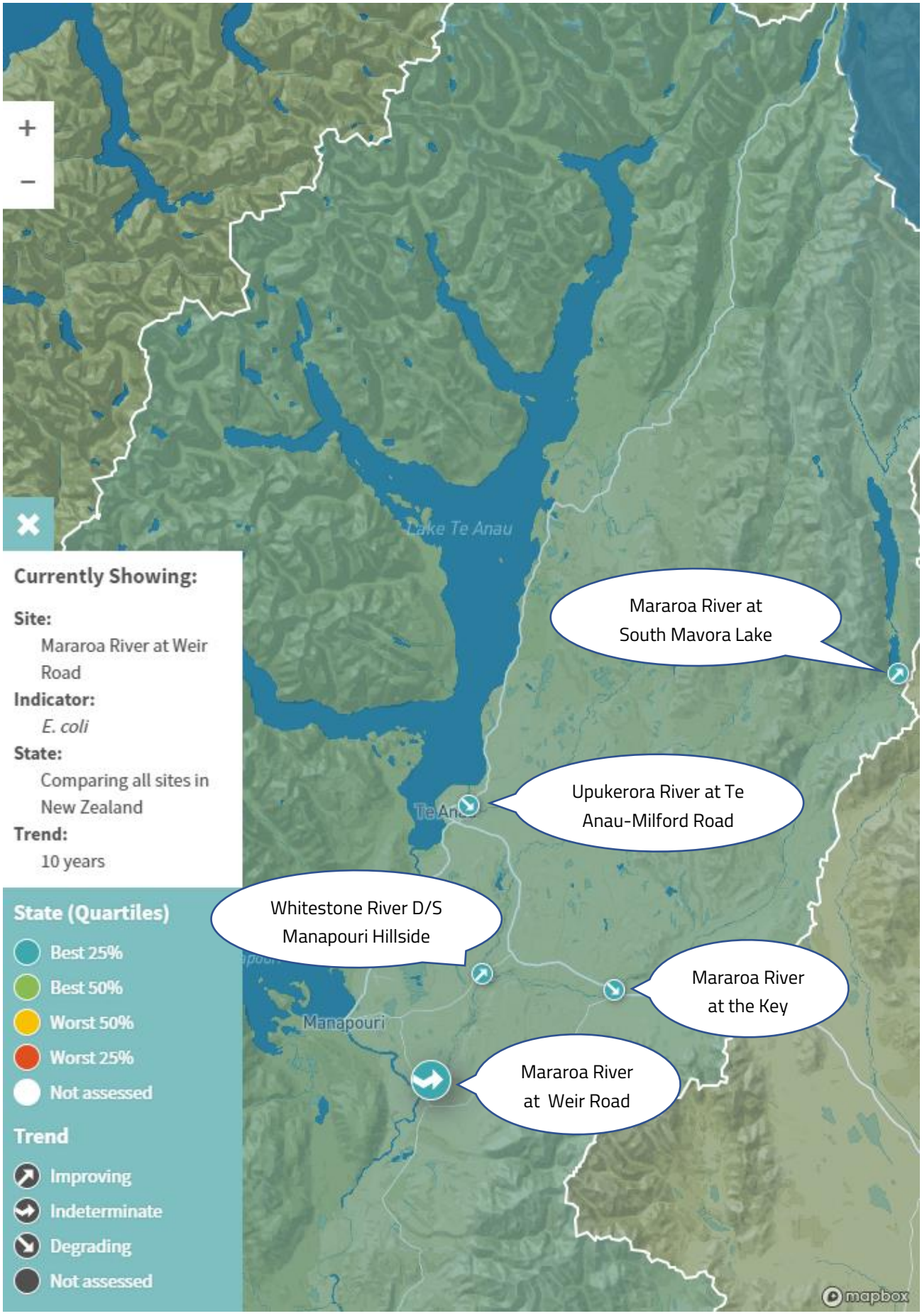


Figure 2 River *E. coli* monitoring site locations (LAWA website, ES data)

In summary, the microbiological water quality data for river water quality (no lake *E. coli* data) in this area indicate that at times the water quality is relatively poor (D Band), while at other times the

microbiological water quality will have been significantly better. This variability is caused by a wide range of factors, particularly the amount, location, and timing of rainfall events and land use prior to those rainfall events.

Figure 1 indicates that the recent very high value will have influenced the D grading while sampling in earlier periods would almost certainly have scored a slightly better five year median result.

4. River water quality - nitrate nitrogen (NO_3-N, TON[3])

- Important nutrient for plant growth but too much can result in accelerated growth of plants in rivers & estuaries.
- Can also cause toxic effects on aquatic life.
- Simpler water quality indicators set to protect against toxicity effects – bands A & B are acceptable. However, a new stricter National Bottom Line established in September 2020 means that C & D bands are not acceptable.

The data for the Te Anau area indicates relatively high quality surface water but with the possibility that the lower Mararoa River has very slowly deteriorated over the past 20+ years. However, this needs to be carefully considered in the context of longer term water quality. The following figure illustrates sampling results for the river water quality monitoring sites in this area including sites in the Mararoa River.

In addition to this overview picture, it is useful to look at one site where there is a long-term record e.g., for the Mararoa River at The Key for the last 20 years.

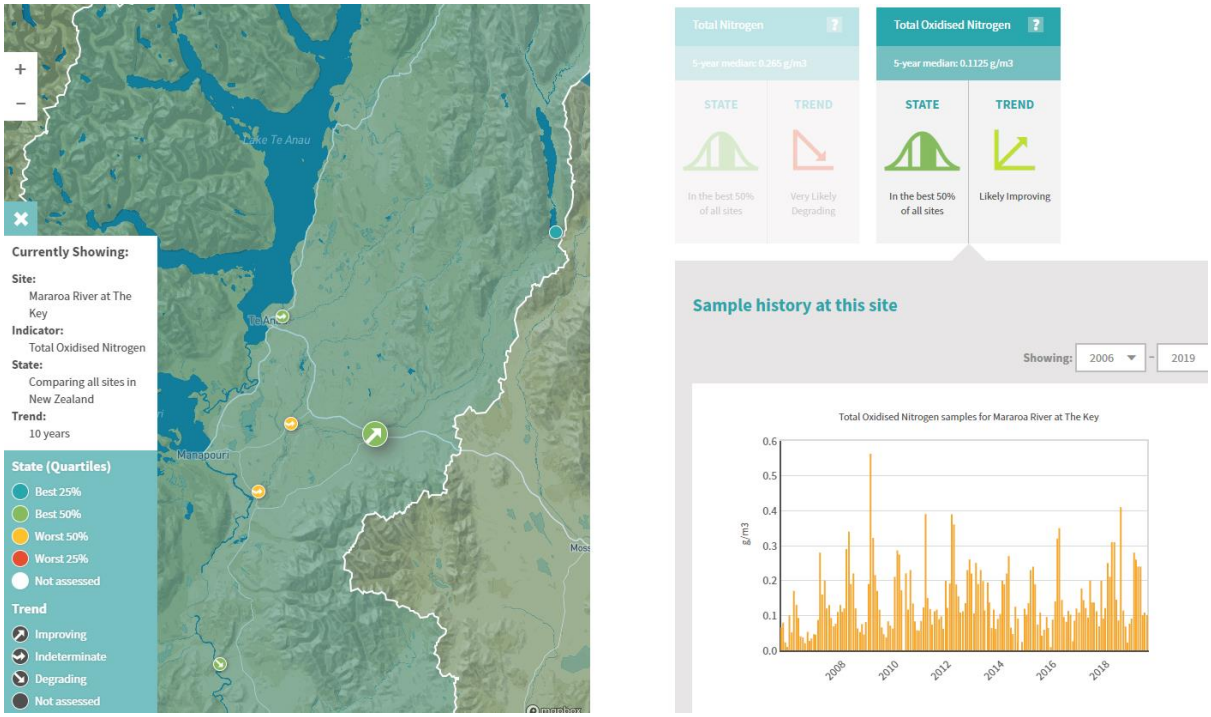


Figure 3. Total oxidised nitrogen (TON) data for Mararoa River at The Key (LAWA website, ES data)

[3] Nitrate nitrogen and total oxidised nitrogen (TON) are effectively equivalent.

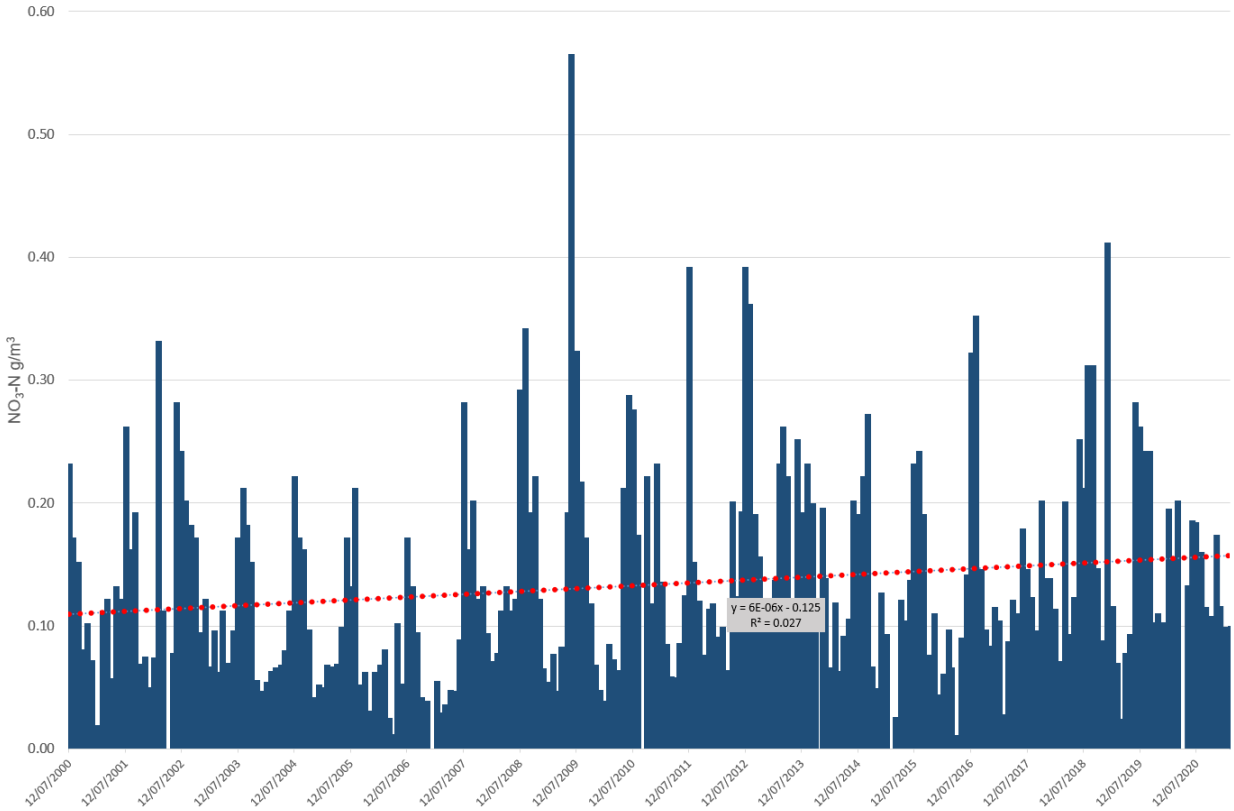


Figure 4. 20 year data for nitrate nitrogen for the Mararoa River at The Key (ES data)

The same data compared to the 'A' band threshold and the National Bottom Line.

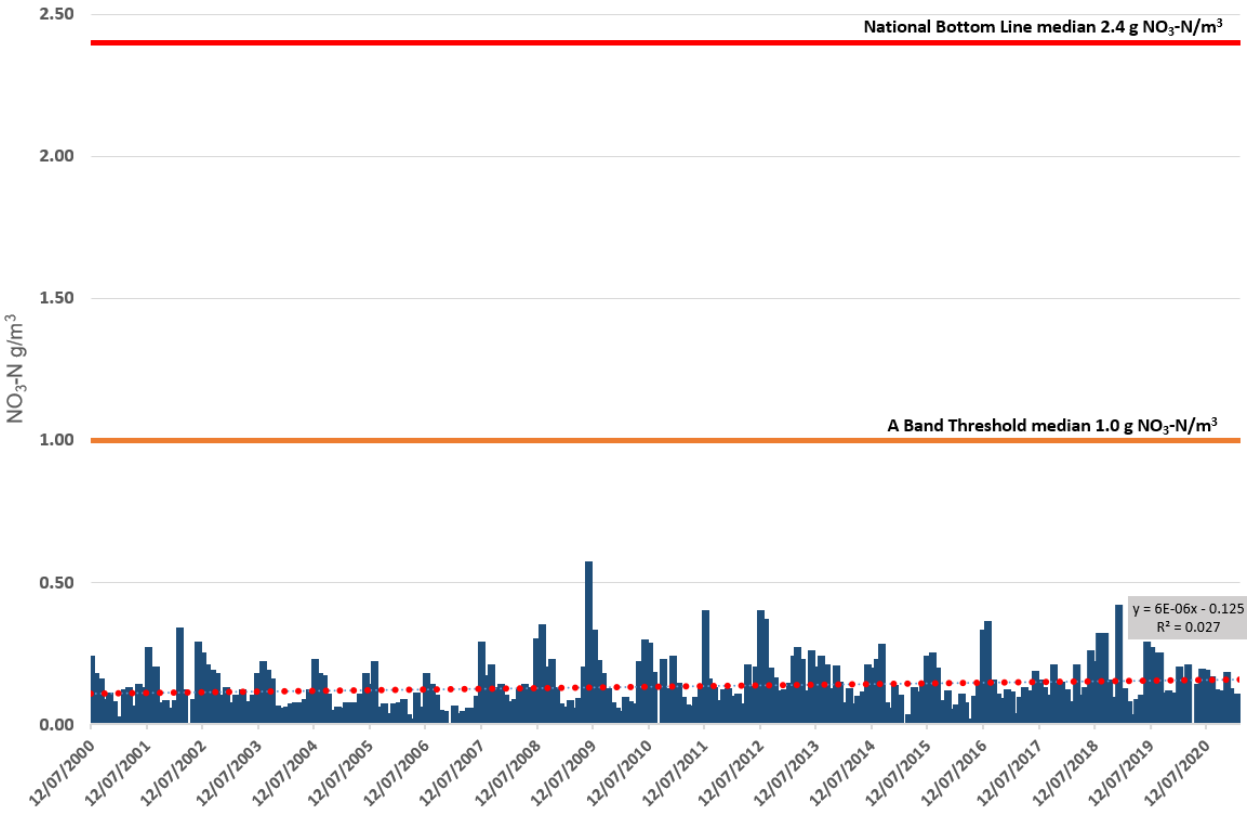


Figure 5. 20 year data for nitrate nitrogen for Mararoa River at The Key compared to NPSFM A band threshold and the National Bottom Line (ES data)

5. Groundwater quality

There is only one long-term groundwater monitoring site in this area at site D43/004 a 13 metre deep bore at The Key. Results from monitoring groundwater quality at this site are summarised in the following figure. The recent five-year nitrate nitrogen median was 2.6 g NO_3-N/m^3 and generally, microbiological testing has shown no *E. coli*. Modelled TON (nitrate nitrogen) for the wider area is also illustrated in Figure 7.

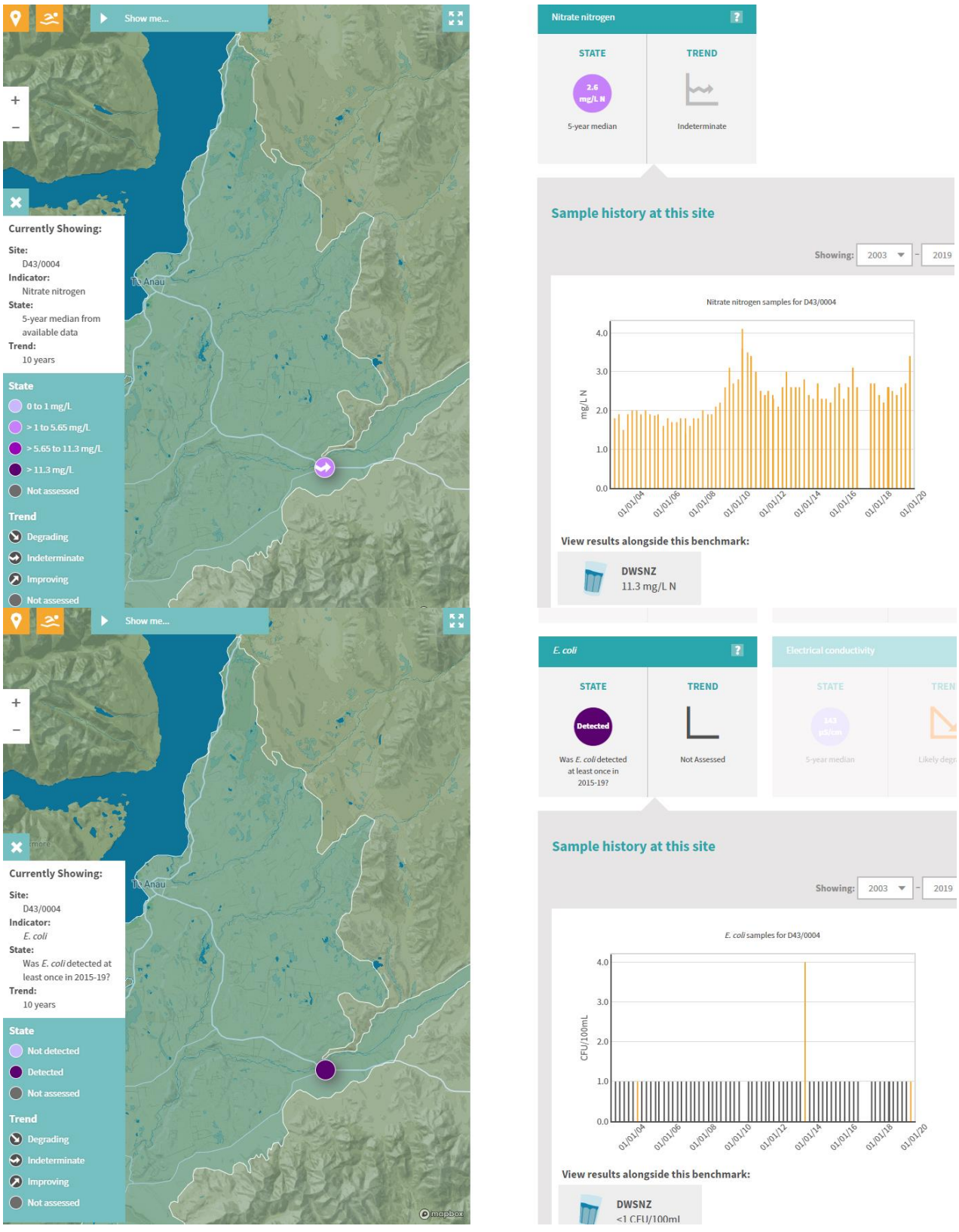


Figure 6. Nitrate nitrogen and *E. coli* monitoring results for bore D43/0004 at The Key (LAWA website, ES data)

6. Te WaeWae (Waiau) Lagoon

The focus of this report is on river and groundwater quality. However, it is useful to have an overview understanding of the status of the state of water quality at the bottom of the Waiau River catchment, because the achievement of water quality goals for a coastal lagoon or estuary can have an influence on land use and management upstream in the catchment.

The Te Waewae Lagoon has been monitored monthly since 2016 and Environment Southland is building up knowledge of the state and trends in the water quality and ecological status of the lagoon. As at the end of 2019, important water quality indicators such as total phosphorus, total nitrogen and secchi disc depth each have 'C' gradings indicating moderate adverse effects but unlikely to be breaching any national bottom lines. The current status of the lagoon is summarised in Figure7.

This data strongly indicate that as part of Environment Southland's future limit setting process there are likely to be land use initiatives that would apply to land in the Te Anau Basin to assist in achieving Te Waewae Lagoon water quality improvements.

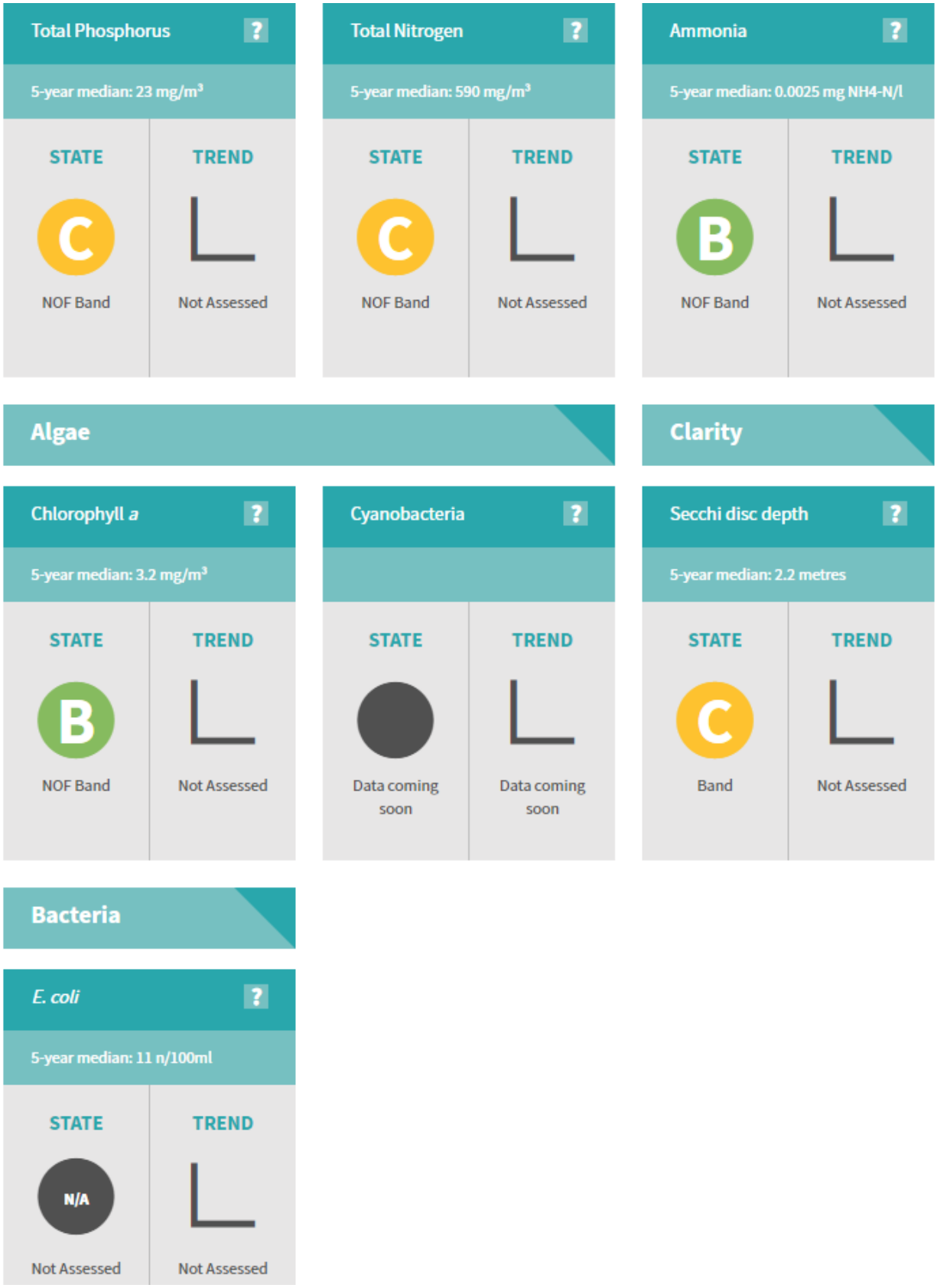


Figure 7. Summary of water quality sampling for the Te Waewae (Waiau) Lagoon (LAWA website, ES data)

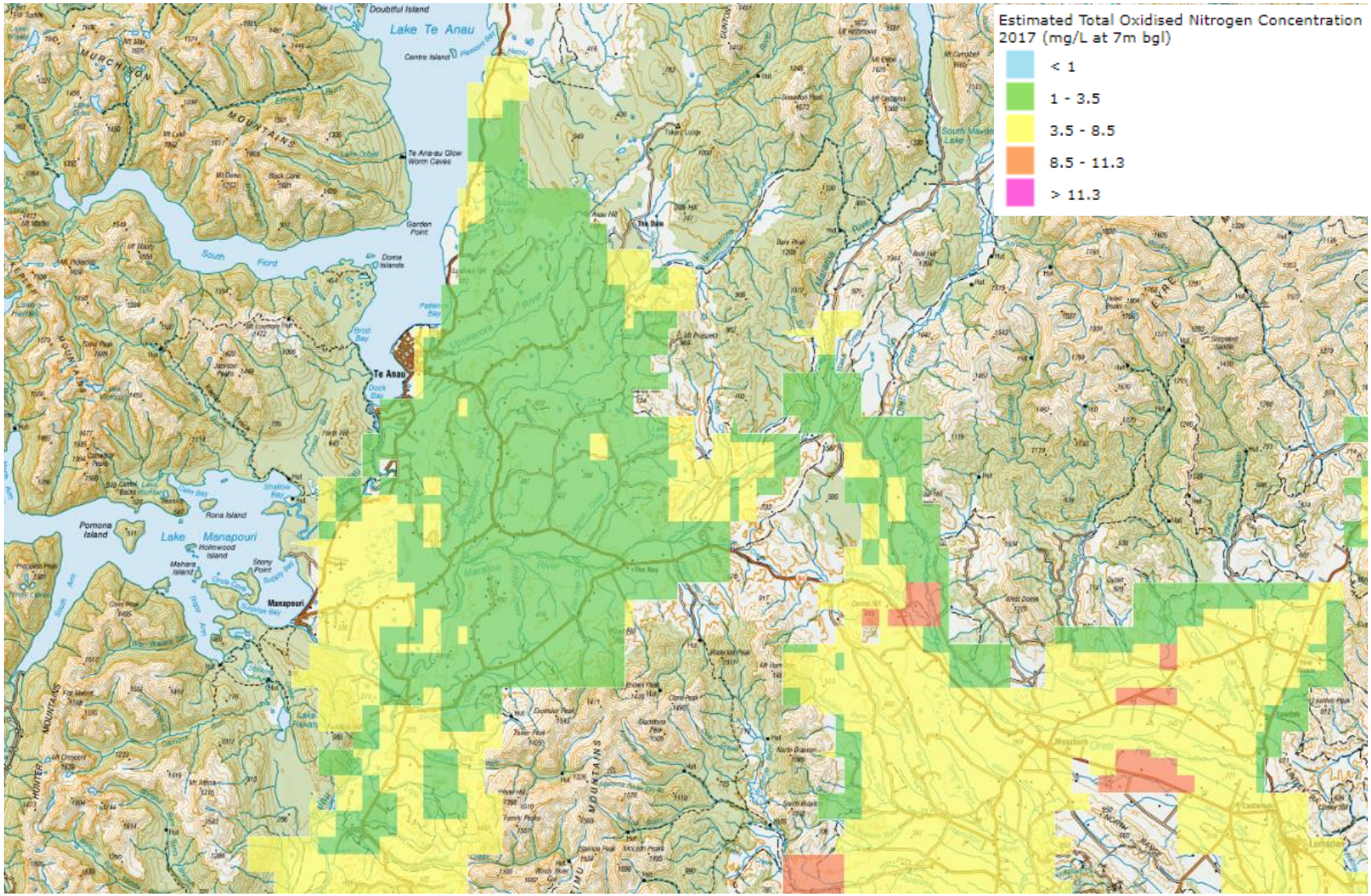


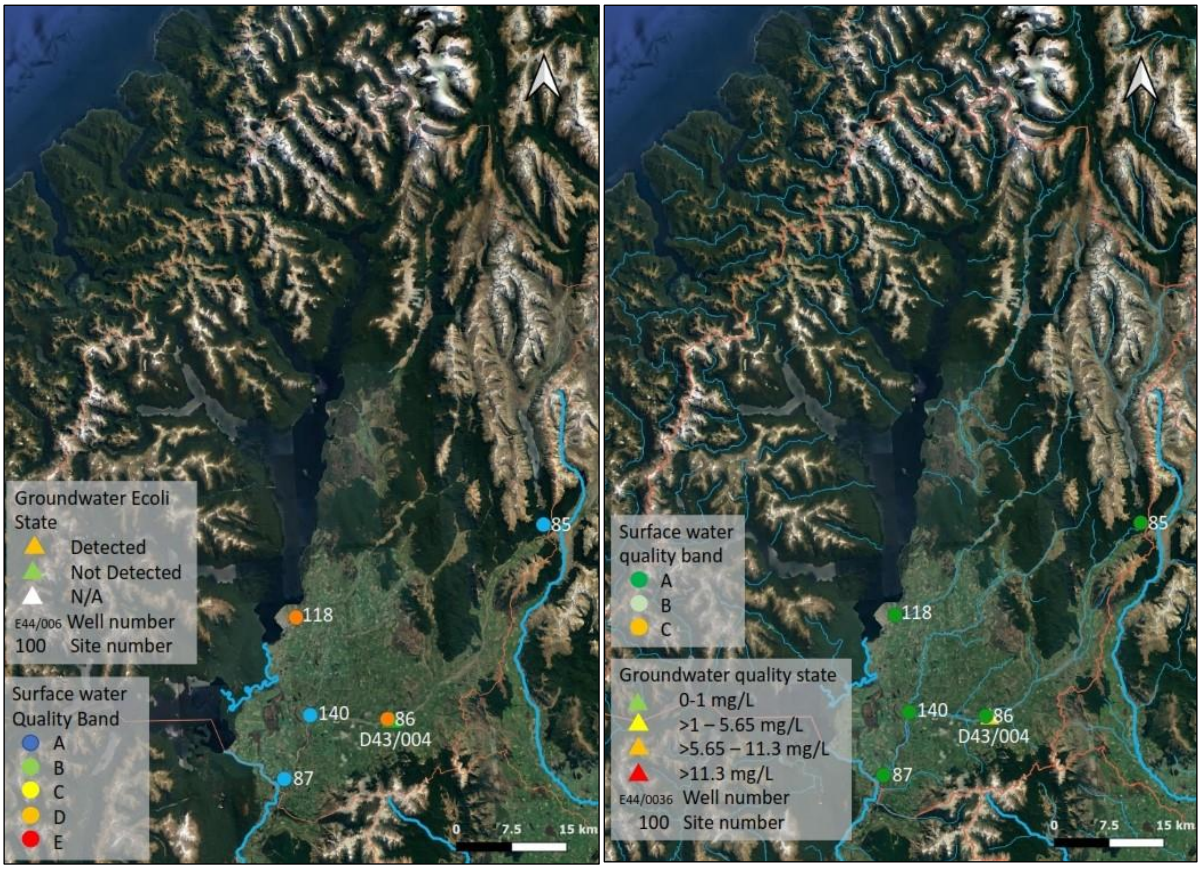
Figure 7. Environment Southland modelled TON (nitrate nitrogen) in the wider Te Anau area (from Beacon website https://maps.es.govt.nz)

7. Conclusions

- The data summarised in this brief report indicate that shallow groundwater quality in the wider Te Anau area is likely to have relatively low nitrate nitrogen concentrations compared to the NZ drinking water standard (MAV) of 11.3 g NO_3-N/m^3. However, the shallow unconfined nature of the groundwater means that it is vulnerable to contamination, particularly microbiological contamination and therefore treatment would generally be appropriate if groundwater is to be used as a source of drinking water.
- Microbiological river water quality is frequently poor and means that there is often a relatively high risk of infection for water contact recreation. This is not unexpected for rivers that receive significant amounts of surface runoff from agricultural land in Southland.
- Nitrate nitrogen concentrations in rivers in the area are relatively low compared to the NPSFM bands and are unlikely to be having any adverse ecosystem toxicity effects. Nitrate nitrogen concentrations in the rivers tested appear to be generally lower than in lowland rivers in other parts of Southland.
- The water quality data indicates that some rivers have trends of increasing nitrate nitrogen concentrations. However, the concentrations are relatively low and do not appear to indicate any significant adverse effects are likely in the medium term.
- Nitrate nitrogen concentrations in rivers generally increase as a river moves through agricultural areas and the Te Waewae (Waiau) Lagoon has relatively high concentration of total nitrogen and total phosphorus. As a consequence it is likely that Environment Southland's future limit setting process will involve catchment land use management initiatives to improve the water quality of the Te Waewae Lagoon.
- These conclusions support the catchment group initiatives to maintain and improve the relatively good quality of rivers and groundwater in the Te Anau Basin area.

Appendix A: Original data from literature review

A copy of the information in the original report is included below. However, note that LAWA data has been updated.



Left: ***E. coli* surface and groundwater monitoring sites current state**

Right: **TON (surface water) and NO3-N (groundwater) monitoring sites current state**

Site key: **Groundwater △ as labelled**

Surface water ◯ refer to Appendix B for site names

Surface Water Quality State and Trends

Summary of *E. Coli* state and trends in surface water

E. Coli	**State***	**Trend**		
Monitoring sites in catchment	**NOF band**	**5-year**	**10-year**	**15-year**
Mararoa River at South Mavora Lake	A	Not assessed	Indeterminate	Indeterminate
Mararoa River at The Key	D	Indeterminate	Likely improving	Very likely improving
Mararoa River at Weir Road	A	Indeterminate	Very likely improving	Very likely improving
Upukerora River at Te Anau Milford Road	D	Indeterminate	Indeterminate	Very likely improving
Whitestone River d/s Manapouri-Hillside	A	Likely improving	Very likely improving	Very likely improving

* 2014-2018 LAWA median graded as per NPS-FM 2020

Summary of Total Oxidised Nitrogen (TON) state and trends in surface water

Total Oxidised Nitrogen (TON)^	State*	Trend		
Monitoring sites in catchment	NOF band	5-year	10-year	15-year
Mararoa River at South Mavora Lake	A	Not assessed	Not assessed	Not assessed
Mararoa River at The Key	A	Very likely degrading	Indeterminate	Not assessed
Mararoa River at Weir Road	A	Likely degrading	Likely degrading	Not assessed
Upukerora River at Te Anau Milford Road	A	Indeterminate	Indeterminate	Not assessed
Whitestone River d/s Manapouri-Hillside	A	Likely improving	Likely degrading	Not assessed

^ Total Oxidized Nitrogen (TON) is the sum of nitrate and nitrite. Nitrite is generally a very small fraction of the TON concentration in rivers, TON is taken to be equivalent to the nitrate concentration

* 2014-2018 LAWA median graded per NPS-FM 2020 using TON as surrogate for NO_3-N

Groundwater Quality State and Trends

Summary of *E. Coli* state and trends in groundwater

E. Coli	Statistics NZ comparison to DWSNZ* or LAWA data	
Monitoring sites in catchment	Median (2014-18)	Exceedance category^
D43/0004	Not detected	0%

* https://www.stats.govt.nz/indicators/groundwater-quality

^ Grades Stats NZ (2014-2018)

Appendix B: Detailed NPSFM *E. coli* and nitrate nitrogen "attribute" definitions

Table 9 – *Escherichia coli* (*E. coli*)

Value	Human contact			
Freshwater body type	Lakes and rivers			
Attribute unit	*E. coli*/100 mL (number of *E. coli* per hundred millilitres)			
Attribute band and description	**Numeric attribute state**			
Description of risk of *Campylobacter* infection (based on *E. coli* indicator)	% exceedances over 540/100 mL	% exceedances over 260/100 mL	Median concentration /100 mL)	95th percentile of *E. coli*/100 mL
A (Blue) 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 (Green) For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 2%.	5-10%	20-30%	≤130	≤1000
C (Yellow) For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 3%.	10-20%	20-34%	≤130	≤1200
D (Orange) 20-30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >3%.	20-30%	>34%	>130	>1200
E (Red) For more than 30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >7%.	>30%	>50%	>260	>1200

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.

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

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.

Table 6 – Nitrate (toxicity)

Value (and component)	Ecosystem health (Water quality)	
Freshwater body type	Rivers	
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
National bottom line	**2.4**	**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
D Impacts on growth of multiple species, and starts approaching acute impact level (that is, risk of death) for sensitive species at higher concentrations (>20 mg/L).	>6.9	>9.8
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.		