

# 2019/20 Groundwater quality monitoring



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## Disclaimer

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For the latest available results go to the [GWRC environmental data hub](#).

## Programme overview

Groundwater in the Wellington region is used extensively for drinking water, stock supply, irrigation and industry. Groundwater also provides baseflow to rivers, streams and wetlands, or forms natural springs or seeps where it discharges at the ground's surface. The protection of these surface water ecosystems requires careful management of the quality and quantity of the underlying groundwater.

To assist with the sustainable management of groundwater resources in the Wellington region, Greater Wellington Regional Council (Greater Wellington) conducts regular monitoring of groundwater quality at 72 sites across the region, shown on the map below. Three key indicators of groundwater contamination (typically arising from land use intensification and/or on-site wastewater disposal systems) are presented in this report:

- **Nitrate-nitrogen**: a key indicator of groundwater contamination typically arising from land use intensification and/or on-site wastewater disposal systems. Nitrate in groundwater can affect its quality for drinking-water supply. The Drinking Water Standard New Zealand (DWSNZ) sets a Maximum Acceptable Value (MAV) for nitrate at 50 mg/L (equivalent to nitrate-nitrogen of 11.3 mg/L), based on a risk to bottle-fed babies ([MoH, 2018](#)).
- **E. coli bacteria**: a key indicator of groundwater contamination by microorganisms, some of which can cause diseases. Faecal bacteria from livestock, onsite wastewater discharges, stormwater and other sources can contaminate groundwater. Any detection of 1 cfu/100 ml exceeds the DWSNZ ([MoH, 2018](#)).
- **Saline intrusion** - a key indicator for seawater contamination in coastal wells. The difference in conductivity between seawater and fresh groundwater is very marked, making it a useful indicator.

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## Monitoring network

Groundwater quality monitoring wells are spread across the region, with the total number of wells in four of the five Whaitua (main river) catchments listed below:

- Ruamāhanga - 46 (1 of which are not included in this report due to 3-yearly sampling).
- Kāpiti Coast - 12.
- Te Whanganui-a-Tara (Wellington and Hutt Valley) - 13.
- Wairarapa Coast - 1.

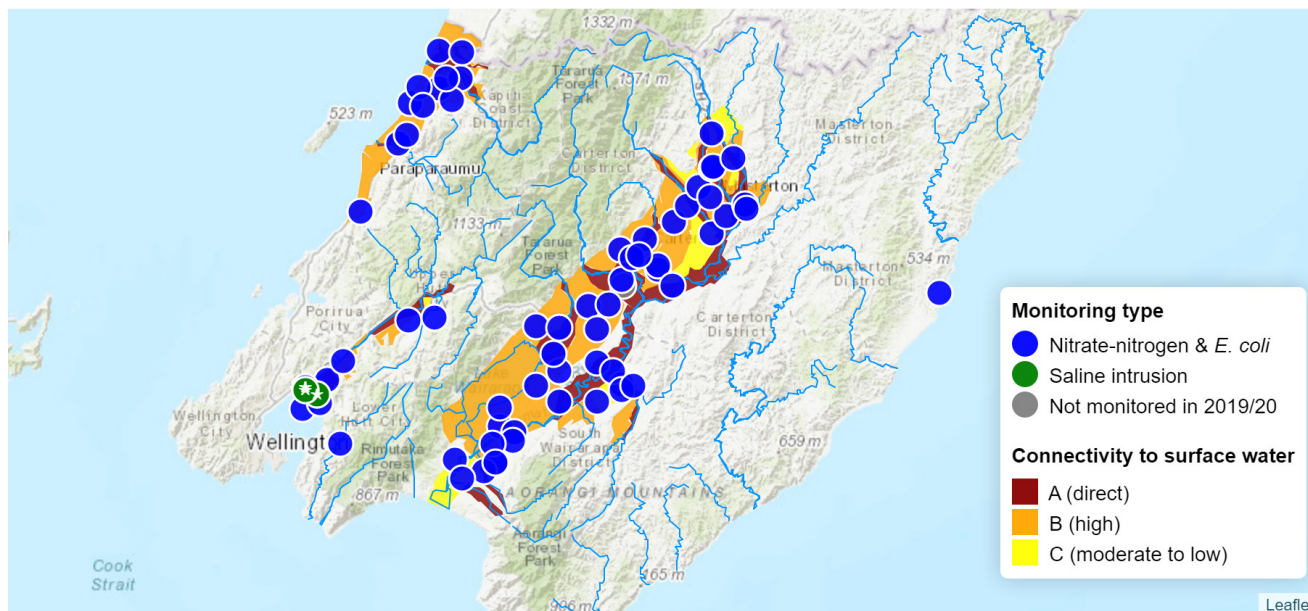


Figure 1: Locations of groundwater quality monitoring sites. See the [methods](#) section for more information on the monitoring network and each “Connectivity to surface water” category. *Note: circles marked with a star (★) have two bores in the same location at different depths.*

More information on each site including bore depth and monitoring frequency can be found in the [Appendix Monitoring details](#) table.

## Monitoring data

Full monitoring data is downloadable in the [Resources](#) section and additional information for each nitrate-nitrogen & *E. coli* site is available at [Land and Water Aotearoa \(LAWA\)](#). The video at this link explains LAWA groundwater information further: <https://www.youtube.com/embed/dlg6s6tUAiA>.

# Methods

## Analytical methods

Table 1: Water quality sampling methods and detection limits.

Variable	Method	Detection limit
Nitrate + nitrite nitrogen	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO <sub>3</sub> - I (Modified) 22nd Ed. 2012	0.001 mg/L
Nitrite nitrogen	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO <sub>3</sub> - I (Modified) 22nd Ed. 2012	0.002 mg/L
Nitrate nitrogen	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N	0.001 mg/L
E. coli	APHA 9222G 22nd Ed. 2012	1 cfu/100mL

## Groundwater connectivity

Proposed management categories for differing levels of hydraulic connectivity of groundwater to surface water. See section 2.3 of [Wairarapa Valley groundwater resource investigation](#) for more detail.

### Category A: Direct hydraulic connectivity

Category A includes areas of the hydrogeological system which exhibit direct connectivity with surface water. Stream flow depletion occurs shortly following the commencement of groundwater abstraction with the depletion effect increasing to a level close to the overall pumping rate and dissipating quickly once pumping stops. As a consequence, a high proportion of the overall volume of groundwater pumped effectively represents induced flow loss from local surface waterways. Due to the immediacy of impact, groundwater abstraction from Category A aquifers can be considered analogous to direct surface water abstraction and managed in terms of the environmental flow and water level regimes established for hydraulically connected surface waterbodies.

### Category B: High hydraulic connectivity

Category B includes those areas of the hydrogeological system where groundwater abstraction may potentially result in significant impacts on surface water but where pumping regulation does not always provide an effective option for mitigating direct stream depletion effects. Category B

represents the transition between indirect and direct stream depletion effects where it may be appropriate to manage groundwater takes in terms of either surface water or groundwater allocation depending on localised factors (e.g. local aquifer hydraulic parameters, abstraction rate and location of pumping with respect to surface waterbodies).

## Category C: Moderate to low hydraulic connectivity

Category C covers those areas of the hydrogeological system where groundwater abstraction may contribute to an overall reduction in baseflow discharge at a catchment scale but where active regulation of pumping does not provide effective mitigation of potential effects on surface water. Cumulatively, these takes are more appropriately managed at a catchment or sub-catchment scale through the establishment of volumetric abstraction limits.

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## Sampling notes

During the 2019/20 monitoring period, some wells were only sampled two or three times. Brief explanations as to why wells could not be sampled are included below:

- R26/6503 was unable to be sampled in September 2019 due to the sampling point being removed.
- R27/0320 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- R27/1137 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- R27/1180 was unable to be sampled in March 2020 due to Covid-19 lockdown and in September 2020 due to an electrical fault with the pump.
- R27/1182 was unable to be sampled in March 2020 due to Covid-19 lockdown and December 2020 due to temporary restricted access.
- R27/1183 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- R27/1265 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- R27/6833 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- S26/0117 was unable to be sampled in March 2020 due to the bore being dry.
- S27/0070 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- S27/0283 was unable to be sampled in March 2020 due to Covid-19 lockdown and December 2019 due to insufficient artesian pressure to sample the bore and no back-up power.
- S27/0389 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- S27/0396 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- S27/0344 was unable to be sampled in September 2019 and June 2020 due to wet soil conditions.
- S27/0522 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- S27/0571 was unable to be sampled in March 2020 due to Covid-19 lockdown.
- S27/0607 was unable to be sampled in September 2019 due to distribution pipe being disconnected / bore not operational.
- S27/0681 was unable to be sampled in March 2020 due to Covid-19 lockdown.

- T26/0430 was unable to be sampled in March 2020 due to the bore being dry.

Four bores have been officially removed from the Groundwater Quality State of the Environment network due to loss of access.

- R25/5164 – removed 2018/19
- S26/0756 – removed 2018/19
- S27/0846 – removed 2018/19
- S27/0614 – removed 2018/19



## Results

Each results section presents maps of monitoring results benchmarked against groundwater quality guidelines where applicable. Full tabulated data for each guideline are available in the [Appendix data tables](#) section.

### Groundwater nitrate-nitrogen concentrations

A key indicator of groundwater contamination typically arising from land use intensification and/or on-site wastewater disposal systems. Nitrate-nitrogen in groundwater can affect its quality for drinking-water supply. See the [LAWA factsheet](#) for more information. Switch tabs below to look at different nitrate-nitrogen measures.

#### Human health

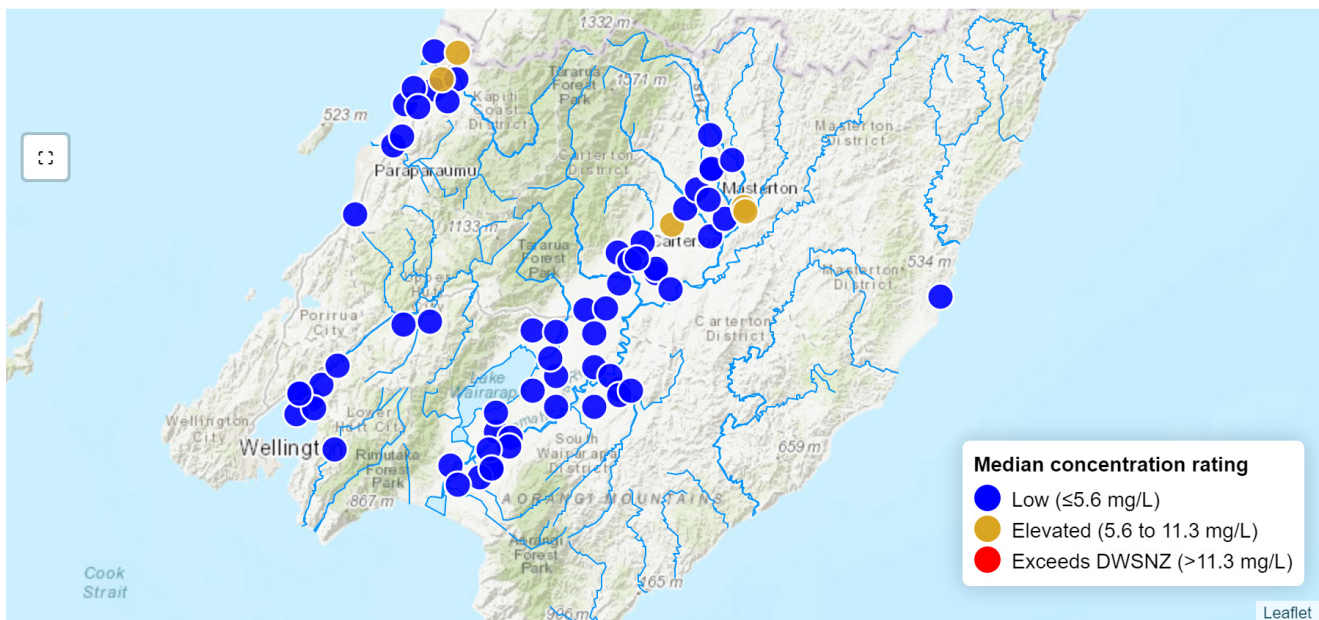


Figure 2: Groundwater nitrate-nitrogen concentrations are evaluated in terms of likely human influence, as excess concentrations can have negative health effects. Bores with annual median concentrations above the [Drinking Water Standard New Zealand \(DWSNZ\)](#) Maximum Acceptable Value (MAV) of 11.3 mg/L are flagged as 'Exceeds DWSNZ', and concentrations above half of this MAV are highlighted as 'Elevated'.

## Ecosystem health

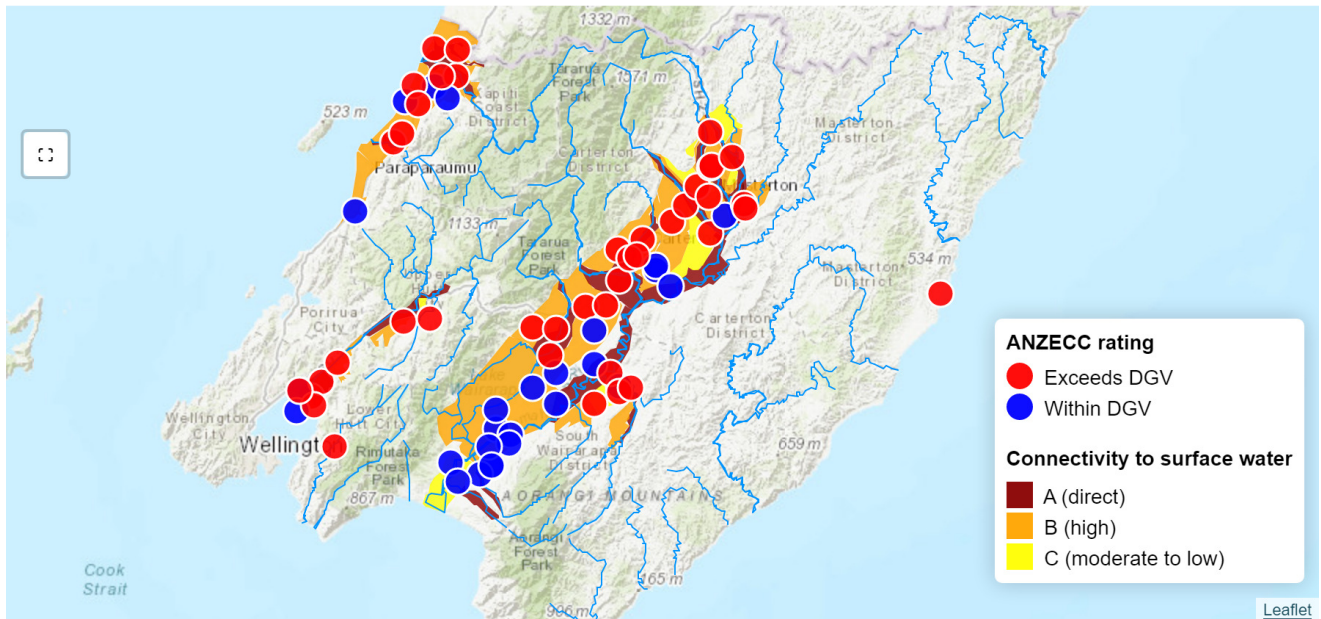


Figure 3: Groundwater discharges from aquifers into a number of surface water bodies throughout the region and there is the potential that groundwater high in nitrate-nitrogen could contribute to the decline of surface water quality. The [2000 Australia New Zealand Guidelines for Fresh and Marine Water Quality](#) (ANZECC) define default guideline values (DGVs) for the 80th percentile of nitrate-nitrogen based on second-level [River Environment Classification](#) (REC) class reference conditions. Groundwater within Connectivity Category A (direct) that has 80th percentile nitrate-nitrogen concentrations above the guideline is the highest risk to ecosystem health in the surface water system. See [groundwater connectivity](#) for more information on surface water connectivity categories.

## Aquatic toxicity

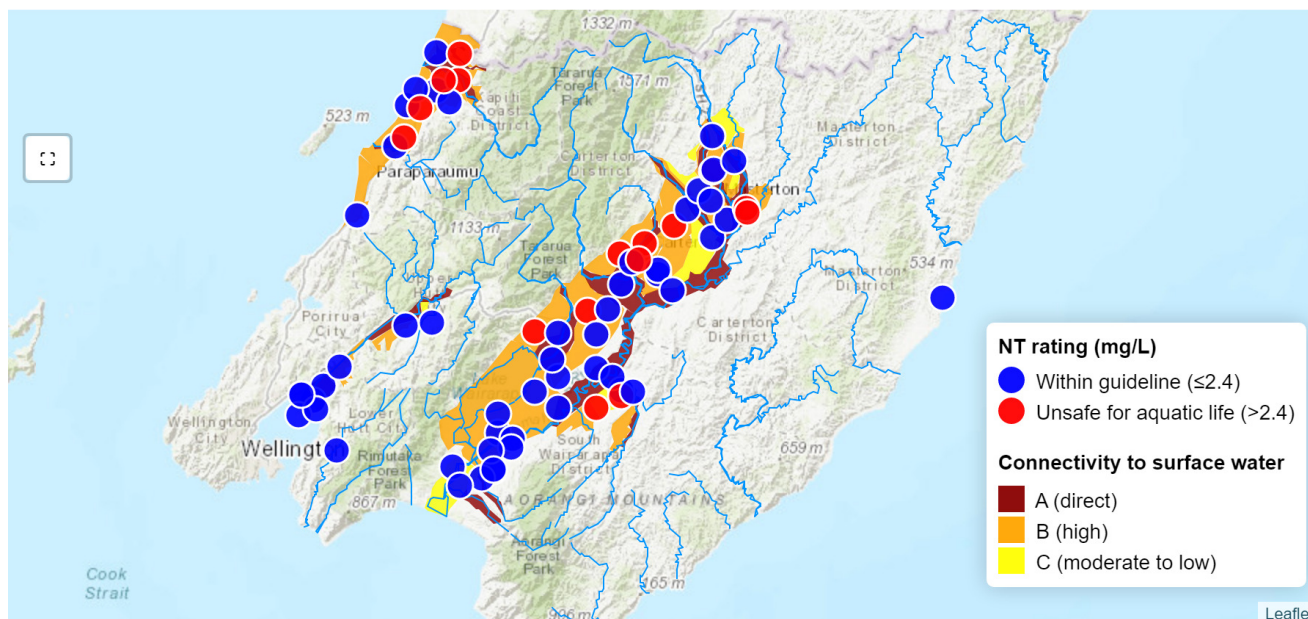


Figure 4: The [National Policy Statement on Freshwater Management \(NPS-FM\)](#) requires regional councils to identify water quality limits to manage values of our aquatic ecosystems. The nitrate toxicity (NT) threshold is calculated at 2.4 mg/L for annual median nitrate-nitrogen concentrations. This is within the guideline described by [Hickey, 2013](#) as ‘Chronic - slightly to moderately disturbed systems (95% protection)’. Freshwater water systems connected to groundwater above this threshold are deemed unsafe for aquatic life. Groundwater within Connectivity Category A (direct) that has median annual nitrate-nitrogen concentrations above the guideline is the highest risk to aquatic life in the surface water system. See [groundwater connectivity](#) for more information on surface water connectivity categories.

## Detection of *E. coli* bacteria

A key indicator of groundwater contamination by microorganisms, some of which can cause diseases. Faecal bacteria from livestock, onsite wastewater discharges, stormwater and other sources can contaminate groundwater. See the [LAWA factsheet](#) for more information.

## Drinking Water Standards New Zealand

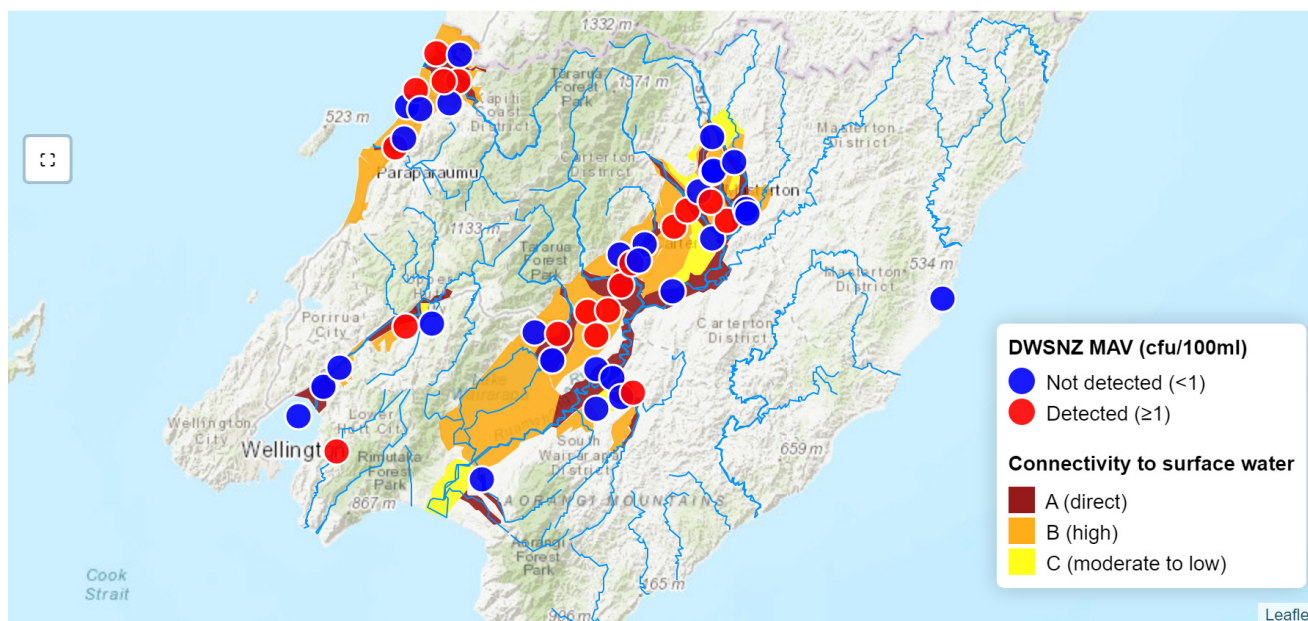


Figure 5: The [Drinking Water Standard New Zealand \(DWSNZ\)](#) uses *E. coli* as an indicator of faecal contamination in drinking water. For drinking water supplies, *E. coli* counts should be below the Maximum Acceptable Value (MAV) of <math><1\text{ cfu}/100\text{ ml}</math>. Groundwater within Connectivity Category A (direct) that has maximum counts above the guideline is the highest risk to drinking water safety in the surface water system. See [groundwater connectivity](#) for more information on surface water connectivity categories.



## Saline intrusion

A key indicator for seawater contamination in coastal wells. The difference in conductivity between seawater and fresh groundwater is very marked, making it a useful indicator. See the [LAWA factsheet](#) for more information.

The charts below show daily average conductivity in  $\mu\text{S}/\text{cm}$  (—) with warning thresholds in dashed red (---) set by GWRC that may reflect the onset of saline intrusion. See the [monitoring details](#) table for more information on the bores below.

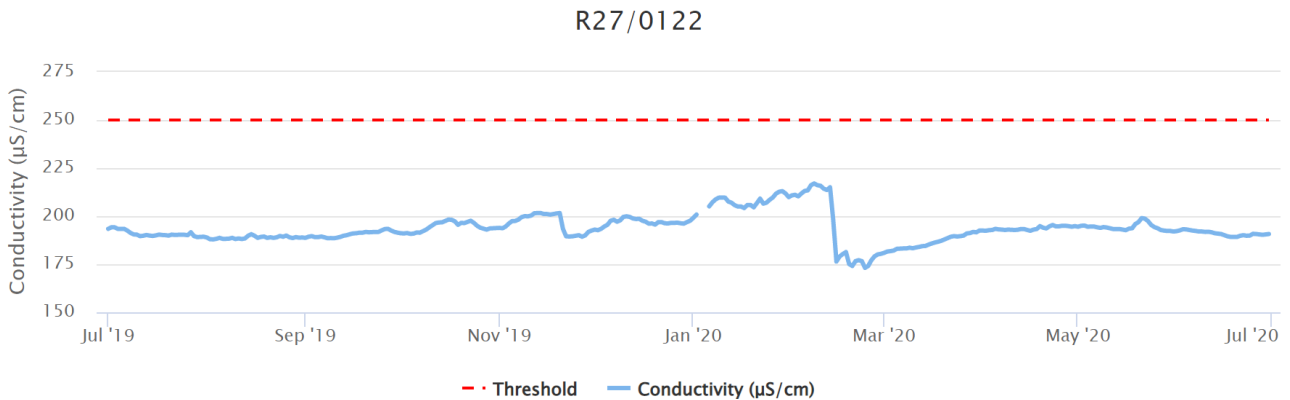


Figure 6: Saline intrusion results for Te Whanganui-a-Tara shallow groundwater bore R27-0122, the warning threshold is 250  $\mu\text{S}/\text{cm}$ .

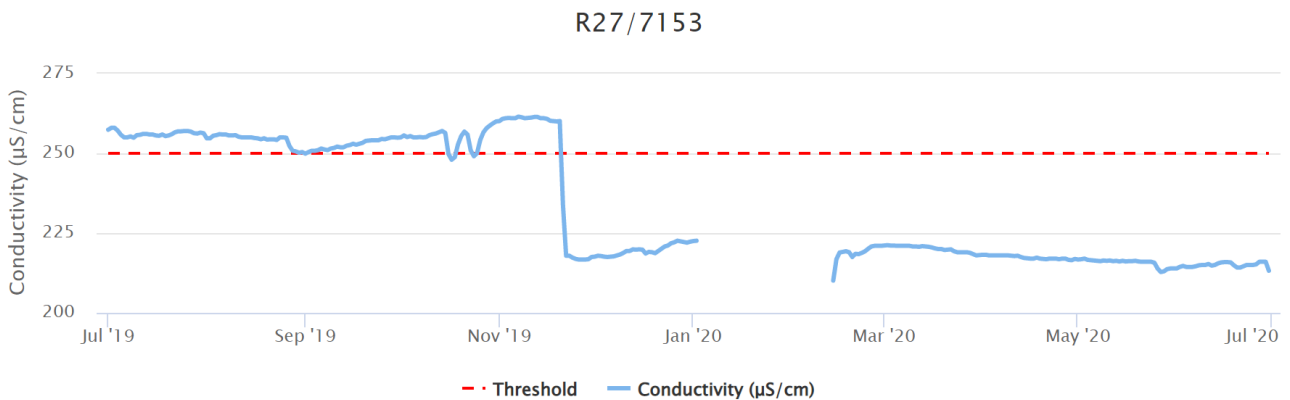


Figure 7: Saline intrusion results for Te Whanganui-a-Tara deep groundwater bore R27-7153, the warning threshold is 250  $\mu\text{S}/\text{cm}$ .

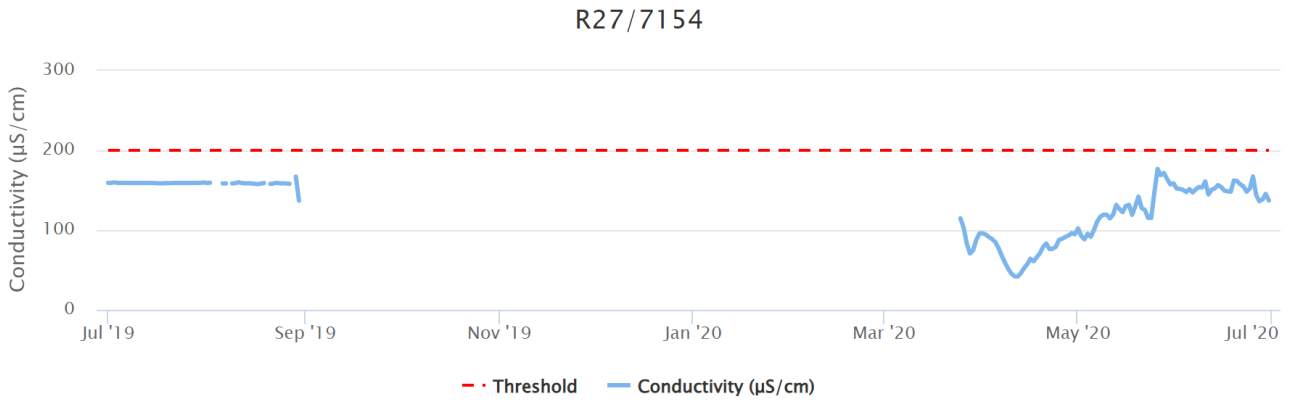


Figure 8: Saline intrusion results for Te Whanganui-a-Tara shallow groundwater bore R27-7154, the warning threshold is 200 µS/cm.

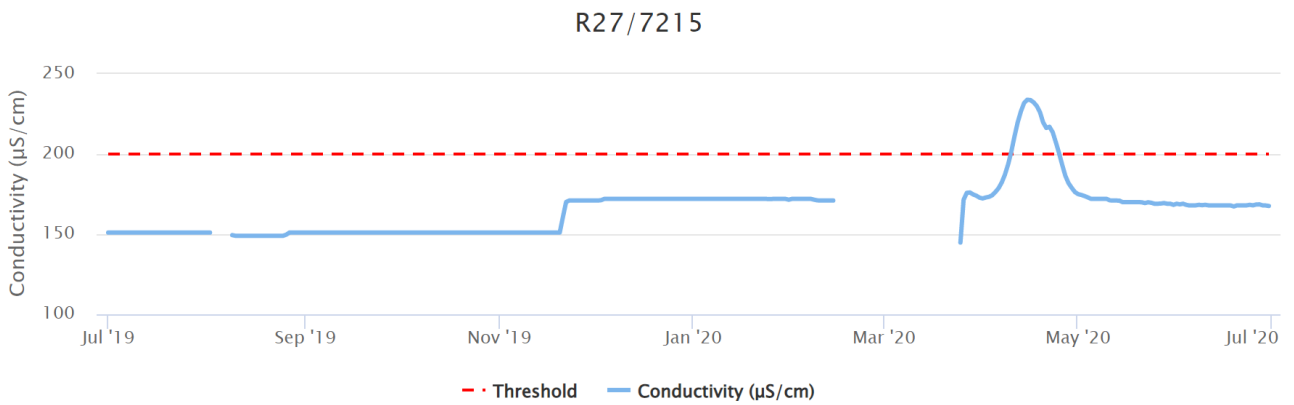


Figure 9: Saline intrusion results for Te Whanganui-a-Tara deep groundwater bore R27-7215, the warning threshold is 200 µS/cm.

## Resources

### Access to monitoring data

Full monitoring data for the 2019/20 monitoring season can be downloaded from the [latest Groundwater quality monitoring report](#) and data for other time periods can be accessed using the [GWRC live data viewer](#). Please read the [disclaimer](#) before using this information.

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### Useful links

- [National Environmental Monitoring Standards: Water Quality Part 1 - Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data](#)
  - [Drinking Water Standard New Zealand](#)
  - [Australian and New Zealand Guidelines for Fresh and Marine Water Quality](#)
  - [Nitrate Toxicity Effects on Freshwater Aquatic Species](#)
  - [Land and Water Aotearoa \(LAWA\) Groundwater](#)
- 

### References

ANZECC 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines*. Australian and New Zealand Environment and Conservation Council. Agriculture and Resource Management Councils of Australia and New Zealand, Canberra.

Hickey, CW. 2013. *Updating nitrate toxicity effects on freshwater aquatic species*. Prepared for Ministry of Building, Innovation and Employment: Funded by Envirolink. NIWA Client Report No: HAM2013-009

Ministry of Health. 2018. *Drinking-water Standards for New Zealand 2005 (revised 2018)*. Ministry of Health, Wellington.

# Appendix

## Monitoring details

Table A1: Monitoring site information.

Whaitua	Site code	Monitoring frequency	Groundwater connectivity	Depth
Ruamāhanga	BQ33/0032	3-yr	Unknown	N/A
Kāpiti Coast	R25/5100	annual	B (high)	48.2m
Kāpiti Coast	R25/5135	annual	B (high)	93.27m
Kāpiti Coast	R25/5164	removed		N/A
Kāpiti Coast	R25/5165	quarterly	B (high)	8.0m
Kāpiti Coast	R25/5190	quarterly	B (high)	5.0m
Kāpiti Coast	R25/5233	quarterly	A (direct)	18.7m
Kāpiti Coast	R26/6503	quarterly	B (high)	14.8m
Kāpiti Coast	R26/6587	quarterly	A (direct)	12.96m
Kāpiti Coast	R26/6624	quarterly	B (high)	10.2m
Te Whanganui-a-Tara	R27/0122	quarterly	B (high)	26.2m
Te Whanganui-a-Tara	R27/0320	quarterly	B (high)	114.6m
Te Whanganui-a-Tara	R27/1137	quarterly	B (high)	20.4m
Te Whanganui-a-Tara	R27/1171	quarterly	B (high)	23.2m
Te Whanganui-a-Tara	R27/1180	quarterly	B (high)	39.0m
Te Whanganui-a-Tara	R27/1182	quarterly	B (high)	38.0m
Te Whanganui-a-Tara	R27/1183	quarterly	B (high)	25.0m
Te Whanganui-a-Tara	R27/1265	quarterly	B (high)	48.3m
Te Whanganui-a-Tara	R27/6418	quarterly	Unknown	8.0m
Te Whanganui-a-Tara	R27/6833	quarterly	Unknown	24.5m
Te Whanganui-a-Tara	R27/7153	quarterly	B (high)	34.0m
Te Whanganui-a-Tara	R27/7154	quarterly	B (high)	45.1m
Te Whanganui-a-Tara	R27/7215	quarterly	B (high)	56.9m
Kāpiti Coast	S25/5125	quarterly	A (direct)	10.0m
Kāpiti Coast	S25/5200	annual	B (high)	45.8m
Kāpiti Coast	S25/5256	quarterly	B (high)	30.78m
Kāpiti Coast	S25/5322	quarterly	B (high)	27.0m
Ruamāhanga	S26/0117	quarterly	A (direct)	4.1m
Ruamāhanga	S26/0223	quarterly	B (high)	9.92m
Ruamāhanga	S26/0299	quarterly	B (high)	8.1m
Ruamāhanga	S26/0439	quarterly	C (moderate to low)	11.5m
Ruamāhanga	S26/0457	quarterly	A (direct)	6.06m
Ruamāhanga	S26/0467	quarterly	A (direct)	6.2m
Ruamāhanga	S26/0568	annual	B (high)	45.0m
Ruamāhanga	S26/0576	3-yr	B (high)	31.0m
Ruamāhanga	S26/0705	3-yr	C (moderate to low)	27.4m
Ruamāhanga	S26/0756	removed		19.0m
Ruamāhanga	S26/0762	quarterly	A (direct)	9.5m
Ruamāhanga	S26/0824	removed		20.6m



<b>Whaitua</b>	<b>Site code</b>	<b>Monitoring frequency</b>	<b>Groundwater connectivity</b>	<b>Depth</b>
Ruamāhanga	S26/0846	quarterly	A (direct)	39.3m
Ruamāhanga	S27/0009	quarterly	B (high)	10.5m
Ruamāhanga	S27/0070	quarterly	B (high)	14.6m
Ruamāhanga	S27/0136	quarterly	B (high)	20.4m
Ruamāhanga	S27/0156	quarterly	B (high)	20.7m
Ruamāhanga	S27/0202	quarterly	B (high)	4.88m
Ruamāhanga	S27/0268	3-yr	C (moderate to low)	58.4m
Ruamāhanga	S27/0283	3-yr	B (high)	19.0m
Ruamāhanga	S27/0299	quarterly	A (direct)	17.4m
Ruamāhanga	S27/0344	3-yr	A (direct)	16.0m
Ruamāhanga	S27/0389	quarterly	C (moderate to low)	17.85m
Ruamāhanga	S27/0396	quarterly	A (direct)	17.0m
Ruamāhanga	S27/0433	3-yr	C (moderate to low)	44.6m
Ruamāhanga	S27/0435	annual	C (moderate to low)	44.0m
Ruamāhanga	S27/0442	annual	C (moderate to low)	177.7m
Ruamāhanga	S27/0495	annual	C (moderate to low)	37.5m
Ruamāhanga	S27/0522	quarterly	C (moderate to low)	21.0m
Ruamāhanga	S27/0571	quarterly	C (moderate to low)	32.0m
Ruamāhanga	S27/0585	3-yr	C (moderate to low)	42.0m
Ruamāhanga	S27/0588	annual	A (direct)	11.7m
Ruamāhanga	S27/0594	annual	C (moderate to low)	44.0m
Ruamāhanga	S27/0602	3-yr	C (moderate to low)	60.95m
Ruamāhanga	S27/0607	annual	C (moderate to low)	38.0m
Ruamāhanga	S27/0615	3-yr	Unknown	18.2m
Ruamāhanga	S27/0681	quarterly	A (direct)	5.0m
Ruamāhanga	T26/0003	quarterly	B (high)	5.5m
Ruamāhanga	T26/0087	quarterly	C (moderate to low)	36.0m
Ruamāhanga	T26/0099	quarterly	B (high)	15.0m
Ruamāhanga	T26/0206	quarterly	C (moderate to low)	28.7m
Ruamāhanga	T26/0259	quarterly	A (direct)	6.1m
Ruamāhanga	T26/0332	quarterly	C (moderate to low)	13.4m
Ruamāhanga	T26/0413	quarterly	C (moderate to low)	23.3m
Ruamāhanga	T26/0430	quarterly	B (high)	0m
Ruamāhanga	T26/0489	quarterly	Unknown	54.0m
Ruamāhanga	T26/0538	quarterly	B (high)	9.0m
Wairarapa Coast	T27/0063	quarterly	Unknown	3.6m

## Data tables

See the respective [methods](#) and [results](#) sections for more information on guidelines and groundwater connectivity categories presented in the following tables.

### Groundwater nitrate-nitrogen concentrations

Table A2: Nitrate-nitrogen results evaluated in terms of human health.

Whaitua	Site code	No. samples	Concentration rating	Median (mg/L)
Ruamāhanga	BQ33/0032	4	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	R25/5100	4	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	R25/5135	4	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	R25/5165	4	Low (≤5.6 mg/L)	0.761
Kāpiti Coast	R25/5190	4	Low (≤5.6 mg/L)	3.993
Kāpiti Coast	R25/5233	4	Low (≤5.6 mg/L)	1.546
Kāpiti Coast	R26/6503	3	Low (≤5.6 mg/L)	0.011
Kāpiti Coast	R26/6587	4	Low (≤5.6 mg/L)	0.725
Kāpiti Coast	R26/6624	4	Low (≤5.6 mg/L)	2.450
Te Whanganui-a-Tara	R27/0122	1	Low (≤5.6 mg/L)	1.084
Te Whanganui-a-Tara	R27/0320	3	Low (≤5.6 mg/L)	<0.002
Te Whanganui-a-Tara	R27/1137	3	Low (≤5.6 mg/L)	1.573
Te Whanganui-a-Tara	R27/1171	4	Low (≤5.6 mg/L)	0.002
Te Whanganui-a-Tara	R27/1180	3	Low (≤5.6 mg/L)	0.800
Te Whanganui-a-Tara	R27/1182	3	Low (≤5.6 mg/L)	0.643
Te Whanganui-a-Tara	R27/1183	3	Low (≤5.6 mg/L)	0.282
Te Whanganui-a-Tara	R27/1265	3	Low (≤5.6 mg/L)	0.103
Te Whanganui-a-Tara	R27/6418	4	Low (≤5.6 mg/L)	1.225
Te Whanganui-a-Tara	R27/6833	3	Low (≤5.6 mg/L)	0.990
Kāpiti Coast	S25/5125	4	Low (≤5.6 mg/L)	2.617
Kāpiti Coast	S25/5200	4	Low (≤5.6 mg/L)	0.005
Kāpiti Coast	S25/5256	4	Elevated (5.6 to 11.3 mg/L)	7.062
Kāpiti Coast	S25/5322	3	Elevated (5.6 to 11.3 mg/L)	9.103
Ruamāhanga	S26/0117	3	Low (≤5.6 mg/L)	3.691
Ruamāhanga	S26/0223	4	Elevated (5.6 to 11.3 mg/L)	10.961
Ruamāhanga	S26/0299	4	Low (≤5.6 mg/L)	1.775
Ruamāhanga	S26/0439	4	Low (≤5.6 mg/L)	3.031
Ruamāhanga	S26/0457	4	Low (≤5.6 mg/L)	0.538
Ruamāhanga	S26/0467	4	Low (≤5.6 mg/L)	1.773
Ruamāhanga	S26/0568	4	Low (≤5.6 mg/L)	0.010
Ruamāhanga	S26/0576	4	Low (≤5.6 mg/L)	0.019
Ruamāhanga	S26/0705	4	Low (≤5.6 mg/L)	3.686
Ruamāhanga	S26/0762	4	Low (≤5.6 mg/L)	0.006
Ruamāhanga	S27/0009	4	Low (≤5.6 mg/L)	3.200
Ruamāhanga	S27/0070	3	Low (≤5.6 mg/L)	0.626
Ruamāhanga	S27/0136	4	Low (≤5.6 mg/L)	3.957

Whaitua	Site code	No. samples	Concentration rating	Median (mg/L)
Ruamāhanga	S27/0156	4	Low (≤5.6 mg/L)	0.021
Ruamāhanga	S27/0202	4	Low (≤5.6 mg/L)	1.769
Ruamāhanga	S27/0268	4	Low (≤5.6 mg/L)	0.007
Ruamāhanga	S27/0283	2	Low (≤5.6 mg/L)	0.010
Ruamāhanga	S27/0299	4	Low (≤5.6 mg/L)	0.381
Ruamāhanga	S27/0344	2	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0389	3	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0396	3	Low (≤5.6 mg/L)	0.542
Ruamāhanga	S27/0433	4	Low (≤5.6 mg/L)	0.006
Ruamāhanga	S27/0435	4	Low (≤5.6 mg/L)	0.006
Ruamāhanga	S27/0442	4	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0495	4	Low (≤5.6 mg/L)	0.003
Ruamāhanga	S27/0522	3	Low (≤5.6 mg/L)	3.291
Ruamāhanga	S27/0571	3	Low (≤5.6 mg/L)	5.077
Ruamāhanga	S27/0585	4	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0588	3	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0594	4	Low (≤5.6 mg/L)	0.006
Ruamāhanga	S27/0602	3	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0607	3	Low (≤5.6 mg/L)	0.010
Ruamāhanga	S27/0615	4	Low (≤5.6 mg/L)	0.006
Ruamāhanga	S27/0681	3	Low (≤5.6 mg/L)	0.576
Ruamāhanga	T26/0003	3	Low (≤5.6 mg/L)	0.854
Ruamāhanga	T26/0087	4	Low (≤5.6 mg/L)	1.137
Ruamāhanga	T26/0099	4	Low (≤5.6 mg/L)	2.581
Ruamāhanga	T26/0206	4	Low (≤5.6 mg/L)	1.982
Ruamāhanga	T26/0259	4	Low (≤5.6 mg/L)	0.857
Ruamāhanga	T26/0332	4	Low (≤5.6 mg/L)	0.747
Ruamāhanga	T26/0413	4	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	T26/0430	4	Low (≤5.6 mg/L)	1.248
Ruamāhanga	T26/0489	4	Elevated (5.6 to 11.3 mg/L)	8.860
Ruamāhanga	T26/0538	4	Elevated (5.6 to 11.3 mg/L)	7.867
Wairarapa Coast	T27/0063	3	Low (≤5.6 mg/L)	0.911

Table A3: Nitrate-nitrogen results evaluated in terms of ecosystem health.

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Ruamāhanga	BQ33/0032	Unknown	4	Within DGV	0.265	0.005
Kāpiti Coast	R25/5100	B (high)	4	Within DGV	0.195	<0.002
Kāpiti Coast	R25/5135	B (high)	4	Within DGV	0.195	0.005
Kāpiti Coast	R25/5165	B (high)	4	Exceeds DGV	0.195	1.850
Kāpiti Coast	R25/5190	B (high)	4	Exceeds DGV	0.195	5.293
Kāpiti Coast	R25/5233	A (direct)	4	Exceeds DGV	0.195	1.723
Kāpiti Coast	R26/6503	B (high)	3	Within DGV	0.065	0.013
Kāpiti Coast	R26/6587	A (direct)	4	Exceeds DGV	0.195	0.969
Kāpiti Coast	R26/6624	B (high)	4	Exceeds DGV	0.065	2.554
Te Whanganui-a-Tara	R27/0122	B (high)	1	Exceeds DGV	0.065	1.084

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Te Whanganui-a-Tara	R27/0320	B (high)	3	Within DGV	0.065	<0.002
Te Whanganui-a-Tara	R27/1137	B (high)	3	Exceeds DGV	0.065	1.613
Te Whanganui-a-Tara	R27/1171	B (high)	4	Within DGV	0.065	0.031
Te Whanganui-a-Tara	R27/1180	B (high)	3	Exceeds DGV	0.065	0.801
Te Whanganui-a-Tara	R27/1182	B (high)	3	Exceeds DGV	0.065	0.651
Te Whanganui-a-Tara	R27/1183	B (high)	3	Exceeds DGV	0.065	0.304
Te Whanganui-a-Tara	R27/1265	B (high)	3	Exceeds DGV	0.065	0.111
Te Whanganui-a-Tara	R27/6418	Unknown	4	Exceeds DGV	0.170	1.648
Te Whanganui-a-Tara	R27/6833	Unknown	3	Exceeds DGV	0.170	1.125
Kāpiti Coast	S25/5125	A (direct)	4	Exceeds DGV	0.195	3.650
Kāpiti Coast	S25/5200	B (high)	4	Within DGV	0.170	0.011
Kāpiti Coast	S25/5256	B (high)	4	Exceeds DGV	0.195	7.150
Kāpiti Coast	S25/5322	B (high)	3	Exceeds DGV	0.195	9.210
Ruamāhanga	S26/0117	A (direct)	3	Exceeds DGV	0.170	3.844
Ruamāhanga	S26/0223	B (high)	4	Exceeds DGV	0.195	11.504
Ruamāhanga	S26/0299	B (high)	4	Exceeds DGV	0.195	2.820
Ruamāhanga	S26/0439	C (moderate to low)	4	Exceeds DGV	0.065	3.454
Ruamāhanga	S26/0457	A (direct)	4	Exceeds DGV	0.195	0.887
Ruamāhanga	S26/0467	A (direct)	4	Exceeds DGV	0.195	2.287
Ruamāhanga	S26/0568	B (high)	4	Within DGV	0.195	0.010
Ruamāhanga	S26/0576	B (high)	4	Within DGV	0.195	0.034
Ruamāhanga	S26/0705	C (moderate to low)	4	Exceeds DGV	0.195	3.743
Ruamāhanga	S26/0762	A (direct)	4	Within DGV	0.195	0.010
Ruamāhanga	S27/0009	B (high)	4	Exceeds DGV	0.065	3.526
Ruamāhanga	S27/0070	B (high)	3	Exceeds DGV	0.195	0.934
Ruamāhanga	S27/0136	B (high)	4	Exceeds DGV	0.195	4.125
Ruamāhanga	S27/0156	B (high)	4	Within DGV	0.195	0.026
Ruamāhanga	S27/0202	B (high)	4	Exceeds DGV	0.195	2.101
Ruamāhanga	S27/0268	C (moderate to low)	4	Within DGV	0.195	0.010
Ruamāhanga	S27/0283	B (high)	2	Within DGV	0.195	0.010
Ruamāhanga	S27/0299	A (direct)	4	Exceeds DGV	0.195	0.406
Ruamāhanga	S27/0344	A (direct)	2	Within DGV	0.195	<0.002
Ruamāhanga	S27/0389	C (moderate to low)	3	Within DGV	0.195	<0.002
Ruamāhanga	S27/0396	A (direct)	3	Exceeds DGV	0.170	0.654
Ruamāhanga	S27/0433	C (moderate to low)	4	Within DGV	0.195	0.010
Ruamāhanga	S27/0435	C (moderate to low)	4	Within DGV	0.195	0.010
Ruamāhanga	S27/0442	C (moderate to low)	4	Within DGV	0.170	<0.002
Ruamāhanga	S27/0495	C (moderate to low)	4	Within DGV	0.195	0.007
Ruamāhanga	S27/0522	C (moderate to low)	3	Exceeds DGV	0.195	3.393
Ruamāhanga	S27/0571	C (moderate to low)	3	Exceeds DGV	0.195	5.218
Ruamāhanga	S27/0585	C (moderate to low)	4	Within DGV	0.195	<0.002
Ruamāhanga	S27/0588	A (direct)	3	Within DGV	0.087	<0.002
Ruamāhanga	S27/0594	C (moderate to low)	4	Within DGV	0.195	0.010
Ruamāhanga	S27/0602	C (moderate to low)	3	Within DGV	0.195	0.006
Ruamāhanga	S27/0607	C (moderate to low)	3	Within DGV	0.195	0.010
Ruamāhanga	S27/0615	Unknown	4	Within DGV	0.195	0.010
Ruamāhanga	S27/0681	A (direct)	3	Exceeds DGV	0.265	0.578

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Ruamāhanga	T26/0003	B (high)	3	Exceeds DGV	0.265	1.392
Ruamāhanga	T26/0087	C (moderate to low)	4	Exceeds DGV	0.195	1.582
Ruamāhanga	T26/0099	B (high)	4	Exceeds DGV	0.195	2.725
Ruamāhanga	T26/0206	C (moderate to low)	4	Exceeds DGV	0.195	2.079
Ruamāhanga	T26/0259	A (direct)	4	Exceeds DGV	0.265	2.311
Ruamāhanga	T26/0332	C (moderate to low)	4	Exceeds DGV	0.195	0.844
Ruamāhanga	T26/0413	C (moderate to low)	4	Within DGV	0.195	0.004
Ruamāhanga	T26/0430	B (high)	4	Exceeds DGV	0.195	1.820
Ruamāhanga	T26/0489	Unknown	4	Exceeds DGV	0.195	9.113
Ruamāhanga	T26/0538	B (high)	4	Exceeds DGV	0.195	8.895
Wairarapa Coast	T27/0063	Unknown	3	Exceeds DGV	0.195	1.058

Table A4: Nitrate-nitrogen results evaluated in terms of aquatic toxicity.

Whaitua	Site code	Connectivity	No. samples	NT rating	Median (mg/L)
Ruamāhanga	BQ33/0032	Unknown	4	Within guideline ( $\leq 2.4$ )	<0.002
Kāpiti Coast	R25/5100	B (high)	4	Within guideline ( $\leq 2.4$ )	<0.002
Kāpiti Coast	R25/5135	B (high)	4	Within guideline ( $\leq 2.4$ )	<0.002
Kāpiti Coast	R25/5165	B (high)	4	Within guideline ( $\leq 2.4$ )	0.761
Kāpiti Coast	R25/5190	B (high)	4	Unsafe for aquatic life ( $> 2.4$ )	3.993
Kāpiti Coast	R25/5233	A (direct)	4	Within guideline ( $\leq 2.4$ )	1.546
Kāpiti Coast	R26/6503	B (high)	3	Within guideline ( $\leq 2.4$ )	0.011
Kāpiti Coast	R26/6587	A (direct)	4	Within guideline ( $\leq 2.4$ )	0.725
Kāpiti Coast	R26/6624	B (high)	4	Unsafe for aquatic life ( $> 2.4$ )	2.450
Te Whanganui-a-Tara	R27/0122	B (high)	1	Within guideline ( $\leq 2.4$ )	1.084
Te Whanganui-a-Tara	R27/0320	B (high)	3	Within guideline ( $\leq 2.4$ )	<0.002
Te Whanganui-a-Tara	R27/1137	B (high)	3	Within guideline ( $\leq 2.4$ )	1.573
Te Whanganui-a-Tara	R27/1171	B (high)	4	Within guideline ( $\leq 2.4$ )	0.002
Te Whanganui-a-Tara	R27/1180	B (high)	3	Within guideline ( $\leq 2.4$ )	0.800
Te Whanganui-a-Tara	R27/1182	B (high)	3	Within guideline ( $\leq 2.4$ )	0.643
Te Whanganui-a-Tara	R27/1183	B (high)	3	Within guideline ( $\leq 2.4$ )	0.282
Te Whanganui-a-Tara	R27/1265	B (high)	3	Within guideline ( $\leq 2.4$ )	0.103
Te Whanganui-a-Tara	R27/6418	Unknown	4	Within guideline ( $\leq 2.4$ )	1.225
Te Whanganui-a-Tara	R27/6833	Unknown	3	Within guideline ( $\leq 2.4$ )	0.990
Kāpiti Coast	S25/5125	A (direct)	4	Unsafe for aquatic life ( $> 2.4$ )	2.617
Kāpiti Coast	S25/5200	B (high)	4	Within guideline ( $\leq 2.4$ )	0.005
Kāpiti Coast	S25/5256	B (high)	4	Unsafe for aquatic life ( $> 2.4$ )	7.062
Kāpiti Coast	S25/5322	B (high)	3	Unsafe for aquatic life ( $> 2.4$ )	9.103
Ruamāhanga	S26/0117	A (direct)	3	Unsafe for aquatic life ( $> 2.4$ )	3.691
Ruamāhanga	S26/0223	B (high)	4	Unsafe for aquatic life ( $> 2.4$ )	10.961
Ruamāhanga	S26/0299	B (high)	4	Within guideline ( $\leq 2.4$ )	1.775
Ruamāhanga	S26/0439	C (moderate to low)	4	Unsafe for aquatic life ( $> 2.4$ )	3.031
Ruamāhanga	S26/0457	A (direct)	4	Within guideline ( $\leq 2.4$ )	0.538
Ruamāhanga	S26/0467	A (direct)	4	Within guideline ( $\leq 2.4$ )	1.773
Ruamāhanga	S26/0568	B (high)	4	Within guideline ( $\leq 2.4$ )	0.010
Ruamāhanga	S26/0576	B (high)	4	Within guideline ( $\leq 2.4$ )	0.019

Whaitua	Site code	Connectivity	No. samples	NT rating	Median (mg/L)
Ruamāhanga	S26/0705	C (moderate to low)	4	Unsafe for aquatic life (>2.4)	3.686
Ruamāhanga	S26/0762	A (direct)	4	Within guideline (≤2.4)	0.006
Ruamāhanga	S27/0009	B (high)	4	Unsafe for aquatic life (>2.4)	3.200
Ruamāhanga	S27/0070	B (high)	3	Within guideline (≤2.4)	0.626
Ruamāhanga	S27/0136	B (high)	4	Unsafe for aquatic life (>2.4)	3.957
Ruamāhanga	S27/0156	B (high)	4	Within guideline (≤2.4)	0.021
Ruamāhanga	S27/0202	B (high)	4	Within guideline (≤2.4)	1.769
Ruamāhanga	S27/0268	C (moderate to low)	4	Within guideline (≤2.4)	0.007
Ruamāhanga	S27/0283	B (high)	2	Within guideline (≤2.4)	0.010
Ruamāhanga	S27/0299	A (direct)	4	Within guideline (≤2.4)	0.381
Ruamāhanga	S27/0344	A (direct)	2	Within guideline (≤2.4)	<0.002
Ruamāhanga	S27/0389	C (moderate to low)	3	Within guideline (≤2.4)	<0.002
Ruamāhanga	S27/0396	A (direct)	3	Within guideline (≤2.4)	0.542
Ruamāhanga	S27/0433	C (moderate to low)	4	Within guideline (≤2.4)	0.006
Ruamāhanga	S27/0435	C (moderate to low)	4	Within guideline (≤2.4)	0.006
Ruamāhanga	S27/0442	C (moderate to low)	4	Within guideline (≤2.4)	<0.002
Ruamāhanga	S27/0495	C (moderate to low)	4	Within guideline (≤2.4)	0.003
Ruamāhanga	S27/0522	C (moderate to low)	3	Unsafe for aquatic life (>2.4)	3.291
Ruamāhanga	S27/0571	C (moderate to low)	3	Unsafe for aquatic life (>2.4)	5.077
Ruamāhanga	S27/0585	C (moderate to low)	4	Within guideline (≤2.4)	<0.002
Ruamāhanga	S27/0588	A (direct)	3	Within guideline (≤2.4)	<0.002
Ruamāhanga	S27/0594	C (moderate to low)	4	Within guideline (≤2.4)	0.006
Ruamāhanga	S27/0602	C (moderate to low)	3	Within guideline (≤2.4)	<0.002
Ruamāhanga	S27/0607	C (moderate to low)	3	Within guideline (≤2.4)	0.010
Ruamāhanga	S27/0615	Unknown	4	Within guideline (≤2.4)	0.006
Ruamāhanga	S27/0681	A (direct)	3	Within guideline (≤2.4)	0.576
Ruamāhanga	T26/0003	B (high)	3	Within guideline (≤2.4)	0.854
Ruamāhanga	T26/0087	C (moderate to low)	4	Within guideline (≤2.4)	1.137
Ruamāhanga	T26/0099	B (high)	4	Unsafe for aquatic life (>2.4)	2.581
Ruamāhanga	T26/0206	C (moderate to low)	4	Within guideline (≤2.4)	1.982
Ruamāhanga	T26/0259	A (direct)	4	Within guideline (≤2.4)	0.857
Ruamāhanga	T26/0332	C (moderate to low)	4	Within guideline (≤2.4)	0.747
Ruamāhanga	T26/0413	C (moderate to low)	4	Within guideline (≤2.4)	<0.002
Ruamāhanga	T26/0430	B (high)	4	Within guideline (≤2.4)	1.248
Ruamāhanga	T26/0489	Unknown	4	Unsafe for aquatic life (>2.4)	8.860
Ruamāhanga	T26/0538	B (high)	4	Unsafe for aquatic life (>2.4)	7.867
Wairarapa Coast	T27/0063	Unknown	3	Within guideline (≤2.4)	0.911

## Detection of *E. coli* bacteria

Table A5: *E. coli* bacteria results benchmarked against Drinking Water Standards New Zealand guidelines.

Whaitua	Site code	Connectivity	No. samples	DWSNZ MAV	No. $\geq 1$ cfu/100ml	Max cfu/100ml
Kāpiti Coast	R25/5100	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5165	B (high)	4	Detected ( $\geq 1$ )	1	1.0
Kāpiti Coast	R25/5190	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5233	A (direct)	4	Detected ( $\geq 1$ )	2	1.0
Kāpiti Coast	R26/6587	A (direct)	4	Detected ( $\geq 1$ )	1	1.0
Kāpiti Coast	R26/6624	B (high)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/1137	B (high)	3	Detected ( $\geq 1$ )	1	24.0
Te Whanganui-a-Tara	R27/1171	B (high)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/1180	B (high)	3	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/1183	B (high)	3	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/6418	Unknown	4	Detected ( $\geq 1$ )	2	44.0
Te Whanganui-a-Tara	R27/6833	Unknown	3	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5125	A (direct)	4	Detected ( $\geq 1$ )	1	1.0
Kāpiti Coast	S25/5200	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5256	B (high)	4	Detected ( $\geq 1$ )	1	1.0
Kāpiti Coast	S25/5322	B (high)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0117	A (direct)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0223	B (high)	4	Detected ( $\geq 1$ )	1	29.0
Ruamāhanga	S26/0299	B (high)	4	Detected ( $\geq 1$ )	1	1.0
Ruamāhanga	S26/0439	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0457	A (direct)	4	Detected ( $\geq 1$ )	1	1.0
Ruamāhanga	S26/0467	A (direct)	4	Detected ( $\geq 1$ )	1	2.0
Ruamāhanga	S26/0705	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0762	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0009	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0070	B (high)	3	Detected ( $\geq 1$ )	1	1.0
Ruamāhanga	S27/0136	B (high)	4	Detected ( $\geq 1$ )	1	33.0
Ruamāhanga	S27/0156	B (high)	4	Detected ( $\geq 1$ )	2	1.0
Ruamāhanga	S27/0202	B (high)	4	Detected ( $\geq 1$ )	2	3.0
Ruamāhanga	S27/0299	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0344	A (direct)	2	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0389	C (moderate to low)	3	Detected ( $\geq 1$ )	1	1.0
Ruamāhanga	S27/0396	A (direct)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0522	C (moderate to low)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0571	C (moderate to low)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0588	A (direct)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0681	A (direct)	3	Detected ( $\geq 1$ )	1	2.0
Ruamāhanga	T26/0003	B (high)	3	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0087	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0099	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0206	C (moderate to low)	4	Not detected (<1)	0	<1.0

<b>Whaitua</b>	<b>Site code</b>	<b>Connectivity</b>	<b>No. samples</b>	<b>DWSNZ MAV</b>	<b>No. <math>\geq 1</math> cfu/100ml</b>	<b>Max cfu/100ml</b>
Ruamāhanga	T26/0259	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0332	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0413	C (moderate to low)	4	Detected ( $\geq 1$ )	1	5.0
Ruamāhanga	T26/0430	B (high)	4	Detected ( $\geq 1$ )	3	4.0
Ruamāhanga	T26/0489	Unknown	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0538	B (high)	4	Not detected (<1)	0	<1.0
Wairarapa Coast	T27/0063	Unknown	3	Not detected (<1)	0	<1.0



## Saline intrusion

Monthly average saline intrusion results for four Te Whanganui-a-Tara groundwater bores.

Table A6: Shallow groundwater bore R27-0122, the warning threshold is 250  $\mu\text{S}/\text{cm}$ .

Month	Mean conductivity ( $\mu\text{S}/\text{cm}$ )	# warning exceedances
2019-07	190.9	0
2019-08	188.8	0
2019-09	190.6	0
2019-10	194.5	0
2019-11	196.3	0
2019-12	196.8	0
2020-01	207.4	0
2020-02	194.4	0
2020-03	186.3	0
2020-04	193.6	0
2020-05	194.3	0
2020-06	191.0	0

Table A7: Deep groundwater bore R27-7153, the warning threshold is 250  $\mu\text{S}/\text{cm}$ .

Month	Mean conductivity ( $\mu\text{S}/\text{cm}$ )	# warning exceedances
2019-07	256.2	31
2019-08	254.4	31
2019-09	252.7	29
2019-10	254.8	27
2019-11	246.8	20
2019-12	219.7	0
2020-01	222.6	0
2020-02	218.7	0
2020-03	220.1	0
2020-04	217.4	0
2020-05	215.8	0
2020-06	215.0	0

Table A8: Shallow groundwater bore R27-7154, the warning threshold is 200  $\mu\text{S}/\text{cm}$ .

Month	Mean conductivity ( $\mu\text{S}/\text{cm}$ )	# warning exceedances
2019-07	159.0	0
2019-08	158.1	0
2020-03	90.0	0
2020-04	73.5	0
2020-05	126.8	0
2020-06	150.9	0

Table A9: Deep groundwater bore R27-7215, the warning threshold is 200  $\mu\text{S}/\text{cm}$ .

<b>Month</b>	<b>Mean conductivity (<math>\mu\text{S}/\text{cm}</math>)</b>	<b># warning exceedances</b>
2019-07	151.0	0
2019-08	149.6	0
2019-09	151.0	0
2019-10	151.0	0
2019-11	157.3	0
2019-12	171.9	0
2020-01	172.0	0
2020-02	171.5	0
2020-03	170.0	0
2020-04	201.6	16
2020-05	170.8	0
2020-06	168.1	0