

2020/21 Groundwater quality monitoring



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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.

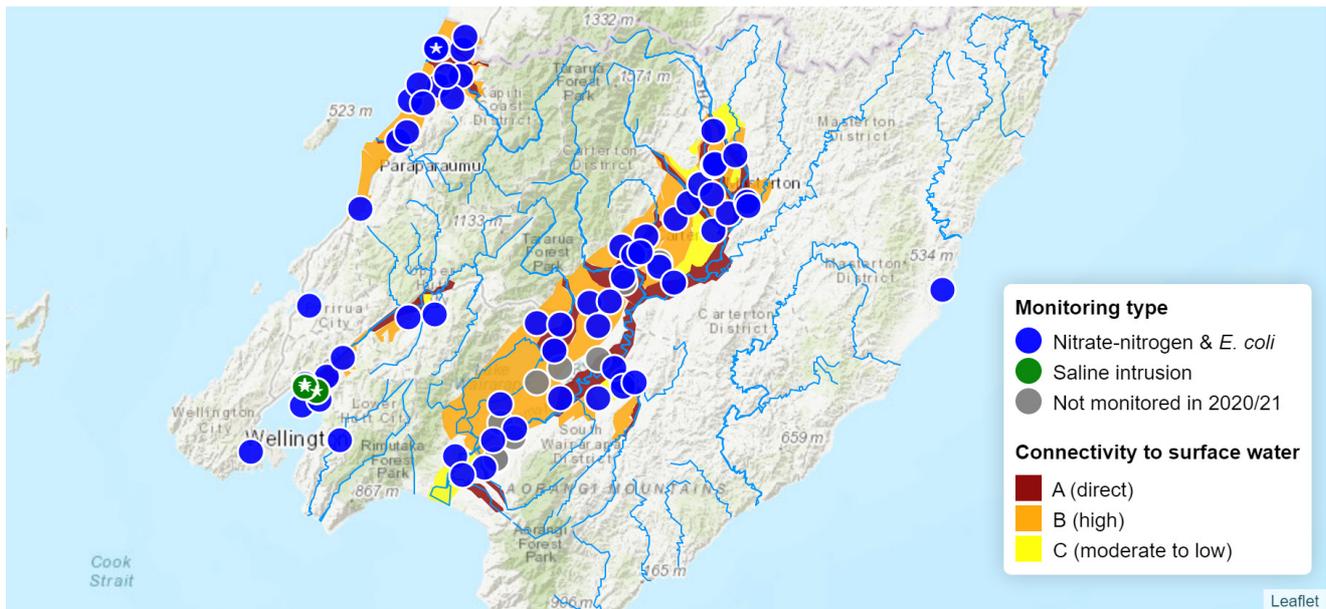
To assist with the sustainable management of groundwater resources in the Wellington region, Greater Wellington Regional Council (Greater Wellington) conducts regular monitoring of groundwater quality at 78 sites across the region, shown on the map below. Three key indicators of groundwater contamination (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.

Monitoring network

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

- Ruamāhanga - 47 (10 of which are not included in this report due to 3-yearly sampling).
- Kāpiti Coast - 15.
- Te Whanganui-a-Tara (Wellington and Hutt Valley) - 14.
- Wairarapa Coast - 1.
- Te Awarua-o-Porirua - 1.



[Leaflet](#)

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 ₃ - I (Modified) 22nd Ed. 2012	0.001 mg/L
Nitrite nitrogen	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ - 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.

Sampling notes

During the 2020/21 monitoring period, six wells were only sampled two or three times. Brief explanations on missed samples are listed below:

- R27/1182: December 2020 due to temporary restricted access.
- R27/1180: September 2020 due to an electrical fault.
- T26/0322: September and December 2020 and March 2021 due to the sample point being removed.
- R27/1265: March 2021 due to insufficient artesian pressure to sample the bore and no backup power.
- S25/5125: June 2021 due to the bore being dry.
- S27/0389: June 2021 due to the pump failure.

Changes to Groundwater Quality State of the Environment (GQSoE) network monitoring frequency:

- The following ten confined bores have been reduced to annual sampling as they have not shown seasonal variation or significant trends over an extended period: R25/5100, S25/5200, R25/5135, S26/0568, S27/0495, S27/0435, S27/0442, S27/0607, S27/0588, S27/0594.
- An additional ten confined bores have been reduced to three-yearly sampling as; they have not shown seasonal variation, long term monitoring indicates that water quality at these bores is similar to annual/quarterly sites, and age dating suggests groundwater at these bores have mean residence times greater than 100 years: S27/0585, S27/0615, BQ33/0032, S27/0602, S27/0268, S27/0283, S27/0344, S26/0576, S27/0433, S26/0705.
- The following bores have been officially removed from the GQSoE network due to loss of access: Removed 2018/19 - R25/5164, S26/0756, S27/0846, S27/0614. S26/0824 was decommissioned and replaced with BP34/0216 in December 2019.

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

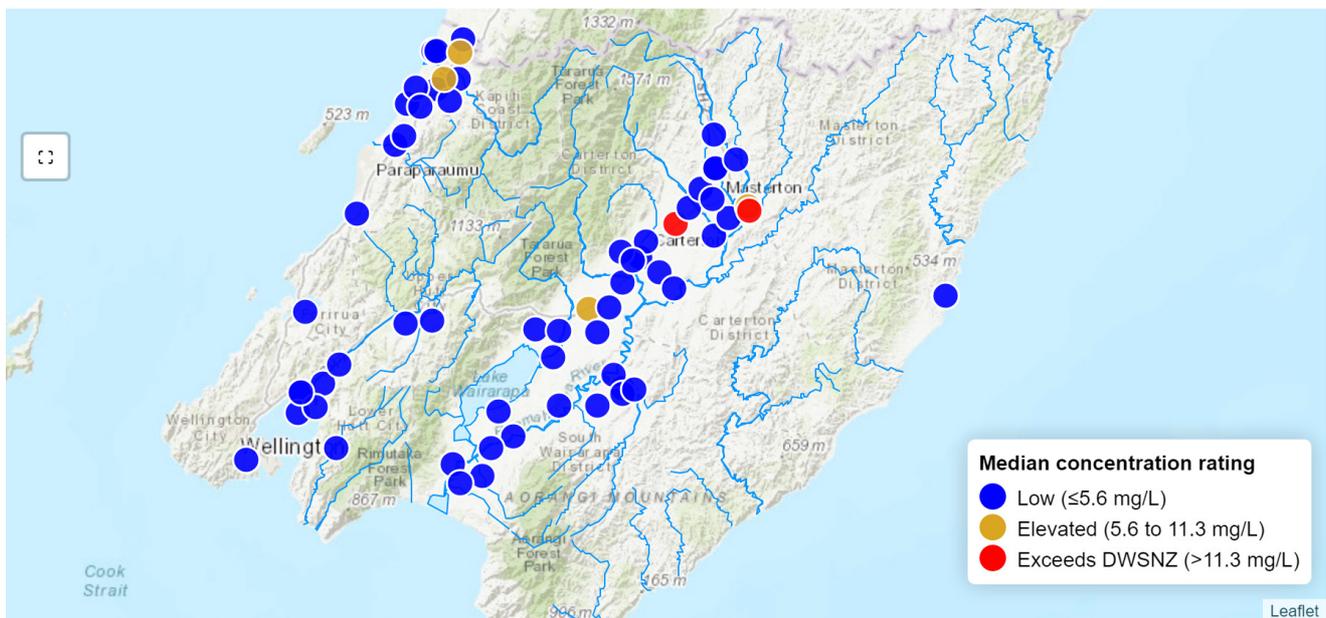


Figure 2: Groundwater nitrate-nitrogen concentrations are evaluated in terms of likely human influence, as excess concentrations can have negative health effects. Bores with annual median concentrations above the [Drinking Water Standard New Zealand \(DWSNZ\)](#) Maximum Acceptable Value (MAV) of 11.3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

Ecosystem health

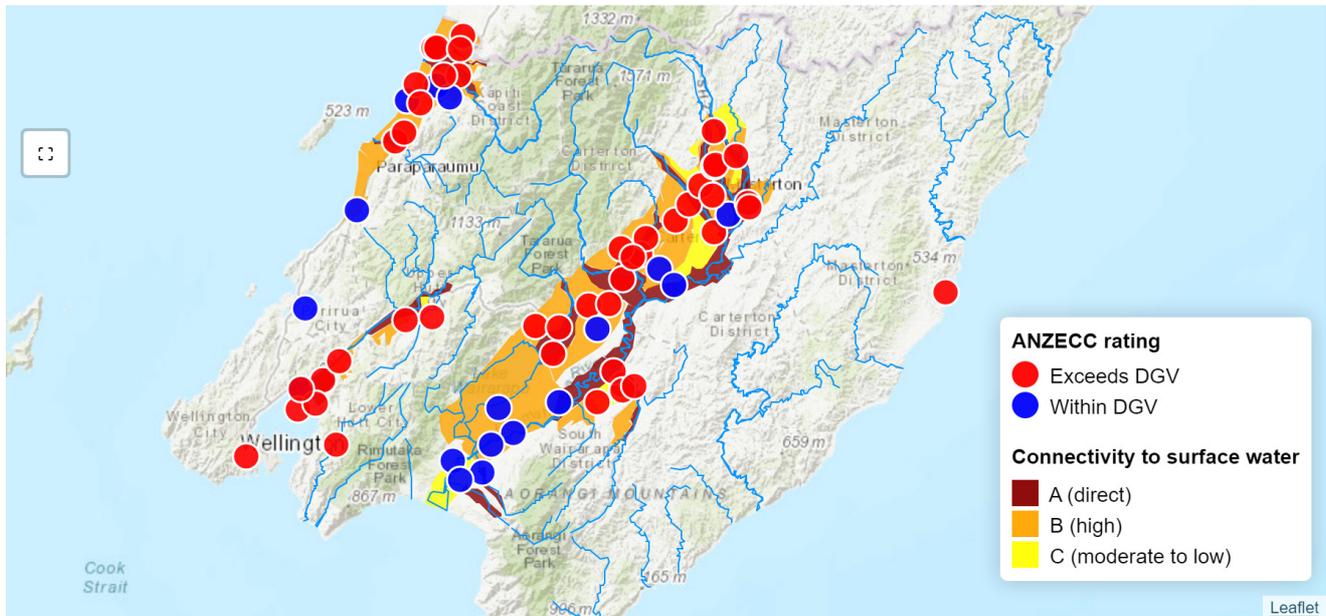


Figure 3: Groundwater discharges from aquifers into a number of surface water bodies throughout the region and there is the potential that groundwater high in nitrate-nitrogen could contribute to the decline of surface water quality. The [2000 Australia New Zealand Guidelines for Fresh and Marine Water 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

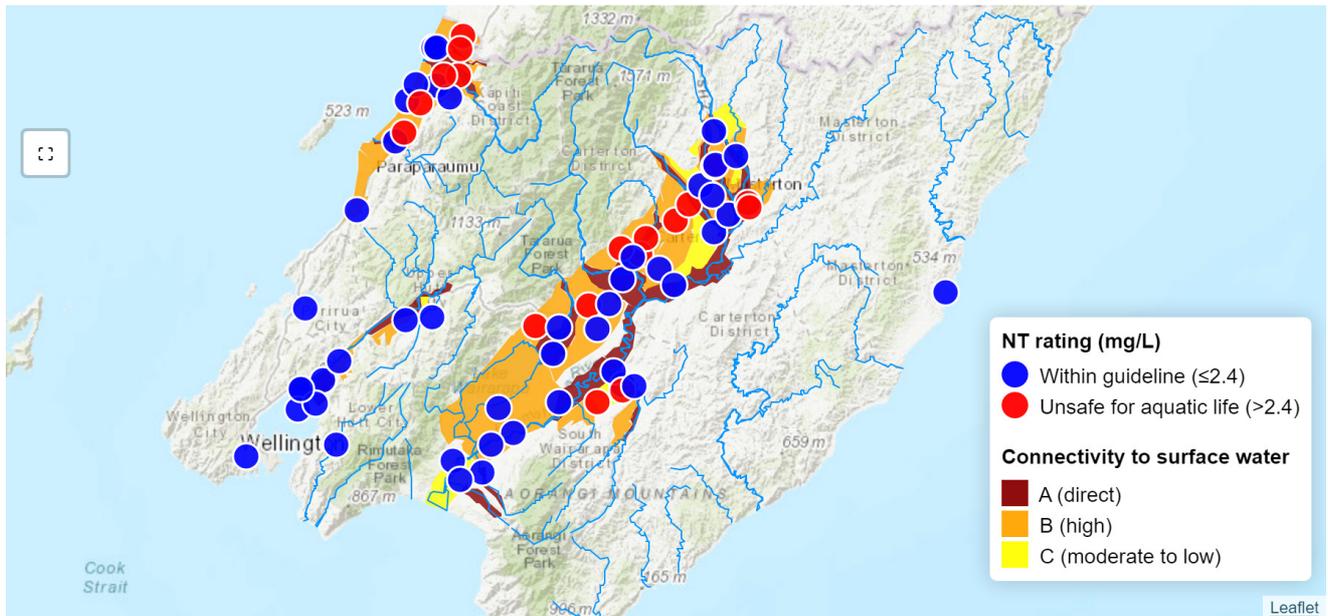


Figure 4: The [National Policy Statement on Freshwater Management \(NPS-FM\)](#) requires regional councils to identify water quality limits to manage values of our aquatic ecosystems. The nitrate toxicity (NT) threshold is calculated at 2.4 mg/L for annual median nitrate-nitrogen concentrations. This 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

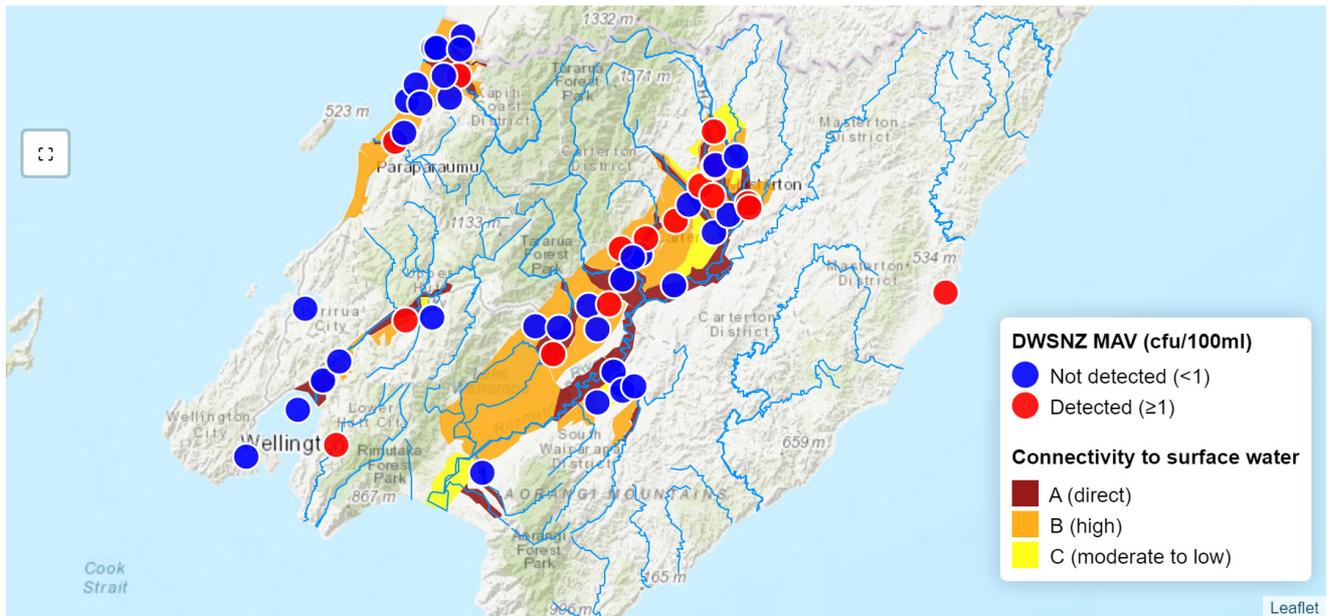


Figure 5: The [Drinking Water Standard New Zealand \(DWSNZ\)](#) uses *E. coli* as an indicator of faecal contamination in drinking water. For drinking water supplies, *E. coli* counts should be below the Maximum Acceptable Value (MAV) of <1 cfu/100 ml. Groundwater within Connectivity Category A (direct) 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.

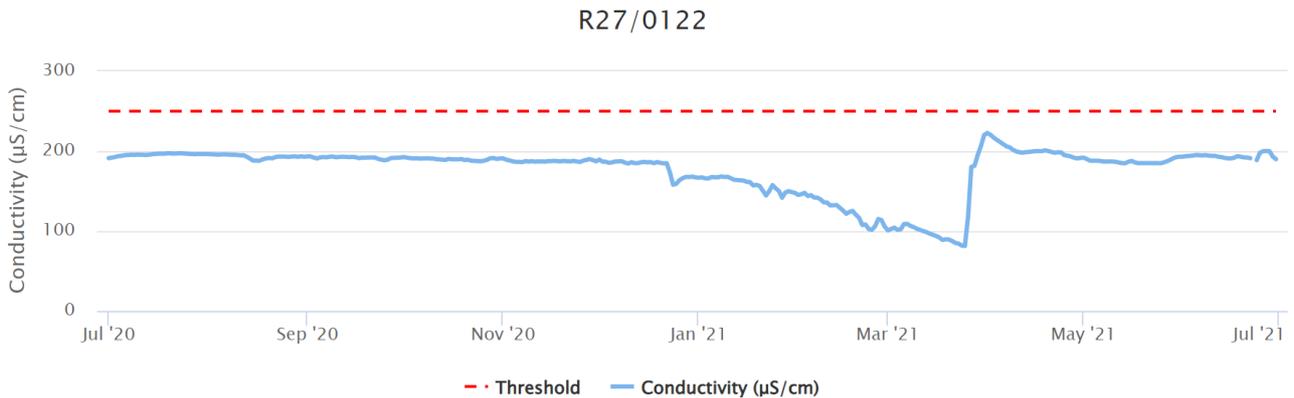


Figure 6: Saline intrusion results for Te Whanganui-a-Tara shallow groundwater bore R27-0122, the warning threshold is 250 $\mu\text{S}/\text{cm}$.

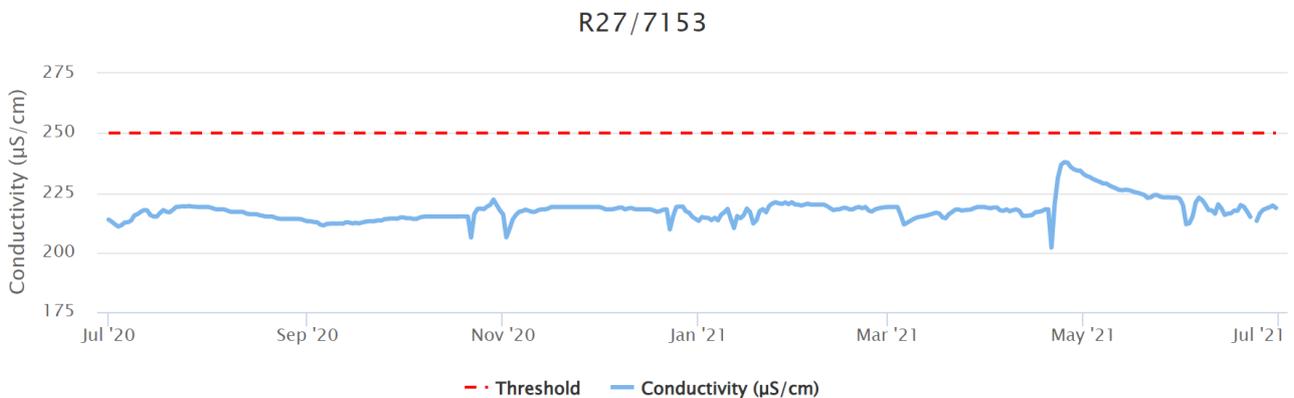


Figure 7: Saline intrusion results for Te Whanganui-a-Tara deep groundwater bore R27-7153, the warning threshold is 250 $\mu\text{S}/\text{cm}$.



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

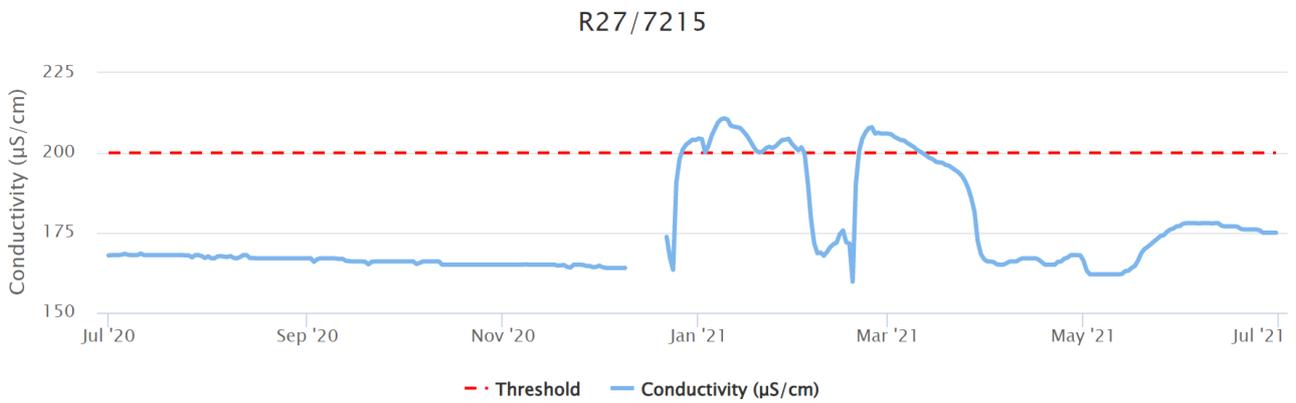


Figure 9: Saline intrusion results for Te Whanganui-a-Tara deep groundwater bore R27-7215, the warning threshold is 200 µS/cm.

Resources

Access to monitoring data

Full monitoring data for the 2020/21 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.

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

Whaitua	Site code	Monitoring frequency	Groundwater connectivity	Depth
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
Kāpiti Coast	BN33/0032	quarterly	B (high)	12.0m
Kāpiti Coast	BN32/0063	quarterly	B (high)	30.0m
Kāpiti Coast	BN32/0062	quarterly	B (high)	5.0m
Ruamāhanga	BP34/0216	quarterly	B (high)	17.7m
Te Whanganui-a-Tara	BQ31/0047	annual	Unknown	48.0m
Te Awarua-o-Porirua	BP32/0103	annual	Unknown	49.0m

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)
Kāpiti Coast	BN32/0062	2	Low (≤5.6 mg/L)	1.592
Kāpiti Coast	BN32/0063	2	Low (≤5.6 mg/L)	0.810
Kāpiti Coast	BN33/0032	3	Low (≤5.6 mg/L)	3.303
Te Awarua-o-Porirua	BP32/0103	1	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	BP34/0216	4	Low (≤5.6 mg/L)	4.768
Te Whanganui-a-Tara	BQ31/0047	1	Low (≤5.6 mg/L)	0.892
Kāpiti Coast	R25/5100	1	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	R25/5135	1	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	R25/5165	4	Low (≤5.6 mg/L)	0.592
Kāpiti Coast	R25/5190	4	Low (≤5.6 mg/L)	3.197
Kāpiti Coast	R25/5233	3	Low (≤5.6 mg/L)	1.547
Kāpiti Coast	R26/6503	4	Low (≤5.6 mg/L)	0.004
Kāpiti Coast	R26/6587	4	Low (≤5.6 mg/L)	0.625
Kāpiti Coast	R26/6624	4	Low (≤5.6 mg/L)	2.651
Te Whanganui-a-Tara	R27/0320	4	Low (≤5.6 mg/L)	<0.002
Te Whanganui-a-Tara	R27/1137	4	Low (≤5.6 mg/L)	1.537
Te Whanganui-a-Tara	R27/1171	4	Low (≤5.6 mg/L)	0.016
Te Whanganui-a-Tara	R27/1180	3	Low (≤5.6 mg/L)	0.816
Te Whanganui-a-Tara	R27/1182	3	Low (≤5.6 mg/L)	0.666
Te Whanganui-a-Tara	R27/1183	4	Low (≤5.6 mg/L)	0.274
Te Whanganui-a-Tara	R27/1265	3	Low (≤5.6 mg/L)	0.111
Te Whanganui-a-Tara	R27/6418	4	Low (≤5.6 mg/L)	1.564
Te Whanganui-a-Tara	R27/6833	4	Low (≤5.6 mg/L)	1.063
Kāpiti Coast	S25/5125	3	Low (≤5.6 mg/L)	3.261
Kāpiti Coast	S25/5200	1	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	S25/5256	4	Elevated (5.6 to 11.3 mg/L)	7.183
Kāpiti Coast	S25/5322	4	Elevated (5.6 to 11.3 mg/L)	8.844
Ruamāhanga	S26/0117	4	Low (≤5.6 mg/L)	4.663
Ruamāhanga	S26/0223	4	Exceeds DWSNZ (>11.3 mg/L)	11.930
Ruamāhanga	S26/0299	4	Low (≤5.6 mg/L)	2.813
Ruamāhanga	S26/0439	4	Low (≤5.6 mg/L)	3.196
Ruamāhanga	S26/0457	3	Low (≤5.6 mg/L)	0.401
Ruamāhanga	S26/0467	4	Low (≤5.6 mg/L)	2.187
Ruamāhanga	S26/0568	1	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S26/0762	4	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0009	3	Low (≤5.6 mg/L)	4.189

Whaitua	Site code	No. samples	Concentration rating	Median (mg/L)
Ruamāhanga	S27/0070	3	Low (≤ 5.6 mg/L)	0.186
Ruamāhanga	S27/0136	3	Elevated (5.6 to 11.3 mg/L)	5.611
Ruamāhanga	S27/0156	3	Low (≤ 5.6 mg/L)	0.011
Ruamāhanga	S27/0202	4	Low (≤ 5.6 mg/L)	2.235
Ruamāhanga	S27/0299	4	Low (≤ 5.6 mg/L)	0.390
Ruamāhanga	S27/0389	3	Low (≤ 5.6 mg/L)	0.004
Ruamāhanga	S27/0396	4	Low (≤ 5.6 mg/L)	0.234
Ruamāhanga	S27/0435	1	Low (≤ 5.6 mg/L)	<0.002
Ruamāhanga	S27/0442	1	Low (≤ 5.6 mg/L)	<0.002
Ruamāhanga	S27/0495	1	Low (≤ 5.6 mg/L)	0.010
Ruamāhanga	S27/0522	4	Low (≤ 5.6 mg/L)	3.197
Ruamāhanga	S27/0571	4	Low (≤ 5.6 mg/L)	4.572
Ruamāhanga	S27/0585	4	Low (≤ 5.6 mg/L)	<0.002
Ruamāhanga	S27/0588	1	Low (≤ 5.6 mg/L)	<0.002
Ruamāhanga	S27/0594	1	Low (≤ 5.6 mg/L)	<0.002
Ruamāhanga	S27/0607	1	Low (≤ 5.6 mg/L)	0.010
Ruamāhanga	S27/0681	4	Low (≤ 5.6 mg/L)	0.290
Ruamāhanga	T26/0003	4	Low (≤ 5.6 mg/L)	1.226
Ruamāhanga	T26/0087	4	Low (≤ 5.6 mg/L)	1.221
Ruamāhanga	T26/0099	4	Low (≤ 5.6 mg/L)	2.712
Ruamāhanga	T26/0206	4	Low (≤ 5.6 mg/L)	1.839
Ruamāhanga	T26/0259	4	Low (≤ 5.6 mg/L)	1.041
Ruamāhanga	T26/0332	1	Low (≤ 5.6 mg/L)	0.276
Ruamāhanga	T26/0413	4	Low (≤ 5.6 mg/L)	<0.002
Ruamāhanga	T26/0430	4	Low (≤ 5.6 mg/L)	1.584
Ruamāhanga	T26/0489	4	Elevated (5.6 to 11.3 mg/L)	9.187
Ruamāhanga	T26/0538	4	Exceeds DWSNZ (>11.3 mg/L)	14.313
Wairarapa Coast	T27/0063	4	Low (≤ 5.6 mg/L)	0.655

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

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Kāpiti Coast	BN32/0062	B (high)	2	Exceeds DGV	0.195	2.155
Kāpiti Coast	BN32/0063	B (high)	2	Exceeds DGV	0.195	0.833
Kāpiti Coast	BN33/0032	B (high)	3	Exceeds DGV	0.195	3.893
Te Awarua-o-Porirua	BP32/0103	Unknown	1	Within DGV	0.195	<0.002
Ruamāhanga	BP34/0216	B (high)	4	Exceeds DGV	0.195	5.001
Te Whanganui-a-Tara	BQ31/0047	Unknown	1	Exceeds DGV	0.195	0.892
Kāpiti Coast	R25/5100	B (high)	1	Within DGV	0.195	<0.002
Kāpiti Coast	R25/5135	B (high)	1	Within DGV	0.195	<0.002
Kāpiti Coast	R25/5165	B (high)	4	Exceeds DGV	0.195	0.937
Kāpiti Coast	R25/5190	B (high)	4	Exceeds DGV	0.195	3.456
Kāpiti Coast	R25/5233	A (direct)	3	Exceeds DGV	0.195	1.691
Kāpiti Coast	R26/6503	B (high)	4	Within DGV	0.065	0.005
Kāpiti Coast	R26/6587	A (direct)	4	Exceeds DGV	0.195	0.704
Kāpiti Coast	R26/6624	B (high)	4	Exceeds DGV	0.065	2.718

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Te Whanganui-a-Tara	R27/0320	B (high)	4	Within DGV	0.065	<0.002
Te Whanganui-a-Tara	R27/1137	B (high)	4	Exceeds DGV	0.065	1.714
Te Whanganui-a-Tara	R27/1171	B (high)	4	Exceeds DGV	0.065	0.171
Te Whanganui-a-Tara	R27/1180	B (high)	3	Exceeds DGV	0.065	0.869
Te Whanganui-a-Tara	R27/1182	B (high)	3	Exceeds DGV	0.065	0.677
Te Whanganui-a-Tara	R27/1183	B (high)	4	Exceeds DGV	0.065	0.300
Te Whanganui-a-Tara	R27/1265	B (high)	3	Exceeds DGV	0.065	0.112
Te Whanganui-a-Tara	R27/6418	Unknown	4	Exceeds DGV	0.170	2.143
Te Whanganui-a-Tara	R27/6833	Unknown	4	Exceeds DGV	0.170	1.336
Kāpiti Coast	S25/5125	A (direct)	3	Exceeds DGV	0.195	3.935
Kāpiti Coast	S25/5200	B (high)	1	Within DGV	0.170	<0.002
Kāpiti Coast	S25/5256	B (high)	4	Exceeds DGV	0.195	7.325
Kāpiti Coast	S25/5322	B (high)	4	Exceeds DGV	0.195	8.880
Ruamāhanga	S26/0117	A (direct)	4	Exceeds DGV	0.170	5.642
Ruamāhanga	S26/0223	B (high)	4	Exceeds DGV	0.195	13.019
Ruamāhanga	S26/0299	B (high)	4	Exceeds DGV	0.195	3.697
Ruamāhanga	S26/0439	C (moderate to low)	4	Exceeds DGV	0.065	3.310
Ruamāhanga	S26/0457	A (direct)	3	Exceeds DGV	0.195	0.526
Ruamāhanga	S26/0467	A (direct)	4	Exceeds DGV	0.195	2.487
Ruamāhanga	S26/0568	B (high)	1	Within DGV	0.195	<0.002
Ruamāhanga	S26/0762	A (direct)	4	Within DGV	0.195	0.005
Ruamāhanga	S27/0009	B (high)	3	Exceeds DGV	0.065	4.208
Ruamāhanga	S27/0070	B (high)	3	Exceeds DGV	0.195	0.444
Ruamāhanga	S27/0136	B (high)	3	Exceeds DGV	0.195	6.028
Ruamāhanga	S27/0156	B (high)	3	Within DGV	0.195	0.018
Ruamāhanga	S27/0202	B (high)	4	Exceeds DGV	0.195	2.596
Ruamāhanga	S27/0299	A (direct)	4	Exceeds DGV	0.195	0.405
Ruamāhanga	S27/0389	C (moderate to low)	3	Exceeds DGV	0.195	0.300
Ruamāhanga	S27/0396	A (direct)	4	Exceeds DGV	0.170	0.541
Ruamāhanga	S27/0435	C (moderate to low)	1	Within DGV	0.195	<0.002
Ruamāhanga	S27/0442	C (moderate to low)	1	Within DGV	0.170	<0.002
Ruamāhanga	S27/0495	C (moderate to low)	1	Within DGV	0.195	0.010
Ruamāhanga	S27/0522	C (moderate to low)	4	Exceeds DGV	0.195	3.307
Ruamāhanga	S27/0571	C (moderate to low)	4	Exceeds DGV	0.195	4.749
Ruamāhanga	S27/0585	C (moderate to low)	4	Within DGV	0.195	<0.002
Ruamāhanga	S27/0588	A (direct)	1	Within DGV	0.087	<0.002
Ruamāhanga	S27/0594	C (moderate to low)	1	Within DGV	0.195	<0.002
Ruamāhanga	S27/0607	C (moderate to low)	1	Within DGV	0.195	0.010
Ruamāhanga	S27/0681	A (direct)	4	Exceeds DGV	0.265	0.575
Ruamāhanga	T26/0003	B (high)	4	Exceeds DGV	0.265	3.040
Ruamāhanga	T26/0087	C (moderate to low)	4	Exceeds DGV	0.195	2.087
Ruamāhanga	T26/0099	B (high)	4	Exceeds DGV	0.195	2.816
Ruamāhanga	T26/0206	C (moderate to low)	4	Exceeds DGV	0.195	2.127
Ruamāhanga	T26/0259	A (direct)	4	Exceeds DGV	0.265	1.524
Ruamāhanga	T26/0332	C (moderate to low)	1	Exceeds DGV	0.195	0.276
Ruamāhanga	T26/0413	C (moderate to low)	4	Within DGV	0.195	<0.002
Ruamāhanga	T26/0430	B (high)	4	Exceeds DGV	0.195	2.539

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Ruamāhanga	T26/0489	Unknown	4	Exceeds DGV	0.195	9.442
Ruamāhanga	T26/0538	B (high)	4	Exceeds DGV	0.195	15.044
Wairarapa Coast	T27/0063	Unknown	4	Exceeds DGV	0.195	0.728

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

Whaitua	Site code	Connectivity	No. samples	NT rating	Median (mg/L)
Kāpiti Coast	BN32/0062	B (high)	2	Within guideline (≤ 2.4)	1.592
Kāpiti Coast	BN32/0063	B (high)	2	Within guideline (≤ 2.4)	0.810
Kāpiti Coast	BN33/0032	B (high)	3	Unsafe for aquatic life (> 2.4)	3.303
Te Awarua-o-Porirua	BP32/0103	Unknown	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	BP34/0216	B (high)	4	Unsafe for aquatic life (> 2.4)	4.768
Te Whanganui-a-Tara	BQ31/0047	Unknown	1	Within guideline (≤ 2.4)	0.892
Kāpiti Coast	R25/5100	B (high)	1	Within guideline (≤ 2.4)	<0.002
Kāpiti Coast	R25/5135	B (high)	1	Within guideline (≤ 2.4)	<0.002
Kāpiti Coast	R25/5165	B (high)	4	Within guideline (≤ 2.4)	0.592
Kāpiti Coast	R25/5190	B (high)	4	Unsafe for aquatic life (> 2.4)	3.197
Kāpiti Coast	R25/5233	A (direct)	3	Within guideline (≤ 2.4)	1.547
Kāpiti Coast	R26/6503	B (high)	4	Within guideline (≤ 2.4)	0.004
Kāpiti Coast	R26/6587	A (direct)	4	Within guideline (≤ 2.4)	0.625
Kāpiti Coast	R26/6624	B (high)	4	Unsafe for aquatic life (> 2.4)	2.651
Te Whanganui-a-Tara	R27/0320	B (high)	4	Within guideline (≤ 2.4)	<0.002
Te Whanganui-a-Tara	R27/1137	B (high)	4	Within guideline (≤ 2.4)	1.537
Te Whanganui-a-Tara	R27/1171	B (high)	4	Within guideline (≤ 2.4)	0.016
Te Whanganui-a-Tara	R27/1180	B (high)	3	Within guideline (≤ 2.4)	0.816
Te Whanganui-a-Tara	R27/1182	B (high)	3	Within guideline (≤ 2.4)	0.666
Te Whanganui-a-Tara	R27/1183	B (high)	4	Within guideline (≤ 2.4)	0.274
Te Whanganui-a-Tara	R27/1265	B (high)	3	Within guideline (≤ 2.4)	0.111
Te Whanganui-a-Tara	R27/6418	Unknown	4	Within guideline (≤ 2.4)	1.564
Te Whanganui-a-Tara	R27/6833	Unknown	4	Within guideline (≤ 2.4)	1.063
Kāpiti Coast	S25/5125	A (direct)	3	Unsafe for aquatic life (> 2.4)	3.261
Kāpiti Coast	S25/5200	B (high)	1	Within guideline (≤ 2.4)	<0.002
Kāpiti Coast	S25/5256	B (high)	4	Unsafe for aquatic life (> 2.4)	7.183
Kāpiti Coast	S25/5322	B (high)	4	Unsafe for aquatic life (> 2.4)	8.844
Ruamāhanga	S26/0117	A (direct)	4	Unsafe for aquatic life (> 2.4)	4.663
Ruamāhanga	S26/0223	B (high)	4	Unsafe for aquatic life (> 2.4)	11.930
Ruamāhanga	S26/0299	B (high)	4	Unsafe for aquatic life (> 2.4)	2.813
Ruamāhanga	S26/0439	C (moderate to low)	4	Unsafe for aquatic life (> 2.4)	3.196
Ruamāhanga	S26/0457	A (direct)	3	Within guideline (≤ 2.4)	0.401
Ruamāhanga	S26/0467	A (direct)	4	Within guideline (≤ 2.4)	2.187
Ruamāhanga	S26/0568	B (high)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S26/0762	A (direct)	4	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0009	B (high)	3	Unsafe for aquatic life (> 2.4)	4.189
Ruamāhanga	S27/0070	B (high)	3	Within guideline (≤ 2.4)	0.186
Ruamāhanga	S27/0136	B (high)	3	Unsafe for aquatic life (> 2.4)	5.611
Ruamāhanga	S27/0156	B (high)	3	Within guideline (≤ 2.4)	0.011

Whaitua	Site code	Connectivity	No. samples	NT rating	Median (mg/L)
Ruamāhanga	S27/0202	B (high)	4	Within guideline (≤ 2.4)	2.235
Ruamāhanga	S27/0299	A (direct)	4	Within guideline (≤ 2.4)	0.390
Ruamāhanga	S27/0389	C (moderate to low)	3	Within guideline (≤ 2.4)	0.004
Ruamāhanga	S27/0396	A (direct)	4	Within guideline (≤ 2.4)	0.234
Ruamāhanga	S27/0435	C (moderate to low)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0442	C (moderate to low)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0495	C (moderate to low)	1	Within guideline (≤ 2.4)	0.010
Ruamāhanga	S27/0522	C (moderate to low)	4	Unsafe for aquatic life (> 2.4)	3.197
Ruamāhanga	S27/0571	C (moderate to low)	4	Unsafe for aquatic life (> 2.4)	4.572
Ruamāhanga	S27/0585	C (moderate to low)	4	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0588	A (direct)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0594	C (moderate to low)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0607	C (moderate to low)	1	Within guideline (≤ 2.4)	0.010
Ruamāhanga	S27/0681	A (direct)	4	Within guideline (≤ 2.4)	0.290
Ruamāhanga	T26/0003	B (high)	4	Within guideline (≤ 2.4)	1.226
Ruamāhanga	T26/0087	C (moderate to low)	4	Within guideline (≤ 2.4)	1.221
Ruamāhanga	T26/0099	B (high)	4	Unsafe for aquatic life (> 2.4)	2.712
Ruamāhanga	T26/0206	C (moderate to low)	4	Within guideline (≤ 2.4)	1.839
Ruamāhanga	T26/0259	A (direct)	4	Within guideline (≤ 2.4)	1.041
Ruamāhanga	T26/0332	C (moderate to low)	1	Within guideline (≤ 2.4)	0.276
Ruamāhanga	T26/0413	C (moderate to low)	4	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	T26/0430	B (high)	4	Within guideline (≤ 2.4)	1.584
Ruamāhanga	T26/0489	Unknown	4	Unsafe for aquatic life (> 2.4)	9.187
Ruamāhanga	T26/0538	B (high)	4	Unsafe for aquatic life (> 2.4)	14.313
Wairarapa Coast	T27/0063	Unknown	4	Within guideline (≤ 2.4)	0.655

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. ≥ 1 cfu/100ml	Max cfu/100ml
Kāpiti Coast	BN32/0062	B (high)	2	Not detected (<1)	0	<1.0
Kāpiti Coast	BN32/0063	B (high)	2	Not detected (<1)	0	<1.0
Kāpiti Coast	BN33/0032	B (high)	3	Not detected (<1)	0	<1.0
Te Awarua-o-Porirua	BP32/0103	Unknown	1	Not detected (<1)	0	<1.0
Ruamāhanga	BP34/0216	B (high)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	BQ31/0047	Unknown	1	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5100	B (high)	1	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5165	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5190	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5233	A (direct)	3	Not detected (<1)	0	<1.0
Kāpiti Coast	R26/6587	A (direct)	4	Detected (≥ 1)	1	2.0
Kāpiti Coast	R26/6624	B (high)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/1137	B (high)	4	Detected (≥ 1)	2	3.0
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)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/6418	Unknown	4	Detected (≥ 1)	2	19.0
Te Whanganui-a-Tara	R27/6833	Unknown	4	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5125	A (direct)	3	Detected (≥ 1)	3	170.0
Kāpiti Coast	S25/5200	B (high)	1	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5256	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5322	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0117	A (direct)	4	Detected (≥ 1)	1	20.0
Ruamāhanga	S26/0223	B (high)	4	Detected (≥ 1)	4	130.0
Ruamāhanga	S26/0299	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0439	C (moderate to low)	4	Detected (≥ 1)	1	2.0
Ruamāhanga	S26/0457	A (direct)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0467	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0762	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0009	B (high)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0070	B (high)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0136	B (high)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0156	B (high)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0202	B (high)	4	Detected (≥ 1)	2	9.0
Ruamāhanga	S27/0299	A (direct)	4	Detected (≥ 1)	1	1.0
Ruamāhanga	S27/0389	C (moderate to low)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0396	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0522	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0571	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0588	A (direct)	1	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0681	A (direct)	4	Not detected (<1)	0	<1.0

Whaitua	Site code	Connectivity	No. samples	DWSNZ MAV	No. ≥ 1 cfu/100ml	Max cfu/100ml
Ruamāhanga	T26/0003	B (high)	4	Detected (≥ 1)	1	3.0
Ruamāhanga	T26/0087	C (moderate to low)	4	Detected (≥ 1)	1	5.0
Ruamāhanga	T26/0099	B (high)	4	Detected (≥ 1)	1	1.0
Ruamāhanga	T26/0206	C (moderate to low)	4	Not detected (< 1)	0	< 1.0
Ruamāhanga	T26/0259	A (direct)	4	Not detected (< 1)	0	< 1.0
Ruamāhanga	T26/0332	C (moderate to low)	1	Not detected (< 1)	0	< 1.0
Ruamāhanga	T26/0413	C (moderate to low)	4	Not detected (< 1)	0	< 1.0
Ruamāhanga	T26/0430	B (high)	4	Detected (≥ 1)	2	2.0
Ruamāhanga	T26/0489	Unknown	4	Detected (≥ 1)	1	2.0
Ruamāhanga	T26/0538	B (high)	4	Detected (≥ 1)	2	2.0
Wairarapa Coast	T27/0063	Unknown	4	Detected (≥ 1)	2	90.0

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
2020-07	195.7	0
2020-08	193.2	0
2020-09	191.9	0
2020-10	190.0	0
2020-11	187.6	0
2020-12	180.1	0
2021-01	159.0	0
2021-02	126.5	0
2021-03	113.3	0
2021-04	201.7	0
2021-05	187.2	0
2021-06	193.8	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
2020-07	216.3	0
2020-08	215.9	0
2020-09	212.8	0
2020-10	215.7	0
2020-11	217.4	0
2020-12	217.5	0
2021-01	216.6	0
2021-02	218.9	0
2021-03	216.5	0
2021-04	221.7	0
2021-05	226.1	0
2021-06	217.6	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
2020-07	139.7	0
2020-08	144.4	0
2020-09	148.1	0
2020-10	150.6	0
2020-11	145.9	0
2020-12	129.5	0
2021-01	121.4	0
2021-02	125.7	0
2021-03	139.5	0
2021-04	143.9	0
2021-05	134.9	0
2021-06	133.0	0

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

Month	Mean conductivity ($\mu\text{S}/\text{cm}$)	# warning exceedances
2020-07	168.0	0
2020-08	167.2	0
2020-09	166.3	0
2020-10	165.3	0
2020-11	164.9	0
2020-12	178.1	5
2021-01	204.6	31
2021-02	186.7	11
2021-03	195.1	11
2021-04	166.3	0
2021-05	167.4	0
2021-06	176.8	0