Memorandum

Project Name	Taylorville Resource Park		
Memo Topic	Review of PDP (11-Oct-24) "Impacts of Taylorville Resource Park Limited Landfill on Grey District Council Coal Creek Water Supply Intake"		
Memo Date	6 November 2024	**Date of Site Visit**	
ENGEO Memo No.	03	**ENGEO Project No.**	26200.000.001
To	Ellen Taylor, TRPL	**Copy**	TRP Project Team
Author	Lyn Nugent	**Reviewer**	Dave Robotham

1 Introduction

ENGEO has undertaken a review of Pattle Delamore Partners Ltd (PDP, 11-Oct-24) *Impacts of Taylorville Resource Park Limited Landfill on Grey District Council Coal Creek Water Supply Intake*, prepared for the West Coast Regional Council (WCRC). As stated in the letter, WCRC engaged PDP to:

> *"…provide an expert opinion on the potential or actual effects of the current Taylorville Resource Park Limited (TRPL) landfill leachate management on groundwater, surface water and human drinking water sources including the Grey District Council (GDC) Coal Creek community water supply".*

In their letter, PDP references the following documents:

- EHS Support (Mar-24) *Assessment of Environmental Effects – Taylorville Resource Park – Discharge to Water;*
- EHS Support (26-Feb-24) *Taylorville Facility – Acceptance of Contaminated Soil;* and
- Appendix 5: Summary of Laboratory Analytical Results, ENGEO (2024) *Preliminary Hydrogeological Assessment – 287 Taylorville Road, Coal Creek, Greymouth.*

Based on their review, PDP concludes that:

> *"…it appears that there are signs of water quality impacts from landfill leachate at groundwater bores MB4d and TSB1, spring seeps TCD1, SP1, SP3, and downgradient drain samples TRD1 and likely TRD5".*

This finding is in general concurrence with the findings of ENGEO (2024); however, we note that PDP did not fully account for trace (background) levels in groundwater when evaluating concentrations from samples collected in Taylorville Road drain (TRD1–TRD5) that exceeded one or more of the assessment criteria (New Zealand Drinking Water Standards [NZDWS; MoH, 2018] and Guidelines for Fresh & Marine Water Quality [NZWQS; Commonwealth of Australia, 2024]).

Analytical results for samples collected in July 2024 from groundwater wells, springs, and TRD1–TRD5 are summarised in Table 1 along with the assessment criteria and trace levels (defined at the upgradient concentrations ± 20%). As shown in Table 1, most of the assessment criteria exceedances in samples collected from TRD1–TRD5 are below the trace (background) levels in groundwater. As discussed in ENGEO (2024), the Taylorville Road drain receives water from daylighting groundwater, creeks, and surface runoff from uphill of the site and along a 1 km length of Taylorville Road. As such, while the site operations may contribute to changes in water quality, the assessment criteria exceedances in the samples collected from locations in off-site locations cannot be definitively attributed to site operations and may be due to trace (background) groundwater quality, local land uses / activities (e.g., aerial spraying of agrichemicals), and / or road runoff (e.g., heavy metals from vehicle movements).

We note that this assessment has been based on a limited dataset. We are currently awaiting laboratory analytical results for samples collected in October 2024 and will provide an updated assessment upon receipt of these results.

We have reviewed the other key findings from the PDP letter (summarised in grey) and our responses below:

- Groundwater flow is not well constrained and additional bores are required to provide additional groundwater elevation measurement locations to accurately define groundwater flow.

As discussed, the PDP letter was prepared without full a review of the ENGEO (2024) report. The groundwater flow direction measured in July 2024 was discussed in Section 2.3 of that report.

A follow-up groundwater monitoring event was undertaken in October 2024. This included monitoring of eight additional wells (MB13–MB19s/d) that were installed following delivery of the ENGEO (2024) report. Based on depth to groundwater measurements collected from all fourteen on-site monitoring bores, the depth to groundwater ranged from 3.01 m (MB17) to 11.35 m (MB4d) below top of casing. The depth to groundwater was subtracted from the surveyed elevation at the top of the well casing to derive the elevation of the water table (in RL). Based on the calculated groundwater elevations, the general groundwater flow direction is towards the west-southwest with a gradient of 0.018 m/m. A preliminary figure showing groundwater contours is included as Figure 1. The final figure will be included in the upcoming ENGEO revised hydrogeological investigation report.

The October 2024 groundwater flow contours corroborate the flow direction derived from groundwater elevations derived in July 2024. This flow direction is further supported by the inferred slope (15˚ – 20˚ to the west-southwest) of the contact between the Pleistocene sandy gravel and the underlying Paleogene Kaiata Formation (Rapahoe Group) mudstone (refer Section 2.2, ENGEO [2024]).

As discussed in Section 6 of the ENGEO (2024) report, water discharged into the soakage area will infiltrate to the water table (in the Pleistocene glacial outwash sandy gravel) and migrate west-southwest with a horizontal conductivity on the order of 10^{-3} m/s (Fetter [2021] *Applied Hydrogeology*. Prentice-Hall, Inc.). At the west-southwest extents of the Pleistocene gravels (refer Figure 8, ENGEO [2024]), the water daylights in the springs along Taylorville Road.

We understand that there is concern regarding the potential for the flow of leachate-impacted groundwater through fractures in the mudstone to within the radius of influence of the GDC abstraction wells. Based on published studies, the anticipated horizontal hydraulic conductivity in the mudstone is on the order of 10^{-8} to 10^{-6} m/s (Bishop & McCarthy [2004] *Hydraulic conductivity of mudstone formations in the West Coast region, South Island, New Zealand,* New Zealand Journal of Geology and Geophysics, 47(3), 421-432), with a ratio of horizontal to vertical conductivity of 10:1 (Domenico [1990] *Physical and Chemical Hydrogeology*. John Wiley & Sons, Inc.).

Mudstone is considered an excellent rock type for geological containment due to very low permeability, even when faulted (Ozaki, et al, [2022] *Variation in fault hydraulic connectivity with depth in mudstone: An analysis of poroelastic hydraulic response to excavation in the Horonobe URL*, Geomechanics for Energy and the Environment, Volume 31:100311). Clay minerals comprising mudstone will expand when they encounter water, thus infilling the fracture and blocking the transmission of water (Baker & Grath [2005] *Hydraulic properties of a fractured mudstone. Hydrogeology Journal*, 13(3), 344-358).

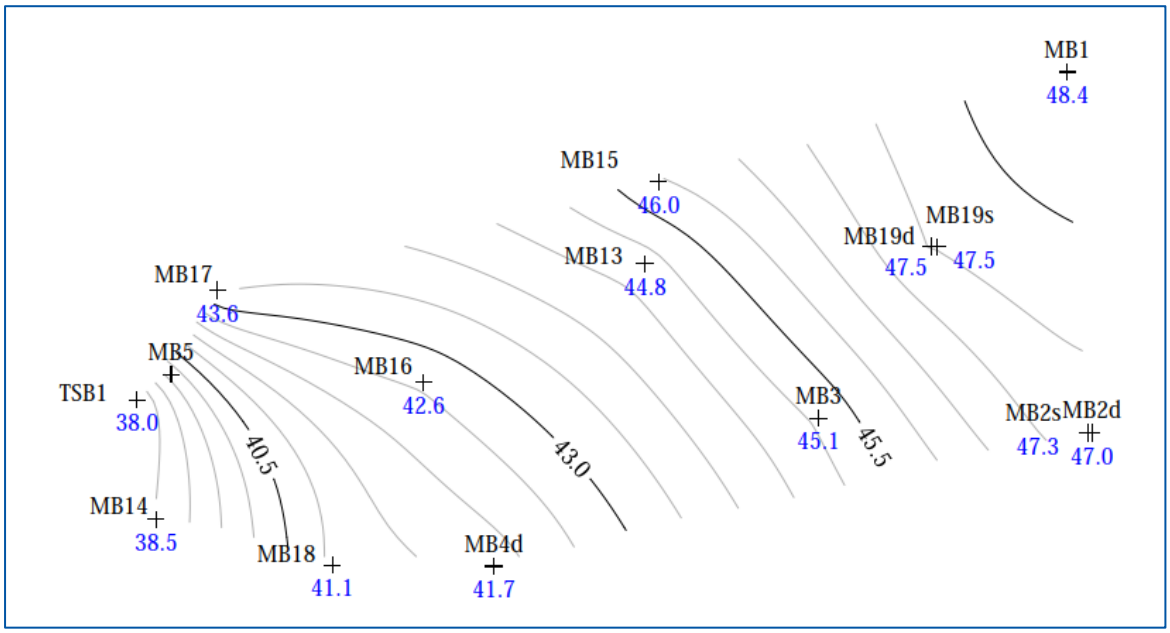
Based on fundamental hydrogeological concepts developed by Henry Darcy (ca. 1856) it is highly unlikely that any greater-than-minor quantity of groundwater will naturally migrate from an unconfined, high-permeability aquifer down through a mudstone aquitard with a hydraulic conductivity that is lower by 3–5 orders of magnitude (i.e., groundwater flow will principally be horizontal within the overlying, high permeability sandy gravel aquifer).

Water in the Taylorville Road drain is piped under the road to an unnamed tributary / wetland on the south side of Taylorville Road, before joining with the Grey River approximately 550 m downstream. Any water that infiltrates to ground into the Holocene gravel and sand deposits adjacent to and underlying the unnamed tributary / wetland will be captured by the flow of groundwater in these river deposits, which flow parallel to the direction of flow in the Grey River. The Holocene gravels estimated hydraulic conductivity is anticipated in the order of 10^{-3} to10^{-4} m/sec, based on unconsolidated ranges (Fetter [1994] *Applied Hydrogeology.* Macmillian College Publishing Company).

We have requested but not been provided with any details of the GDC abstraction wells (e.g., pump test results, abstraction rates); however, based on one publicly available borelog from the GDC treatment plant (BH1), the Holocene gravel deposits extend to a depth of at least 15 m and the Kaiata Formation was not encountered in the borehole. As such, based on the information available, there is not direct pathway between the site and the GDC abstraction wells that is not intercepted by the Holocene gravels.

Considering the distance of the point of discharge into the unnamed tributary / wetland relative to the GDC intake (~250 m) the flow in the Grey River, and the estimated hydraulic conductivity in the Holocene gravels, there is no reasonably practicable overland and / or groundwater flowpath from the discharge site to the GDC water intake.

Figure 1: October 2024 Groundwater Contours



- Water quality sampling data is limited and more information is required to determine the potential scale of impact. More sample parameters should be incorporated.

TRPL are undertaking quarterly comprehensive monitoring to provide an ongoing assessment of water quality at the site. We note that the parameters analysed are generally consistent with recommendations in WasteMINZ (2023) Table 8-2; however, the monitoring programme undergoes review following each monitoring round and additional parameters will be added, if appropriate.

Ongoing monitoring will continue to assess the effect of fugitive discharges (e.g., residue from the former sediment pond, leachate from Cell A that bypasses the on-site sump and leachate collection system); however, none of the results collected to date indicate concentrations of discharges that will exceed the NZDWS following minimal (<10:1) dilution in the receiving environment.

Subsequent to delivery of the ENGEO (2024) report, surface water samples were collected from three locations in the unnamed tributary / wetland: upstream of the TRD drain point of discharge (SW01), downstream of the TRD drain point of discharge (SW02), and downstream of the confluence with Noname Creek (SW03). None of the water samples collected contained concentrations that exceeded the NZDWS. Concentrations of several parameters (e.g., metals, nitrate-N) exceeded the calculated trace levels for groundwater and the Taylorville Road Drain, indicating that trace levels are conservative and catchment-wide concentrations are likely elevated. These results will be further discussed in the upcoming ENGEO revised hydrogeological investigation report.

We note that water quality in the water treatment system (e.g., leachate, water in the settlement / retention pond) has been characterised. These concentrations were conservatively used to model the likely concentrations of contaminants in groundwater at the point of discharge (where groundwater daylights along Taylorville Road) from an on-site soakage area located approximately 330 m upgradient. This is discussed at length in Section 6 of ENGEO (2024).

Based on the modelling results, contaminants in leachate will generally be attenuated through dilution / dispersion in the unconfined aquifer. Very low concentrations of aluminium, ammoniacal-N, manganese, and nitrate-N may reach the point of discharge; however, the highest modelled concentrations are negligible and below the range of natural variability or analytical error. Groundwater fate and transport modelling will be updated following the receipt of laboratory results from the October 2024 monitoring round and results will be provided in the upcoming ENGEO revised hydrogeological investigation report.

- TRPL have not provided detailed design drawings showing the construction of the former sediment pond and waste cells, and their relationship to the underlying Kaiata Formation.

TRPL has engaged engineering professionals to develop "as-built" drawings, which will be issued in November 2024.

We assume that there is potential for some fugitive discharges of leachate from unlined elements (e.g., former sediment pond, Cell A), regardless of whether the base of the element is in direct contact with the underlying Kaiata Formation; however, these discharges are being assessed through previous and ongoing monitoring of spring locations and TRD1–TRD5 (refer response above).

- TRPL have not provided significant information to confirm that the water treatment system is fit for purpose.

Pilot testing of upgrades and modifications to the water treatment system commenced on 25 September 2024 with the installation of an aeration fountain in the settlement pond. Additional changes (e.g., alterations to the treatment train and flocculation dosing) are currently being implemented and will be assessed early November (depending on external suppliers) using the laboratory analysis of water samples collected from multiple stages in the treatment train.

We concur with the following findings in the PDP letter:

- "*The information available at present indicates that contaminant concentrations in water samples that have reached in close proximity of the culverts that cross Taylorville Road are generally below the DWSNZ health-based MAV criteria.*"
- *"Based on our current limited understanding of the hydrogeological environment, we expect the potential for this flow pathway [AN—groundwater flow under the road] is low. This pathway would likely require a continuous fracture network in the mudstone that underlies the younger gravels within which the landfill is situated."*
- *"As leachate moves away from the landfill, concentrations will decrease due to dilution with groundwater in the surrounding environment and attenuation of contaminant concentrations due to processes such as dispersion, adsorption, and chemical and biological transformation and decay."*
- *"Low drawdown in individual supply bores [AN—GDC] will decrease the potential for water impacted by the landfill reaching the bore intakes"*
- *"If any contaminants were to reach the GDC bore intakes they would be further diluted by the large volume of water drawn into the intakes that come from all around the bores, including from the Grey River side."*
- *"Therefore overall, we consider the risk of contamination of the water supply to be low…"*

APPENDIX 1

Tabulated Laboratory Results

Table 1: TRPL Groundwater and Offsite Sample Results

Analyte	NZDWS [1]	NZWQS (95%) [2]	NZWQS (90%) [2]	NZWQS (80%) [2]	31/07/24 GW Trace [3]	31/07/24 TRD Trace [4]	MB1	MB2s	MB2d	MB3	MB4d	TSB1	TCD1	SP1	SP2	SP3	TRD1
							30/07/24	30/07/24	30/07/24	30/07/24	30/07/24	30/07/24	31/07/24	31/07/24	31/07/24	31/07/24	31/07/24
Sum of Anions					4.68	0.89	0.73	0.84	3.9	0.74	1.8	0.29	3.1	0.4	0.37	2.8	2.6
Sum of Cations					4.68	0.91	0.77	0.89	3.9	0.8	1.91	0.51	3.1	0.4	0.39	2.7	2.7
An/Cat balance (%)							-3%	-3%	0%	-4%	-3%	-28%	0%	0%	-3%	2%	-2%
pH		7.7	7.7	7.7	-	-	6.1	6.1	6.8	6	6.5	5.6	6.6	6	4.9	6.4	7.7
Total Alkalinity					211.2	19.6	17.2	19.2	176	16.2	43	3.5	55	4.1	1.4	4.3	53
Bicarbonate					252	23.8	21	23	210	19.8	53	4.3	67	5	1.7	5.2	64
Total Hardness	200				60	31.2	25	32	50	28	76	7.8	125	7	5.9	109	109
Electrical conductivity (mS/m)		10.7	10.7	10.7	42.96	9.7	8.4	9.8	***35.8***	8.9	***19.9***	3.5	***32.8***	4.5	4.7	***30.4***	***28.3***
Dissolved aluminium	0.1	0.055	0.08	0.15	0.1116	0.032	***0.093***	*0.069*	0.004	*0.062*	0.009	***1.77***	0.012	***0.093***	***0.31***	0.047	0.027
Total aluminium		0.055	0.08	0.15	23.16	0.2	***0.29***	***1.22***	***19.3***	***0.68***	***0.34***	***60***	0.038	***0.196***	***0.49***	***0.155***	***0.28***
Dissolved calcium					15.96	9.8	7.6	11.1	13.3	9.4	28	2.5	43	1.45	0.85	36	38
Dissolved iron					< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	< 0.02	0.04
Total iron	0.2				18.36	0.042	0.115	0.96	15.3	0.5	0.31	41	0.032	0.053	0.138	0.19	1.2
Dissolved magnesium					4.92	1.57	1.39	1.1	4.1	1.04	1.64	0.38	4.0	0.81	0.91	4.6	3.3
Total magnesium					8.4	1.49	1.39	1.29	7	1.16	1.64	10.3	4.0	0.82	0.85	4.6	3.3
Dissolved manganese	0.4	1.9	2.5	3.6	0.66	0.013	0.0077	0.075	0.55	0.146	0.191	0.033	0.92	0.0061	0.0118	0.0019	0.0064
Total manganese		1.9	2.5	3.6	0.9	0.017	0.0104	0.088	0.75	0.151	0.192	0.76	0.94	0.0182	0.0117	0.005	0.04
Dissolved potassium					1.908	0.6	0.61	0.89	1.59	0.69	0.79	0.52	3.7	0.13	0.25	0.6	3.2
Dissolved sodium	200				76.8	6.1	5.6	4.9	64	4.9	8.4	3.3	11.8	5.5	5.1	12.2	10.5
Chloride	250				13.32	9.7	6.7	7.8	11.1	7	7	4.7	7.7	8.4	7.2	11.5	9.6
Total Ammoniacal-N	0.82	0.9	1.43	2.3	0.3	< 0.010	< 0.010	< 0.010	0.25	< 0.010	0.039	< 0.010	0.011	0.011	0.013	< 0.010	< 0.010
Nitrite-N	0.912				< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.034	< 0.002	0.008	< 0.002	< 0.002	< 0.002	0.003
Nitrate-N	11.3	0.092	0.092	0.092	1.476	1.02	***1.07***	***1.23***	< 0.002	***1.42***	***1.92***	***0.3***	***2.6***	***0.66***	***1.13***	***0.22***	***1.22***
Nitrite+Nitrate-N					1.476	1.02	1.07	1.23	< 0.002	1.42	1.95	0.3	2.6	0.66	1.13	0.22	1.22
DRP		0.009	0.009	0.009	0.1932	< 0.004	0.005	< 0.004	***0.161***	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Sulphate	250				8.28	7.2	5.6	6.9	0.6	5.8	29	3.3	75	1.7	2.9	112	59
cBOD5					< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
COD					36	< 6	< 6	< 6	30	< 6	< 6	43	8	10	< 6	14	26
Dissolved arsenic	0.01	0.013	0.42	1.4	0.009	< 0.0010	< 0.0010	< 0.0010	0.0075	< 0.0010	< 0.0010	< 0.0010	0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved cadmium	0.004	0.0002	0.0004	0.0008	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved chromium	0.05	0.0033	0.006	0.04	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0007	< 0.0005	< 0.0005	< 0.0005	0.0007
Dissolved copper	2	0.0014	0.0018	0.0025	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	***0.0032***	*0.0015*	< 0.0005	< 0.0005	< 0.0005	0.0008
Dissolved lead	0.01	0.0034	0.0056	0.0094	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00054	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved nickel	0.08	0.011	0.013	0.017	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0012	< 0.0005	< 0.0005	< 0.0005	0.0007
Dissolved zinc	1.5	0.008	0.015	0.031	0.00408	< 0.0010	0.0016	0.0034	< 0.0010	0.0033	0.0018	***0.026***	0.005	< 0.0010	0.001	< 0.0010	0.0012
Total arsenic		0.013	0.42	1.4	0.0252	< 0.0011	< 0.0011	< 0.0011	*0.021*	< 0.0011	< 0.0011	*0.021*	< 0.0011	< 0.0011	< 0.0011	< 0.0011	0.0014
Total cadmium		0.0002	0.0004	0.0008	0.00072	< 0.000053	< 0.000053	< 0.000053	***0.0006***	< 0.000053	< 0.000053	0.00012	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Total chromium (IV)		0.0033	0.006	0.04	0.01344	< 0.00053	< 0.00053	0.00083	***0.0112***	< 0.00053	< 0.00053	***0.029***	0.00092	< 0.00053	< 0.00053	< 0.00053	0.0013
Total copper		0.0014	0.0018	0.0025	0.0288	< 0.00053	< 0.00053	*0.0015*	***0.024***	0.00072	0.00081	***0.062***	*0.00169*	< 0.00053	< 0.00053	< 0.00053	0.00113
Total lead		0.0034	0.0056	0.0094	0.036	< 0.00011	0.00034	0.00169	***0.03***	0.00082	0.00065	***0.075***	< 0.00011	0.00011	0.00012	0.00013	0.00046
Total nickel		0.011	0.013	0.017	0.01632	< 0.00053	< 0.00053	0.00129	***0.0136***	0.00063	< 0.00053	***0.04***	0.00135	< 0.00053	< 0.00053	< 0.00053	0.00093
Total zinc		0.008	0.015	0.031	0.0708	< 0.0011	0.003	0.007	***0.059***	0.0053	0.0035	***0.172***	0.0053	0.0019	0.0026	0.0014	0.007

Notes:

All values provided in units of miligrams per liter (mg/L) unless otherwise specified.

[1] Ministry of Health (2018). Drinking-water Standards for New Zealand 2005 (revised 2018). Table 2.2 (health based), Table 2.3 (aesthetic)

[2] Australia and New Zealand Guidelines from Fresh & Marine Water Quality. Default Guideline Values, level of protection specified. Where no Toxicant DGV has been derived, values are for physical chemical (PC) stressors (based on MfE REC CX/L)

[3] Trace concentration (defined as the highest upgradient [MB1, MB2s, MB2d] concentration ± 20%).

[4] Trace concentration (defined as the upgradient [TRD3] concentration ± 20%).

Values in red exceed the groundwater trace level

Values in green exceed the TRD trace level but are below the groundwater trace level (TRD and tributary samples only)

Bordered values exceed the NZDWS (MAV or GV)

Values in *italics* exceed the NZWQS, 95% level of protection

Values in **bold** exceed the NZWQS, 90% level of protection

Gray highlighted values exceed the NZWQS, 80% level of protection

- Not analysed

< Below the laboratory reporting limit (<RL)

Table 1: TRPL Groundwater and Offsite Sample Results

Analyte	NZDWS [1]	NZWQS (95%) [2]	NZWQS (90%) [2]	NZWQS (80%) [2]	31/07/24 GW Trace [3]	31/07/24 TRD Trace [4]	TRD2 31/07/24	TRD3 31/07/24	TRD4 31/07/24	TRD5 31/07/24	SW01 16/09/24	SW02 16/09/24	SW03 16/09/24
Sum of Anions					4.68	0.89	2.4	0.74	2.1	2.9	1.9	2.9	2.3
Sum of Cations					4.68	0.91	2.4	0.76	2	3.1	1.92	3	2.5
An/Cat balance (%)							0%	-1%	2%	-3%			
pH		7.7	7.7	7.7	-	-	6.4	7	7.3	6.9	7.2	7.5	7.6
Total Alkalinity					211.2	19.6	7	16.3	22	11.4	20	29	50
Bicarbonate					252	23.8	8.6	19.8	27	13.8	24	35	60
Total Hardness	200				60	31.2	96	26	82	122	73	122	103
Electrical conductivity (mS/m)		10.7	10.7	10.7	42.96	9.7	***26.2***	8.1	***23.3***	***31.1***	***21***	***30.6***	***25***
Dissolved aluminium	0.1	0.055	0.08	0.15	0.1116	0.032	0.064	0.027	0.021	***0.132***	0.051	***0.1***	0.053
Total aluminium		0.055	0.08	0.15	23.16	0.2	***0.51***	***0.143***	***2.6***	***0.21***	***0.116***	***0.14***	***0.109***
Dissolved calcium					15.96	9.8	32	8.2	28	39	24	41	37
Dissolved iron					< 0.02	< 0.02	< 0.02	< 0.02	0.02	0.08	0.03	0.05	0.09
Total iron	0.2				18.36	0.042	0.105	0.035	6.5	0.183	0.081	0.086	0.179
Dissolved magnesium					4.92	1.57	4.1	1.31	2.9	6.3	3.3	5	2.5
Total magnesium					8.4	1.49	4.1	1.24	3.3	6.4	3.2	4.9	2.4
Dissolved manganese	0.4	1.9	2.5	3.6	0.66	0.013	0.063	0.0107	0.0012	0.026	0.0027	0.0103	0.0084
Total manganese		1.9	2.5	3.6	0.9	0.017	0.074	0.0143	0.3	0.027	0.0067	0.0148	0.037
Dissolved potassium					1.908	0.6	0.44	0.5	0.47	1.01	1.53	1.35	2.9
Dissolved sodium	200				76.8	6.1	10.7	5.1	9.1	13.5	9.5	13	8.6
Chloride	250				13.32	9.7	9.7	8.1	9.2	12.8	10.2	12.2	8.9
Total Ammoniacal-N	0.82	0.9	1.43	2.3	0.3	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.066	0.02	0.015
Nitrite-N	0.912				< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.007
Nitrate-N	11.3	0.092	0.092	0.092	1.476	1.02	0.015	***0.85***	***0.56***	***0.21***	0.022	***0.1***	***0.88***
Nitrite+Nitrate-N					1.476	1.02	0.016	0.85	0.56	0.21	0.023	0.1	0.89
DRP		0.009	0.009	0.009	0.1932	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	0.005
Sulphate	250				8.28	7.2	93	6	66	109	58	94	48
cBOD5					< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
COD					36	< 6	12	< 6	50	8	14	25	10
Dissolved arsenic	0.01	0.013	0.42	1.4	0.009	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved cadmium	0.004	0.0002	0.0004	0.0008	< 0.00005	< 0.00005	0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved chromium	0.05	0.0033	0.006	0.04	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0007
Dissolved copper	2	0.0014	0.0018	0.0025	< 0.0005	< 0.0005	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0008
Dissolved lead	0.01	0.0034	0.0056	0.0094	< 0.00010	< 0.00010	0.00014	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00012
Dissolved nickel	0.08	0.011	0.013	0.017	< 0.0005	< 0.0005	*0.0129*	< 0.0005	0.0036	0.001	< 0.0005	0.0009	0.0005
Dissolved zinc	1.5	0.008	0.015	0.031	0.00408	< 0.0010	*0.0143*	< 0.0010	< 0.0010	0.0031	0.0034	0.0024	0.0038
Total arsenic		0.013	0.42	1.4	0.0252	< 0.0011	< 0.0011	< 0.0011	0.0021	< 0.0011	< 0.0011	< 0.0011	< 0.0011
Total cadmium		0.0002	0.0004	0.0008	0.00072	< 0.000053	0.000063	< 0.000053	0.000064	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Total chromium (IV)		0.0033	0.006	0.04	0.01344	< 0.00053	< 0.00053	< 0.00053	0.0023	< 0.00053	0.00055	0.00077	0.00108
Total copper		0.0014	0.0018	0.0025	0.0288	< 0.00053	0.00127	< 0.00053	***0.0024***	< 0.00053	0.00058	0.00064	0.00108
Total lead		0.0034	0.0056	0.0094	0.036	< 0.00011	0.00055	< 0.00011	0.0025	< 0.00011	0.00011	< 0.00011	0.0003
Total nickel		0.011	0.013	0.017	0.01632	< 0.00053	***0.0132***	< 0.00053	*0.0113*	0.00099	0.00064	0.00096	0.00055
Total zinc		0.008	0.015	0.031	0.0708	< 0.0011	***0.0159***	< 0.0011	***0.031***	0.0034	0.0033	0.006	0.0053

Notes:

All values provided in units of miligrams per liter (mg/L) unless otherwise specified.

[1] Ministry of Health (2018). Drinking-water Standards for New Zealand 2005 (revised 2018). Table 2.2 (health based), Table 2.3 (aesthetic)

[2] Australia and New Zealand Guidelines from Fresh & Marine Water Quality. Default Guideline Values, level of protection specified. Where no Toxicar

[3] Trace concentration (defined as the highest upgradient [MB1, MB2s, MB2d] concentration ± 20%).

[4] Trace concentration (defined as the upgradient [TRD3] concentration ± 20%).

Values in red exceed the groundwater trace level

Values in green exceed the TRD trace level but are below the groundwater trace level (TRD and tributary samples only)

Bordered values exceed the NZDWS (MAV or GV)

Values in *italics* exceed the NZWQS, 95% level of protection

Values in **bold** exceed the NZWQS, 90% level of protection

Gray highlighted values exceed the NZWQS, 80% level of protection

- Not analysed

< Below the laboratory reporting limit (<RL)