TOITŪ TE WHENUA

LAND INFORMATION NEW ZEALAND

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146 TE MAWHAI ROAD, FORMER TOKANUI PSYCHIATRIC HOSPITAL, TE AWAMUTU

TOKANUI CLOSED LANDFILL, WHAREKORINO STREAM & BORE WATER SAMPLING, WATER QUALITY ANNUAL REPORT - 2024

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TOKANUI CLOSED LANDFILL, WHAREKORINO STREAM & BORE WATER SAMPLING QUALITY ANNUAL REPORT - 2024

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FORMER TOKANUI PSYCHIATRIC HOSPITAL CLOSED LANDFILL, TE AWAMUTU
WHAREKŌRINO STREAM & BORE WATER SAMPLING
WATER QUALITY ANNUAL REPORT – 2024

TABLE OF CONTENTS

APPENDICES

FORMER TOKANUI PSYCHIATRIC HOSPITAL CLOSED LANDFILL, TE AWAMUTU
WHAREKŌRINO STREAM & BORE WATER SAMPLING
WATER QUALITY ANNUAL REPORT – 2024

1 INTRODUCTION AND PURPOSE

The Tokanui Closed Landfill resource consent (102269) includes several monitoring conditions that must be met each year. LINZ have commissioned Fraser Thomas Ltd (FTL) to assist with fulfilment of the Site Management and Aftercare section requirements. The purpose of this report is to provide the annual results from the combined surface water and ground water sampling rounds undertaken in May and September 2024, as well as the annual site visual walkover.

2 CONSENT CONDITIONS

The stream and bore water sampling report has been produced in order to satisfy condition 7 of the Site Management and Aftercare requirements of the Tokanui Closed Landfill resource consent, dated 17th April 2000 and referenced by Waikato Regional Council as RC102269.01.01. This consent specifically relates to the Wharekōrino stream surface water and ground water sampling. Condition 7 requires the following:

The consent holder shall undertake a formal inspection of the surface and capping of the landfill site on at least an annual basis to check for the following;
I. Poor pasture establishment;
II. Vegetation die off;
III. Refuse protruding through the cap;
IV. Damage to capping materials;
V. Differential settlement and ponding;
VI. Subsidence or erosion;
VII. Leachate springs;
VIII. Visual surface water quality and
IX. Erosion at or near the Wharekōrino Stream bank.

Any defects noticed during the inspection shall be remedied immediately. A report on the inspection, including any remedial actions taken, shall be forwarded to the Waikato Regional Council within two months of inspection.

In addition, condition number 7 specifies the monitoring requirements detailed below.

The consent holder shall characterise the quality of the groundwater and the quality of the Wharekōrino Stream (upstream and downstream of the landfill) to the satisfaction of the Waikato Regional Council. To this end, the consent holder shall develop a monitoring plan in consultation with the Waikato Regional Council. This plan shall be lodged with the Waikato Regional Council for written approval within three months of the granting of this consent. The plan shall include the following sampling programme as a minimum:

Source	Frequency	Location	Parameters
Wharekōrino Stream Water	*At least twice a year to coincide with high and low groundwater levels (generally September and April). The samples shall be taken when no surface water runoff is occurring.*	*All parameters shall be taken at locations S1, S2 and S3 as shown in Figure 1 attached to this consent except for the PAHs which shall be taken from location S4.*	• *Estimate of stream flow* • *pH* • *conductivity* • *suspended solids* • *total boron·* • *total iron* • *total mercury* • *potassium* • *chloride* • *ammoniacal nitrogen* • *nitrate nitrogen* • *sulphate* • *Polycyclic Aromatic Hydrocarbons*
Groundwater	*At least twice a year to coincide with high and low groundwater levels (generally September and April)*	*Monitoring wells P2 and P7 as shown in Figure 1 attached to this consent.*	• *Water level* • *pH* • *Total Alkalinity* • *Conductivity* • *dissolved boron·* • *dissolved iron* • *dissolved mercury* • *chloride* • *ammoniacal nitrogen* • *nitrate nitrogen* • *sulphate* • *total organic carbon*

The consent holder shall undertake the monitoring programme specified in the monitoring plan or any amendment to the plan that has been made in consultation with, and with the written agreement of, the Waikato Regional Council. The consent holder shall forward the results of the monitoring to the Waikato Regional Council within two months of sampling.

3 BACKGROUND

The resource consent RC102269.01.01 allows for the discharge of leachate from the Tokanui Hospital landfill into land in circumstances that may result in contaminants entering groundwater. The “landfill” in this case refers to a number of areas close to the Wharekōrino Stream that were used for the landfilling of hospital waste over at least 40 years until the late 1990s. A large range of typical domestic, construction and specific medical waste materials were deposited in these landfilling areas, with some refuse burnt and covered with hospital boiler ash. Some of the landfilling areas were also ‘capped’ with low permeability clay cover and topsoil and then grassed. The landfilled area is now part of a dairy farm and is understood to be used only for grazing.

The groundwater and stream water quality monitoring events are undertaken twice yearly to check for potential leaching of contaminants from the landfilled materials into the underlying groundwater and adjacent Wharekōrino stream.

Visual checks are also undertaken of the landfill surface annually to check for a range of issues, including any refuse that may have come to the surface and any differential settlement issues, that may promote ponding on the landfill surface. Settlement of the ground may arise from consolidation of the deposited fill materials and from degradation of the waste itself. The latter depends on the nature of the waste materials. Organic waste materials degrade relatively quickly and decrease in volume faster, compared with materials that are more resistant to degradation such as metals, building rubble, treated timber and plastics.

4 METHODOLOGY

4.1 Stream and Bore Sampling

Stream flows were not quantitatively measured during the 2024 sampling rounds, which is consistent with previous WSP reports and the FTL 2022/23 monitoring reports. However, it was noted that flows appeared low during the May sampling event, and higher than normal during the September sampling event. Areas of stagnant water were commonly observed in the downstream portion near sampling location S2.

The first round of water quality sampling for 2024 was undertaken on 1st May 2024, and the second round was undertaken on 18th September 2024, which both involved collection of water quality samples from Wharekōrino Stream and Borehole P2. Weather conditions were mainly fine during each visit.

On both occasions, Bore P7 was found to be dry. This has been the case on all previous sampling occasions and, as such, no sample could be taken from this bore.

The sampling locations are shown in Figure 1.

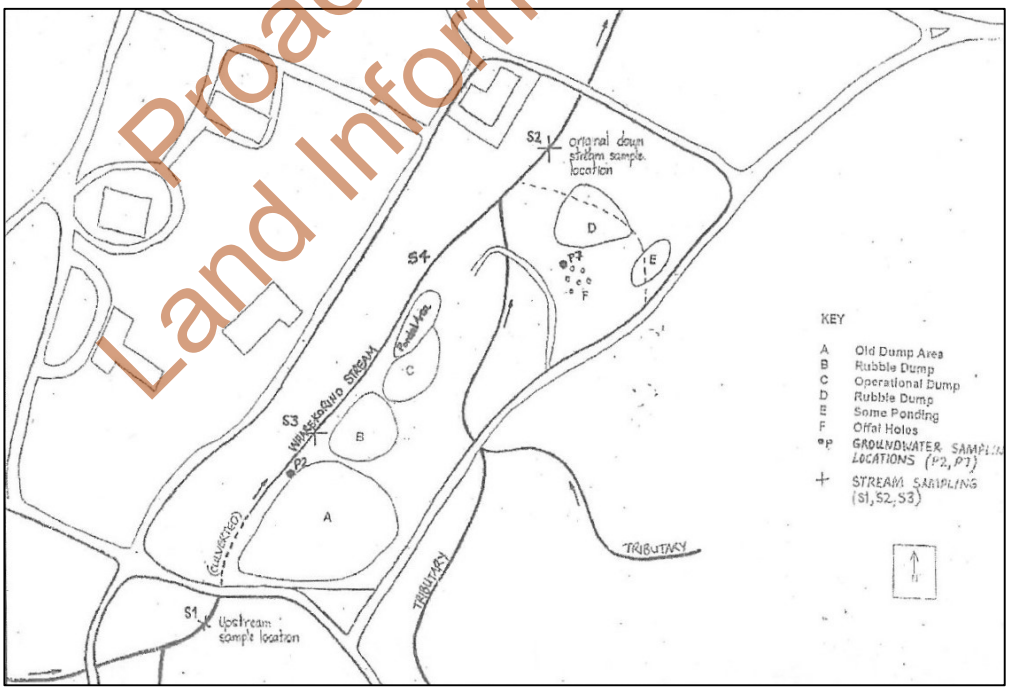


Figure 1: Location of stream and bore (groundwater) sampling sites and landfill areas.

Sampling was undertaken at the bank of the stream at locations S1-S4 on both occasions, taking two large water sampling bottles to receive the direct flow from the centre of the stream. A YSI pro plus multimeter was also used to measure temperature, pH, conductivity, DO (dissolved oxygen), and ORP (oxidation reduction potential) at stream locations S1-S4. Sampling conducted from the borehole at P2 also involved using a YSI pro plus multimeter to measure pH, conductivity, DO (dissolved oxygen), and ORP (oxidation reduction potential).

The groundwater level was approximately 1.25m higher during the September 2024 sampling round, compared with the May 2024 round, which can be attributed to the winter rainfall. Field measurements were fairly consistent between the May and September sampling rounds. Generally, Bore P2 had significantly higher dissolved oxygen, slightly higher pH, lower conductivity, and temperature, and very low ORP during the September sampling compared with the May sampling.

Table 1: Field Measurements at P2 Borehole in May and September 2024

Field Measurements 2024	May	September
Groundwater depth (m bgl)	4.891 from top of borehole	3.64 from top of borehole
Temperature (C°)	15.4	14.3
pH	6.21	6.39
DO (mg/L)	0.38	0.99
DO %	3.8	9.5
Specific Conductivity (µs/cm)	1033	831
ORP (mV)	109.8	15.7

Water quality samples (S1-S4 & P2) were sent to Hills Laboratories in a ruggedized chilly bin under standard chain of custody procedures for analysis.

Table 2: Field Measurements at Wharekōrino Stream (S1-S4) in May and September 2024

Field Measurements 2024	S1 May	S1 Sep	S3 May	S3 Sep	S4 May	S4 Sep	S2 May	S2 Sep
Temperature (C°)	9.1	11.6	11	11.3	10.3	11.4	9.7	11.5
pH	6.55	6.13	6.54	6.06	6.64	6.07	7.37	6.28
DO (mg/L)	6.93	9.76	4.94	9.51	4.63	82.3	6.38	8.69
DO %	61	89.8	44.7	86.3	41.6	82.3	56.7	78.7
Specific Conductivity (µs/cm)	131.2	136.8	138.5	140.2	137.4	141.7	138	142.8
ORP (mV)	103.3	36.7	135.7	51.9	156.1	60.9	129.7	59.4

4.2 Landfill Visual Assessment

A grid site walkover was undertaken of the landfill on 18th September 2024. Observations were made for each grid in accordance with the consent requirements. The grid plan used is included in Appendix A along with representative photos.

5 RESULTS

5.1 Stream and Bore Sampling

The stream sampling and borehole sampling results are appended to this report. Results from locations S1, S2, S3 and S4 are given in Table 3 while the results from borehole P2 are given in Table 4.

The results were compared to Australian and New Zealand Environmental and Conservation Council (ANZECC) 95% trigger level for freshwater, ANZECC livestock drinking water guidelines, ANZECC Irrigation long term (100 years) guidelines, ANZECC Irrigation long term (20 years), and Ministry of Health (MoH) Drinking water Standards (Aesthetics, and Health). For ammonia, the trigger value varies with pH, and was adjusted from the default pH of 8.0 to the lab pH of 6.8 and 6.7 respectively, using the formula in the ANZECC guidelines.

Table 3: Results of the Wharekorino Stream water sampling – May and September 2024

Tokanui Landfill Monitoring: SW Results															
Sample Date		**ANZECC (2000)**				**Drinking Water Standards (2005-2008) (Revised 2018)**		1-May-24				18-Sep-24			
Sample Name								S1	S3	S4	S2	S1	S3	S4	S2
Sample Depth (m)								Surface Water							
Lab Number								3566987.2	3566987.5	3566987.3	3566987.4	3674981.1	3674981.3	3674981.4	3674981.2
Individual Tests	**Unit of measurement**	**95% Freshwater**	**Livestock**	**Irrigation Long term 100 years**	**Irrigation short term 20 years**	**Health**	**Aesthetics**								
pH	**pH Units**	-	-	-	-	-	7-8.5	6.9	6.9	-	6.8	6.6	6.6	-	6.7
Electrical Conductivity	**mS/m**	-	-	-	-	-	-	13.1	13.5	-	13.6	13.6	14.0	-	14.3
Total Suspended Solids		-	-	-	-	-	1,000	6	3	-	9	7.0	5.0	-	14.0
Total Boron		0.37	5.0	0.50	-	1.4	-	0.0154	0.07	-	0.085	0.0172	0.0530	-	0.0670
Total Iron		ID	-	0.20	10.00	-	0.2	*1.56*	*1.81*	-	*1.98*	*0.79*	*0.78*	-	*0.89*
Total Mercury		0.0006	0.002	0.002	0.002	0.007		< 0.00008	< 0.00008	-	< 0.00008	< 0.00008	< 0.00008	-	< 0.00008
Total Potassium		-	-	-	-	-	-	3.8	4.1	-	4.0	3.4	3.4	-	3.5
Chloride	**g/m³**	-	-	-	-	-	250.0	16.9	16.9	-	16.4	18.4	18.5	-	18.7
Total Ammoniacal-N		5.944 @ 6.8pH 6.084 @ 6.7 pH	-	-	-	-	-	0.080	0.094	-	0.031	0.136	0.138	-	0.118
Nitrite-N		-	-	-	-	3.0	-	0.012	0.012	-	0.007	0.016	0.016	-	0.015
Nitrate-N		0.7	-	-	-	50.0		0.67	0.58	-	0.60	<u>1.94</u>	<u>1.93</u>	-	<u>1.89</u>
Nitrate-N + Nitrite N		-	-	-	-	-	-	0.68	0.59	-	0.60	1.95	1.95	-	1.91
Sulphate		-	-	-	-	-	250.0	5.1	5.1	-	5.2	5.9	6.3	-	6.4
PAHs															
BaP (BAP)	**g/m³**	ID	-	-	-	-	-	-	-	< 0.000008	-	-	-	< 0.000008	-
Naphthalene		0.016	-	-	-	-	-	-	-	< 0.00004	-	-	-	< 0.00004	-

Note:

<u>Underlined:</u>	above ANZECC 95% Freshwater guideline values
Italicized	above ANZECC Irrigation Long Term 100 years
BLUE	above ANZECC Irrigation Short Term 20 years
BOLD	above ANZECC Livestock drinking water guidelines
RED :	exceeded Drinking water standards for health or Aesthetics (2005-2008)
ND	not detected
- :	not tested for

Table 4: Results of the Wharekorino Stream water sampling - May and September 2024

Tokanui Landfill Monitoring: P2 GW Results									
Sample Date		**ANZECC (2000)**				**Drinking Water Standards (2005-2008) (Revised 2018)**		1-May-24	18-Sep-24
Sample Name								P2	P2
Lab Number								3566987.10	3674981.5
Individual Tests	**Unit of measurement**	**95% Freshwater**	**Livestock**	**Irrigation Long term 100 years**	**Irrigation short term 20 years**	**Health**	**Aesthetics**		
pH	**pH Units**	-	-	-	-	-	7-8.5	6.5	6.8
Total Alkalinity	**g/m³ as $CaCO_3$**	-	-	-	-	-	-	310	350
Electrical Conductivity	**mS/m**	-	-	-	-	-	-	93.7	82.7
Dissolved Boron	**g/m3**	0.37	5.0	0.50	-	1.4	-	***38***	***18***
Dissolved Iron		-	-	0.20	10.00	-	0.2	0.0300	< 0.02
Dissolved Mercury		0.0006	0.002	0.002	0.002	0.007	-	< 0.00008	< 0.00008
Chloride		-	-	-	-	-	250.0	17.2	10.3
Total Ammoniacal-N		5.944 @ 6.8pH	-	-	-	-	-	0.013	< 0.010
Nitrite-N		-	-	-	-	3.0	-	< 0.002	< 0.002
Nitrate-N		0.7				50.0	-	0.02	3.00
Nitrate-N + Nitrite N		-	-	-	-	-	-	0.02	3.00
Sulphate		-	-	-	-	-	250.0	185.0	97.0
Total Organic Carbon		-	-	-	-	-	-	5.5	0.6

Note:

Underlined:	above ANZECC 95% Freshwater guideline values
Italicized	above ANZECC Irrigation Long Term 100 years
BLUE	above ANZECC Irrigation Short Term 20 years
BOLD	above ANZECC Livestock drinking water guidelines
RED :	exceeded Drinking water standards for health or Aesthetics (2005-2008)
ND	not detected
- :	not tested for

Note: P7 was dry on both occasions so not included in above table.

The latest boron levels in the landfill (P2) as well as upstream (S1), midstream (S3) and downstream (S2) were added to the long-term monitoring data and the results are given in Figures 2-4 below. Similarly, the latest and long-term nitrate monitoring results are given in Figure 5.

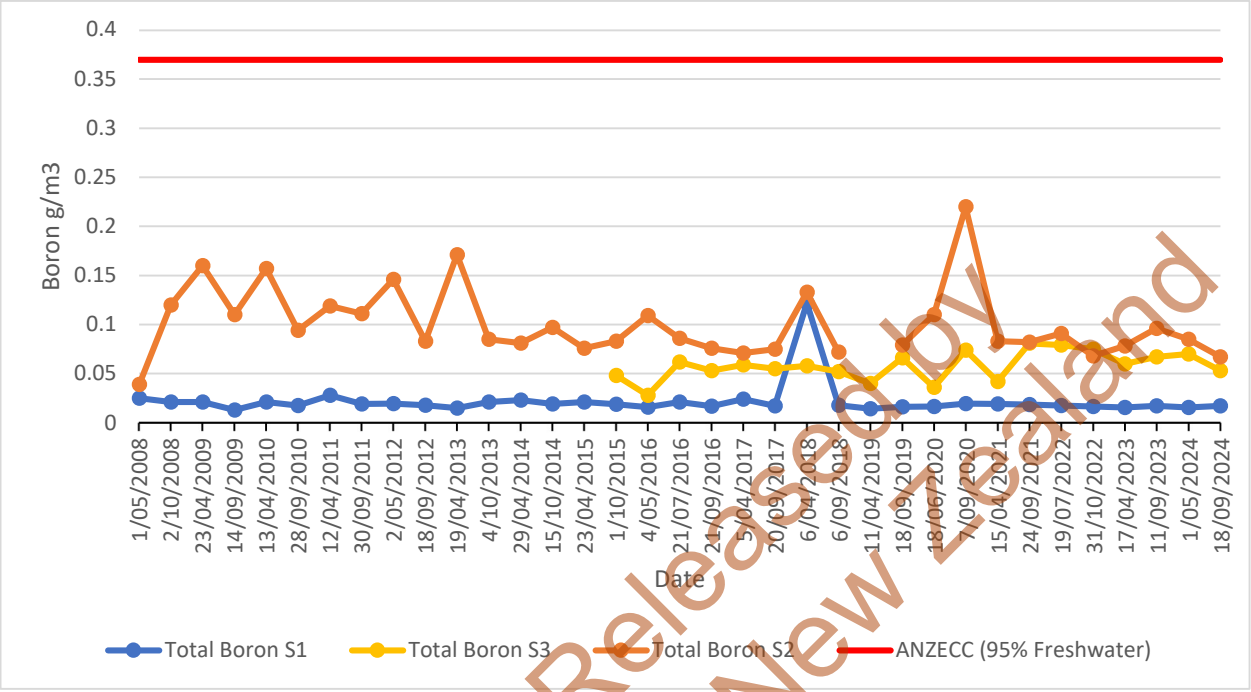


Figure 2: Long term boron levels (g/m³) upstream (S1), midstream (S3), and downstream (S2) of the landfill in comparison to ANZECC 95% protection trigger value for aquatic species.

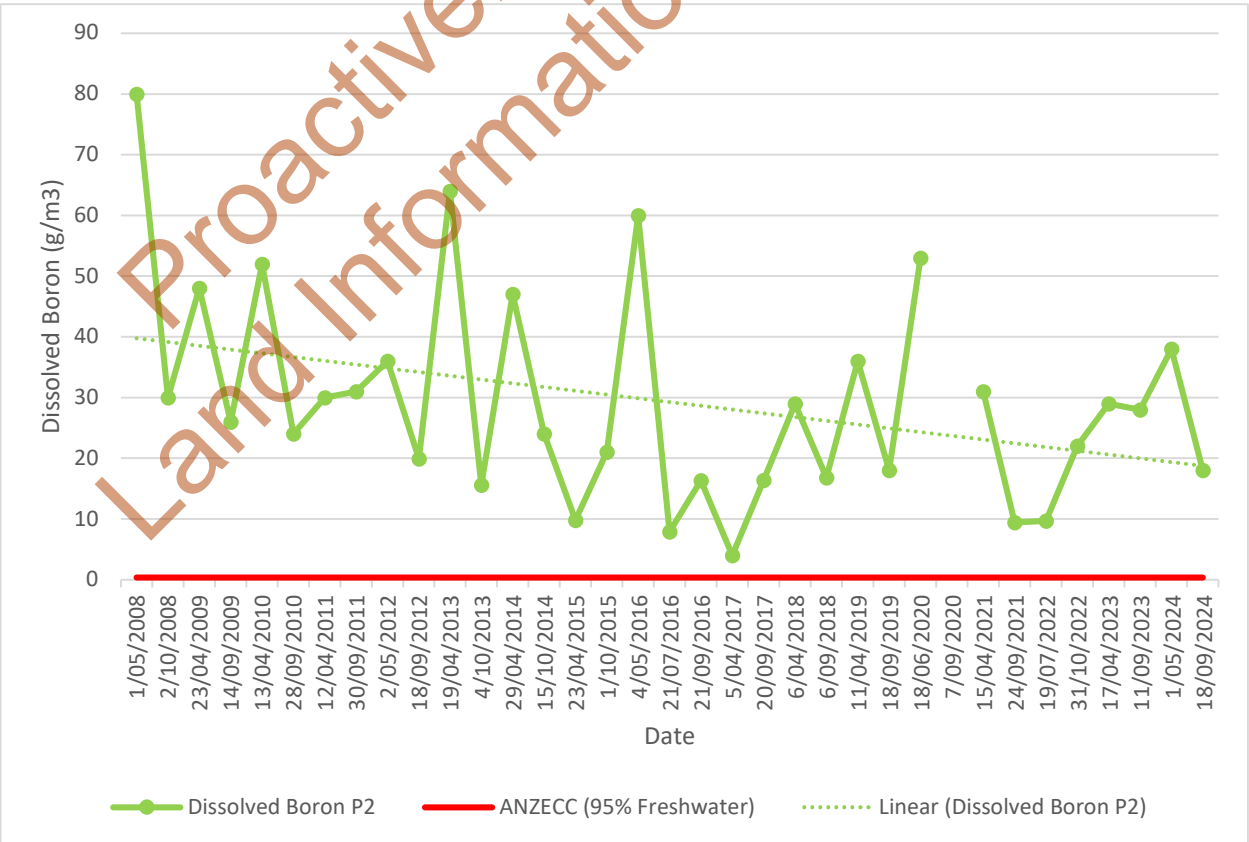


Figure 3: Long term dissolved boron levels (g/m³) within the landfill (P2).

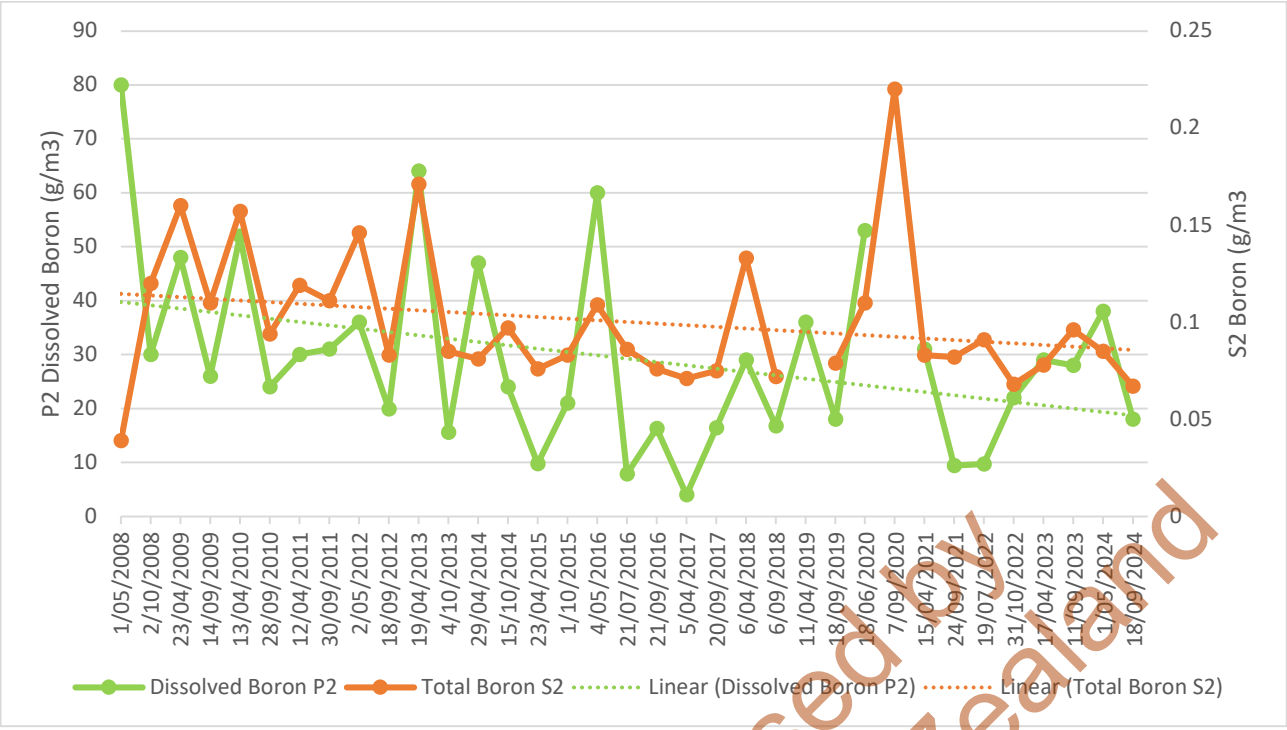


Figure 4: Relationship between boron levels (g/m³) at the downstream site (S2) and bore (P2). Stream (S2) boron values are shown on the left axis, bore (P2) values on the right axis.

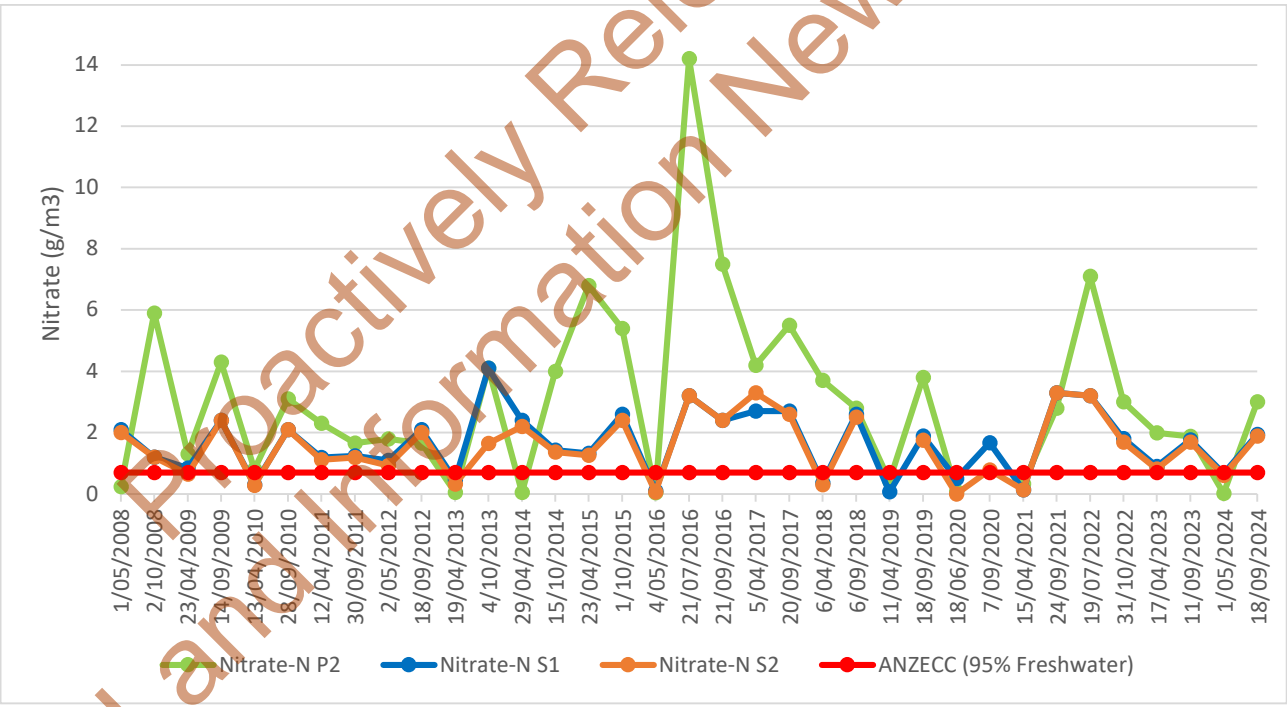


Figure 5: Long term nitrate levels (g/m³) in the landfill (P2) and upstream (S1) and downstream (S2) of the landfill. Note that the P2 bore was dry during the sampling period of September 2020.

5.2 Landfill Walkover Observations

Landfill walkover observations are summarised in Table 5 (below), with reference to grid locations for each item, where relevant.

It is important to note that intrusive (test pit) investigations of the landfill were undertaken over the period 2022-24 by Fraser Thomas Ltd. The test pit contents were replaced in the same order they were taken out, but some localised settlement at test pit locations did occur, creating small depressions. Additional retopsoiling was undertaken in February 2024 to fill in these depressions to match adjacent ground levels.

Table 5: Landfill Walkover Site Observations Summary

Item	2022 Walkover and Grid Reference	2023 Walkover & Grid Reference	2024 Walkover & Grid Reference
Pasture Establishment	A1, B1, E6, E7, F6, G5, J5 Generally good, except patchy in specified locations	E6, F5, H5, I4, L6, L7, M7, M8, M9, N8, 08	Patchy vegetation growth - B4, C4, F5
Vegetation Die-off	H4 Vegetation die-off at stream bank near ponding location	Unchanged from 2022	Unchanged from 2023
Refuse protruding through landfill cap	A3, B3, B4, D4, E4, H6, H7, L5, M6, N6 Consistently positioned near the extents of the landfill.	Test pit & trench locations containing fill generally exhibit subduction & refuse protrusion through landfill cap post intrusive investigation	Test Pit and Trench locations have been remediated and reinstated with topsoil, so refuse protrusion far less frequent/significant since 2023
Damage to capping materials	A3, N8 Minor (couple) of noticeable instances	Unchanged from 2022	Unchanged from 2023
Differential settlement & ponding	B2, D7, E4, H4, I7, K4, K5, Ponding near stream and extents, significant at H4	Brown/oily sheen observed at H4 during the 2023 site walkover	C2, C5, D2, D6, D7, E5, J4, J5, K4, L5 Brown oily sheen remains present at H4/I4 during 2024 site walkover
Subsidence or erosion	A3, E4, I5, J8, K6, N7, N8, Subsidence present along extents of landfill, and in centre of area D	Unchanged from 2022	Test Pit and Trench locations have been remediated and reinstated with topsoil. Hence, these conditions have improved from 2023
Leachate Springs	None found		Unchanged from 2023
Surface water quality	No visual changes observed		
Stream bank erosion	None noted		
Burn Piles	None noted	L8, K8, I7 – 3 large burn piles consisting of charred felled trees	No burn piles noted

5.2.1 Pasture Establishment

The pasture appeared mostly lush, in clearly improved condition since 2023, but some localized areas of patchiness or die off remain visible where test pits and trenches had been excavated during the previous FTL intrusive investigation (see Appendix A).

5.2.2 Vegetation die-off

Overall, the vegetation on the banks of the Wharekōrino stream and areas surrounding the landfill appeared to be healthy. Some tree die-off (unconfirmed species) was observed bordering area A, B and C, and some die-off of grasses along the bank of the Wharekōrino Stream was present bordering the area of ponding at area C. (see Appendix A - pages 22/23). Vegetation die-off appeared unchanged between 2023 and 2024.

5.2.3 Refuse protruding through the cap

Protrusion of refuse through the landfill cap has been significantly reduced since 2023, following retopsoiling of FTL intrusive investigation trenches and test pits. Previous instances of refuse protrusion that were unrelated to the FTL intrusive investigation (mostly at landfill extents) remain present (see Appendix A). Overall, refuse protrusion appeared to have reduced between 2023 and 2024.

5.2.4 Damage to capping materials

Overall, only one area of note showing damage to capping materials (i.e. cavity creation) was found in grid A3 prior to completion of the 2022 FTL Intrusive investigation – this was also mentioned in previous WSP reports. Following completion of the FTL intrusive investigation, an additional cavity was identified in grid N8, and areas of test-pitting and trenching have resulted in some localised subsidence. The localised subsidence has been remedied following filling of these areas with topsoil; however the cavities approximately located at Grids A3 and N8 remain present (see Appendix A). Overall, damage to capping materials appeared reduced between 2023 and 2024.

5.2.5 Differential settlement and ponding

Ponding was observed across much of the site, exacerbated during periods of heavy rainfall and unlikely to be reflective of normal weather conditions in some areas. Grid H4/I4 at the border of Area C has shown consistent ponding since the 2017 WSP field visit, and therefore a frequent ongoing ponding problem is likely present (see Appendix A - page 8). Temporary ponding within test-pits and trenches from the FTL intrusive investigation has been resolved following topsoiling of these areas. Overall, differential settlement and ponding at the site has been improved between 2023 and 2024, and only remains an issue in areas where a consistent trend of long-term ponding has been present.

5.2.6 Erosion and Subsidence

There was no erosion noted across the landfill areas. Minor subsidence observed following the FTL intrusive investigation has been remedied following topsoiling of these instances (see Appendix A). Overall, these factors appeared to be unchanged between 2023 and 2024.

5.2.7 Leachate Springs/Seeps

No leachate springs/seeps were observed during the inspection, or during the 2022, 2023, or 2024 inspections. There is one area in grid I4 (Appendix A, pg 23) where ponded water was brown in colour with a surface sheen, but it is suspected this is a natural phenomenon due to iron oxide bacteria, rather than an indicator of leachate seepage.

5.2.8 Visual Surface water quality

The Wharekōrino Stream had a moderate upstream and low downstream flow rate and was mostly clear with localised areas of clouding and surface scum observed during both the May and September visits. Flow rate was generally higher at S1, showing a gradual reduction with proximity to S2. Water appeared mostly stagnant at S2.

5.2.9 Erosion at or near the Wharekōrino Stream Bank

No significant erosion was observed along the stream bank of the Wharekōrino stream. Debris build-up at the fence line and ponding in the paddock (both remaining since 2022 FTL visit) suggest that when flows are high, the capacity of the stream banks is exceeded and the overflow spills and ponds into low lying pasture.

5.2.10 Burn Piles

No burn piles were identified during the September site walkover. Remnants of a pile of felled trees were present in grid J8, however, no burned material was identified; only sawdust and bark were present (see Appendix A – page 26).

Photographs presented in Appendix A in this report have been aggregated with the intention of focusing on both general site condition and significant site walkover observations from the 2024 Site Walkover.

6 DISCSUSSION

6.1 Wharekōrino Stream

Generally, during the 2024 sampling events, stream water samples had neutral to slightly acidic pH, low levels (but higher than normal) of suspended solids and electrical conductivity, low boron and low chloride levels. Heavy metal concentrations were typically considerably lower than all comparable ANZECC criteria.

Total Iron concentrations were found to be in exceedance of the ANZECC long term Irrigation (100 years), and the Drinking water standards for Aesthetics (2005-2008), in samples S1, S2 and S3 by approximately 8-10x guideline values during the May 2024 sampling event, and by 4-5x guideline values during the September 2024 sampling event. Total Iron concentration ranges were relatively consistent by location across both sampling events (May 2024 – range of 1.56-1.98g/m^3 & September 2024 – range of 0.78-0.89g/m^3). The downstream sampling results at S3 (1.81g/m^3, 0.78g/m^3) and S2 (1.98g/m^3, 0.89g/m^3) are similar or only slightly higher (0-26%) than the upstream sampling results at S1 (1.56g/m^3, 0.79g/m^3) and hence show only a minor indicator of potential leachate seepage effects. The low levels of dissolved iron in corresponding groundwater samples suggest this effect is not landfill related, but more likely other natural phenomena.

Furthermore, iron is only considered a cause for concern in situations where the water is used for continuous long-term irrigation (>100 years). The long-term value applied above (0.2g/m^3) is significantly lower than the short-term use (up to 20 year) value (10g/m^3). Pūniu River Care do have a surface water take from the Wharekōrino Stream below Te Mawhai Road for their nursery operation, but the nursery plants would only be watered for a short time until of a sufficient size to leave the nursery for planting elsewhere. Hence, these elevated iron levels are not considered a cause for concern and in any case are considered not to be attributable to the landfill.

Nitrate levels in stream samples from the May 2024 sampling event were found to be below the applicable ANZECC 95% Level of protection for freshwater, while the nitrate levels in samples from the September 2024 sampling event were elevated above ANZECC 95% Freshwater guidelines for aquatic species protection (all approximately 3x higher than May levels). Nitrate levels were consistent across all stream sampling locations tested at each visit, ranging between 0.58-0.67 g/m^3 in the May 2024 samples, and 1.89-1.94 g/m^3 in the September 2024 samples, and are slightly higher at the upstream sample location (S1) compared with the downstream samples. Hence, the nitrate results in the stream do not show any indication of being affected by the landfill. Instead, nitrate concentrations in the stream are more likely attributed to grazing activity and fertiliser application in the stream catchment.

All stream site samples recorded boron levels below the ANZECC 95% Freshwater guidelines for aquatic species protection and the MoH Drinking Water Standards for Health (Appendix B). Historical data, including the 2024 sampling results, show that boron levels are consistently higher downstream of the landfill (Figure 2), with concentrations at location S2 (downstream) being slightly higher than at S3 (midstream). This indicates that boron is leaching from the landfill into the stream, as in other years, and is supported by the groundwater results (see below).

PAHs were not detected above the laboratory limit of detection, which is consistent with all previous sampling rounds over the period 2016-2024. Mercury was also not detected, which is consistent with long term trends.

Overall, the water quality results indicate in our opinion that the historic landfilling activity is not affecting the surface water quality in the stream, other than for boron.

6.2 Bore Water

Bore P7 has been observed as dry and no sampling was able to take place. This is consistent with previous sampling events.

Nitrate levels in groundwater samples from Bore location P2 were elevated above the ANZECC 95% freshwater guidelines for aquatic species, with a value of 0.02 g/m^3 (May) and 3g/m^3 (September) compared with the guideline value of 0.7 g/m^3. It is worth noting that the May value is significantly lower, and the September value is significantly higher than the 2023 sampling results.

Historical nitrate levels for the P2 Bore site have been highly variable, fluctuating from 0.0039-14.2 g/m^3 over the period from October 2015 to present. Values over 0.7 g/m^3 exceed the thresholds for aquatic species protection (95%). Therefore, it is possible that these values will exceed ANZECC guidelines in the future, as was found to be the case in the September 2024 sampling round.

The P2 bore site has consistently higher and more variable nitrate levels than the stream sites, and results from the 2024 sampling events support this trend. However, contrary to the prior five test results, nitrate concentrations in the P2 bore water have increased in the results of the September sampling event (first increase in the last three years). However, this has not impacted on stream water quality, as the downstream sampling site (S2) has lower nitrate levels than the upstream site (S1). The nitrate groundwater results are more likely attributable to farming activities (grazing, fertiliser application) within the groundwater catchment than the landfill.

Water from Bore P2 produced a level of 38 g/m^3 of dissolved boron in the May sampling results, and a level of 18 g/m^3 in the September sampling results. These results maintain the trend of historic results from sampling events in the first half of the year having roughly double the average dissolved boron levels than samples taken during the second half of the year, since 2015. Generally, historical data shows a regular seasonal fluctuation of dissolved boron levels and an overall decline over time.

Historic data indicates a possible relationship between boron levels at the bore (P2) and downstream (S2) sites (Figure 4). This relationship along with the higher boron levels downstream (S2) compared with upstream (S1) suggests possible contamination from groundwater seepage through the landfill into the stream. However, as stated above all contaminant levels in the stream have remained below ANZECC Freshwater guidelines for aquatic species 95% protection.

6.3 Landfill Assessment

Following intrusive investigations by Fraser Thomas Limited during 2022-24, retopsoiling of test pit areas showing localised settling in February 2024 has effectively eliminated this issue, other than for a few areas which still appear to have patchy grass growth. Some unidentified trees adjacent to the landfill, as well as grasses alongside the Wharekōrino Stream bank showed signs of dieback. Area C has continued to show frequent ponding conditions, which appeared brown with a surface sheen (possible natural ferrous oxide production by bacteria) on the surface during the 2024 site walkover where the ponded water has settled and been isolated from the stream. Wharekōrino Stream continued to present a clear and, in places, slightly cloudy appearance, with debris build-up at the fence line and ponding in the paddock indicative of stream bank overtopping during periods of high stream flows. Apart from the retopsoiled areas, observations of ponding, subsidence and erosion, surface water quality and stream bank erosion appear generally unchanged since the 2023 intrusive investigation.

7 CONCLUSIONS AND RECOMMENDATIONS

Long term monitoring data appears to show that boron is leaching from the landfill into the stream. The likely source is coal ash, which is understood to have been used as a cover material in some landfilling areas.

Water quality test parameters should be reviewed and discussed with WRC this year, as some parameters have consistently not been detected for many sampling rounds (e.g. mercury, PAHs). Similarly, some consent requirements, such as stream flow measurement, should be discussed with WRC, as these have never been reported on to our knowledge and never been raised as an issue by WRC.

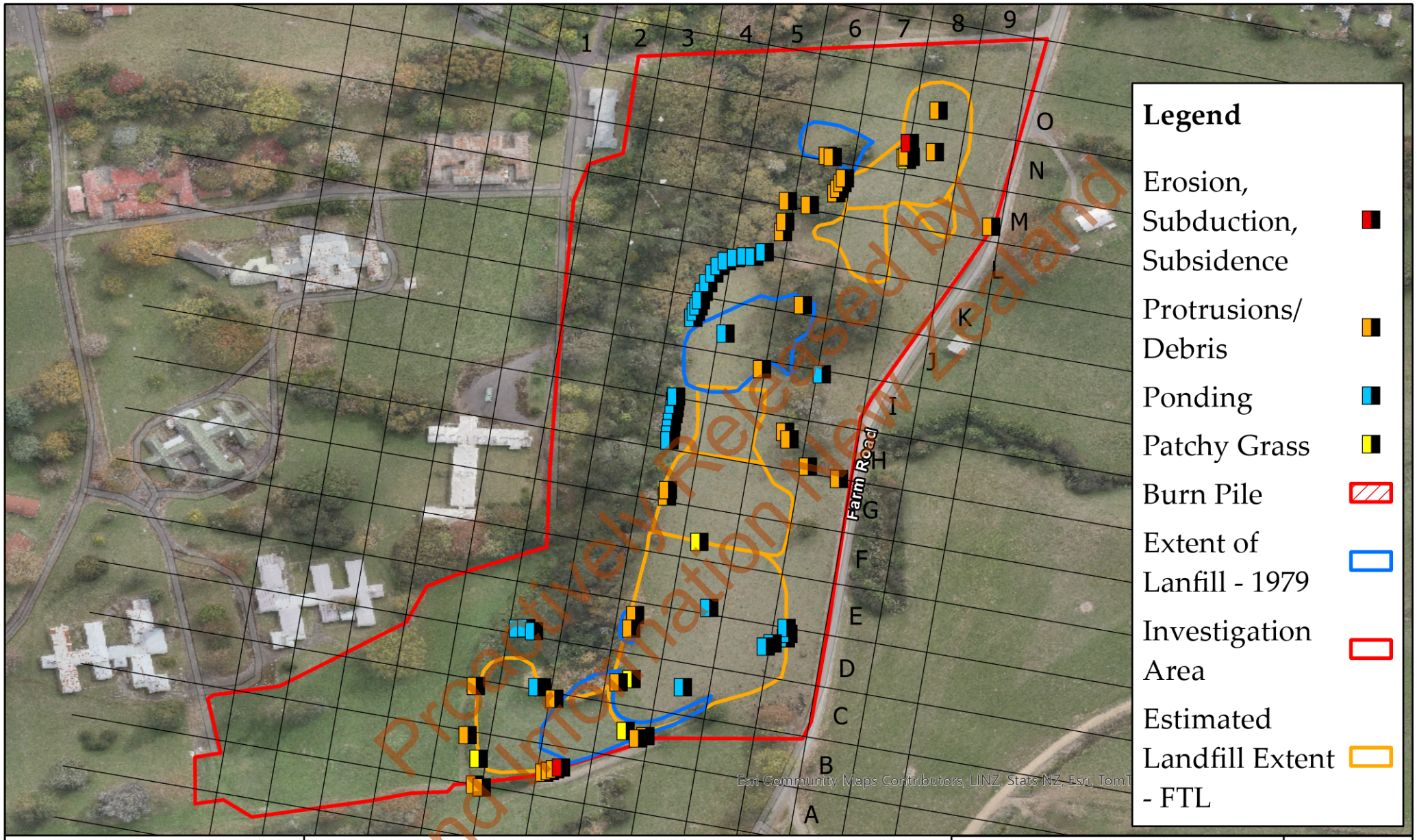
Grid walkover survey findings were similar to the 2023 Fraser Thomas Investigation, with changes detailed in Table 4. Overall, ground surface conditions appear to have improved since 2022 and 2023 following

completion of retopsoiling areas of test pit and trench subsidence, which was recommended in the 2023 report; however, most site features of note remain largely unchanged.

Landfill repair and upgrade works are proposed to address some potential long term issues with the existing landfill. These works will address the majority of the minor issues identified above. These works are described in the separate resource consent application to be lodged shortly by SLR on behalf of LINZ.

Appendix A

Landfill Grid Walkover Survey



Fraser Thomas
ENGINEERS · RESOURCE MANAGERS · SURVEYORS

Appendix A - Site Features Plan

Toitū Te Whenua Land Information New Zealand
Landfill Grid Walkover Survey
Tokanui Closed Landfill, Te Awamutu
Wharekorino Stream & Bore Water Sampling
Water Quality Annual Report - 2024

Date:	18/11/2024
Figure Reference:	33097/A
Drawn by:	BLM
Reviewed by:	SF
Job Number:	33097

N

0 25 50 100 150 200 250
Meters

Tokanui Closed Landfill

Grid Walkover 2024

A1

A1

A2

A2

A3

A3

B1

B1

B2

B2

B3

B3

B4

B4 Patchy Vegetation Growth

B5

B5

B6

B6

C2

C2

C2 Minor Ponding

C3

C3

C4 Patchy Vegetation Growth

C4

C4

C5

C5

C5 Ponding

C6

C6

C7

C7

D2

D2 Ponding

D2

D4

D4

D5

D5

D6

D6

D6 Minor Ponding

D7

D7 Ponding

D7

E4

E4

E5

E5 Minor Ponding

E5

E6

E6

E7

E7

F4

F4

F5

F5

F5 Patchy Vegetation Growth

F6

F6

F7

F7

G4

G4

G5

G5

G6

G6

G7

G7

G7

H4

H4 Ponding

H4

H5

H5

H6

H6

H6 Debris

I4

H7

H7

I4

I4 Ponding

I4 Ponding sheen

I5

I5

I6

I6

I7

I7

J4

J4

J5

J5 Ponding

J5

J6

J6

J7

J7

J8

J8

K4

K4

K6

K6

K8

K8

L5

L5 Ponding

L5

L6

L6

L7

L7

L8

L8

L9

L9

M7

M7

M7

M8

M8

M9

M9

M9 Debris

M9

N6

N6

N7

N7 Debris

N7

N8

N8 Subduction

N8

N9

N9

O5

O5

O6

O6

O8

O9

P7

P7

P8

P8

P9

P9

Appendix B

Sampling Results and Lab Transcripts

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28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

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Certificate of Analysis

Client:	Fraser Thomas Limited	**Lab No:**	3566987 SPv1
Contact:	Dr S Finnigan	**Date Received:**	01-May-2024
	C/- Fraser Thomas Limited	**Date Reported:**	09-May-2024
	PO Box 204006	**Quote No:**	117021
	Highbrook	**Order No:**	PO001099
	Auckland 2161	**Client Reference:**	LINZ Six Monthly Landfill Monitoring - Water
		Submitted By:	Elliot Bish

Sample Type: Aqueous

Sample Name:		P2	S1	S4	S2	S3
Lab Number:		3566987.1	3566987.2	3566987.3	3566987.4	3566987.5
Individual Tests						
pH	pH Units	6.5	6.9	-	6.8	6.9
Total Alkalinity	g/m³ as $CaCO_3$	310	-	-	-	-
Electrical Conductivity (EC)	mS/m	93.7	13.1	-	13.6	13.5
Total Suspended Solids	g/m³	-	6	-	9	3
Dissolved Boron	g/m³	38	-	-	-	-
Total Boron	g/m³	-	0.0154	-	0.085	0.070
Dissolved Iron	g/m³	0.03	-	-	-	-
Total Iron	g/m³	-	1.56	-	1.98	1.81
Dissolved Mercury	g/m³	< 0.00008	-	-	-	-
Total Mercury	g/m³	-	< 0.00008	-	< 0.00008	< 0.00008
Total Potassium	g/m³	-	3.8	-	4.0	4.1
Chloride	g/m³	17.2	16.9	-	16.4	16.9
Total Ammoniacal-N	g/m³	0.013	0.080	-	0.031	0.094
Nitrite-N	g/m³	< 0.002	0.012	-	0.007	0.012
Nitrate-N	g/m³	0.024	0.67	-	0.60	0.58
Nitrate-N + Nitrite-N	g/m³	0.024	0.68	-	0.60	0.59
Sulphate	g/m³	185	5.1	-	5.2	5.1
Total Organic Carbon (TOC)	g/m³	5.5	-	-	-	-
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	-	< 0.000008	-	-
Acenaphthylene	g/m³	-	-	< 0.000008	-	-
Anthracene	g/m³	-	-	< 0.000008	-	-
Benzo[a]anthracene	g/m³	-	-	< 0.000008	-	-
Benzo[a]pyrene (BAP)	g/m³	-	-	< 0.000008	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	-	< 0.000008	-	-
Benzo[g,h,i]perylene	g/m³	-	-	< 0.000008	-	-
Benzo[k]fluoranthene	g/m³	-	-	< 0.000008	-	-
Chrysene	g/m³	-	-	< 0.000008	-	-
Dibenzo[a,h]anthracene	g/m³	-	-	< 0.000008	-	-
Fluoranthene	g/m³	-	-	< 0.000008	-	-
Fluorene	g/m³	-	-	< 0.000008	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	-	< 0.000008	-	-
Naphthalene	g/m³	-	-	< 0.00004	-	-
Phenanthrene	g/m³	-	-	< 0.000008	-	-
Pyrene	g/m³	-	-	< 0.000008	-	-

Analyst's Comments

Sample 1 Comment:
Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 200-300% at the 95% confidence level).

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq	Liquid / liquid extraction, GC-MS/MS analysis. In-house based on US EPA 8270.	0.000005 g/m³	3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2, 4-5
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	2, 4-5
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-2, 4-5
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) : Online Edition.	1.0 g/m³ as $CaCO_3$	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-2, 4-5
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) : Online Edition.	3 g/m³	2, 4-5
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B : Online Edition.	-	1
Filtration for dissolved metals analysis - Misc	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B : Online Edition.	-	1
Dissolved Boron	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.005 g/m³	1
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0053 g/m³	2, 4-5
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.02 g/m³	1
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m³	2, 4-5
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	1
Total Mercury	Bromine Oxidation followed by Atomic Fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	2, 4-5
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.053 g/m³	2, 4-5
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m³	1-2, 4-5
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m³	1-2, 4-5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m³	1-2, 4-5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m³	1-2, 4-5
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m³	1-2, 4-5
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m³	1-2, 4-5
Total Organic Carbon (TOC)	Supercritical persulphate oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC -TIC.The uncertainty of the calculated result is a combination of the uncertainties of the two analytical determinands in the subtraction calculation. Where both determinands are similar in magnitude, the calculated result has a significantly higher uncertainty than would normally be achieved if one of the results was significantly less than the other. In such cases, the elevated uncertainty should be kept in mind when interpreting the data. APHA 5310 C (modified) : Online Edition.	0.5 g/m³	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 03-May-2024 and 09-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Martin Cowell - BSc
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Fraser Thomas Limited	**Lab No:**	3674981 SPv1
Contact:	Dr S Finnigan	**Date Received:**	18-Sep-2024
	C/- Fraser Thomas Limited	**Date Reported:**	25-Sep-2024
	PO Box 204006	**Quote No:**	117021
	Highbrook	**Order No:**	PO001163
	Auckland 2161	**Client Reference:**	LINZ Six Monthly Landfill Monitoring - Water
		Submitted By:	Elliot Bish

Sample Type: Aqueous

Sample Name:		S1	S2	S3	S4	P2
Lab Number:		3674981.1	3674981.2	3674981.3	3674981.4	3674981.5
Individual Tests						
pH	pH Units	6.6	6.7	6.6	-	6.8
Total Alkalinity	g/m³ as $CaCO_3$	-	-	-	-	350
Electrical Conductivity (EC)	mS/m	13.6	14.3	14.0	-	82.7
Total Suspended Solids	g/m³	7	14	5	-	-
Dissolved Boron	g/m³	-	-	-	-	18.0
Total Boron	g/m³	0.0172	0.067	0.053	-	-
Dissolved Iron	g/m³	-	-	-	-	< 0.02
Total Iron	g/m³	0.79	0.89	0.78	-	-
Dissolved Mercury	g/m³	-	-	-	-	< 0.00008
Total Mercury	g/m³	< 0.00008	< 0.00008	< 0.00008	-	-
Total Potassium	g/m³	3.4	3.5	3.4	-	-
Chloride	g/m³	18.4	18.7	18.5	-	10.3
Total Ammoniacal-N	g/m³	0.136	0.118	0.138	-	< 0.010
Nitrite-N	g/m³	0.016	0.015	0.016	-	< 0.002
Nitrate-N	g/m³	1.94	1.89	1.93	-	3.0
Nitrate-N + Nitrite-N	g/m³	1.95	1.91	1.95	-	3.0
Sulphate	g/m³	5.9	6.4	6.3	-	97
Total Organic Carbon (TOC)	g/m³	-	-	-	-	0.6
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	-	-	< 0.000008	-
Acenaphthylene	g/m³	-	-	-	< 0.000008	-
Anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]pyrene (BAP)	g/m³	-	-	-	< 0.000008	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	-	-	< 0.000008	-
Benzo[g,h,i]perylene	g/m³	-	-	-	< 0.000008	-
Benzo[k]fluoranthene	g/m³	-	-	-	< 0.000008	-
Chrysene	g/m³	-	-	-	< 0.000008	-
Dibenzo[a,h]anthracene	g/m³	-	-	-	< 0.000008	-
Fluoranthene	g/m³	-	-	-	< 0.000008	-
Fluorene	g/m³	-	-	-	< 0.000008	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	-	-	< 0.000008	-
Naphthalene	g/m³	-	-	-	< 0.00004	-
Phenanthrene	g/m³	-	-	-	< 0.000008	-
Pyrene	g/m³	-	-	-	< 0.000008	-

Analyst's Comments

Sample 5 Comment:
Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (>300% at the 95% confidence level).

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq	Liquid / liquid extraction, GC-MS/MS analysis. In-house based on US EPA 8270.	0.000005 g/m^3	4
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3, 5
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-3
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-3, 5
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) : Online Edition.	1.0 g/m^3 as $CaCO_3$	5
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-3, 5
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) : Online Edition.	3 g/m^3	1-3
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B : Online Edition.	-	5
Filtration for dissolved metals analysis - Misc	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B : Online Edition.	-	5
Dissolved Boron	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.005 g/m^3	5
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0053 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.02 g/m^3	5
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	5
Total Mercury	Bromine Oxidation followed by Atomic Fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.053 g/m^3	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-3, 5
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-3, 5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3, 5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-3, 5
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3, 5
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-3, 5
Total Organic Carbon (TOC)	Supercritical persulphate oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC -TIC.The uncertainty of the calculated result is a combination of the uncertainties of the two analytical determinands in the subtraction calculation. Where both determinands are similar in magnitude, the calculated result has a significantly higher uncertainty than would normally be achieved if one of the results was significantly less than the other. In such cases, the elevated uncertainty should be kept in mind when interpreting the data. APHA 5310 C (modified) : Online Edition.	0.5 g/m^3	5

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 19-Sep-2024 and 24-Sep-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental