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ENGINEERS • RESOURCE MANAGERS • SURVEYORS

MEMORANDUM

Date: 20 August 2025 33097

From: S Finnigan

Subject: Former Tokanui Hospital: Estimated Effect of Landfill Upgrade Works on Boron Discharges (V2)

To: Emily Buckingham (emily.buckingham@slrconsulting.com)

1.0 INTRODUCTION

This memo summarises our assessment of the estimated likely reduction in boron discharges to the Wharekōrino Stream as a result of improved landfill capping and groundwater diversion from the landfill, in response to a question raised by Mana Whenua during a site meeting to discuss the landfill repair and upgrade works.

2.0 BACKGROUND INFORMATION

Long-term monitoring (consent compliance) of groundwater downgradient of the landfill, and surface waters in the Wharekōrino Stream upstream and downstream, has indicated that dissolved boron levels from groundwater sampled at monitoring bore P2 exceed Australian and New Zealand Environment and Conservation Council (ANZECC) trigger levels for the protection of 95% of freshwater species. This results in elevated total boron concentrations in mid-stream and downstream samples of the Wharekōrino Stream, but still well within the ANZECC 95% trigger thresholds. These findings are depicted in Figures 1 and 2 below.

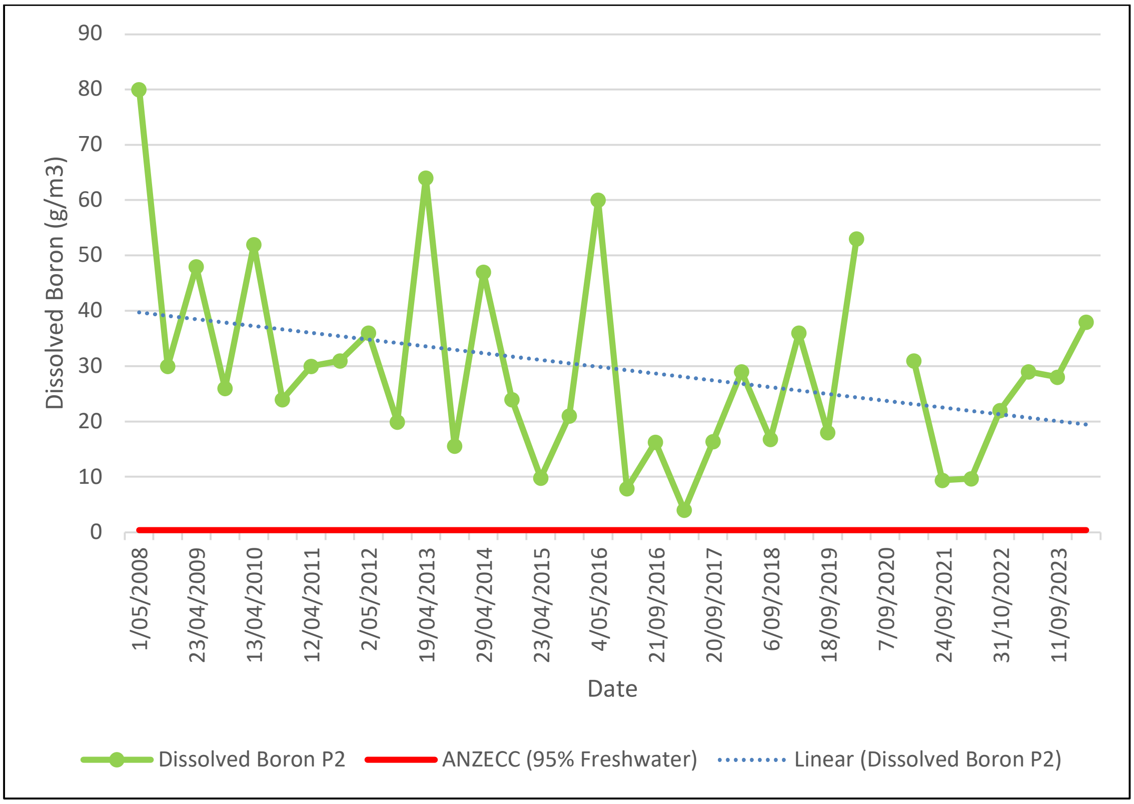


Figure 1: Long term dissolved boron levels (g/m^3) within the landfill (P2)

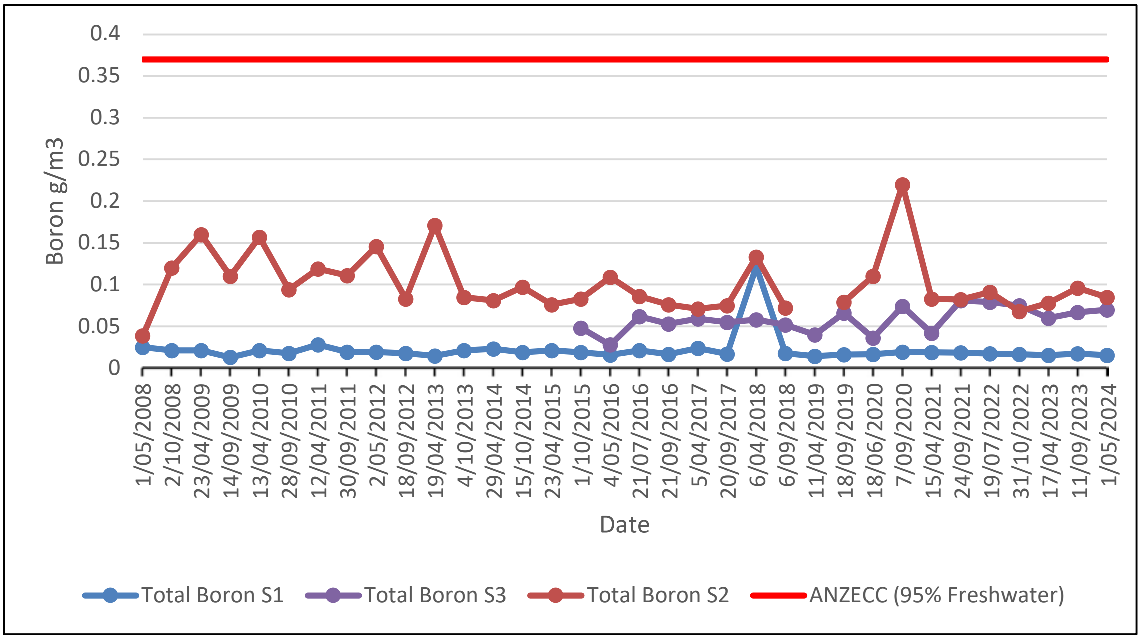


Figure 2: Long-term total boron levels (g/m³) upstream (S1), midstream (S3), and downstream (S2) of the landfill in comparison to the ANZECC trigger value for protection of 95% of aquatic species. Note that the ANZECC boron trigger referred to above comes from the 2000 guidelines and was increased in 2021 to 0.94mg/kg (approximately 3 times higher) based on errors identified in the 2000 derivation and new data becoming available.

Boron leaching to groundwater and the stream currently occurs via two main pathways:

(a) Shallow groundwater from upgradient travelling through the refuse to the stream.

(b) Rainfall infiltrates through the landfill and passes through the refuse, and then combines with shallow groundwater going to the stream.

The current situation and these pathways are illustrated in Figure 3 below.

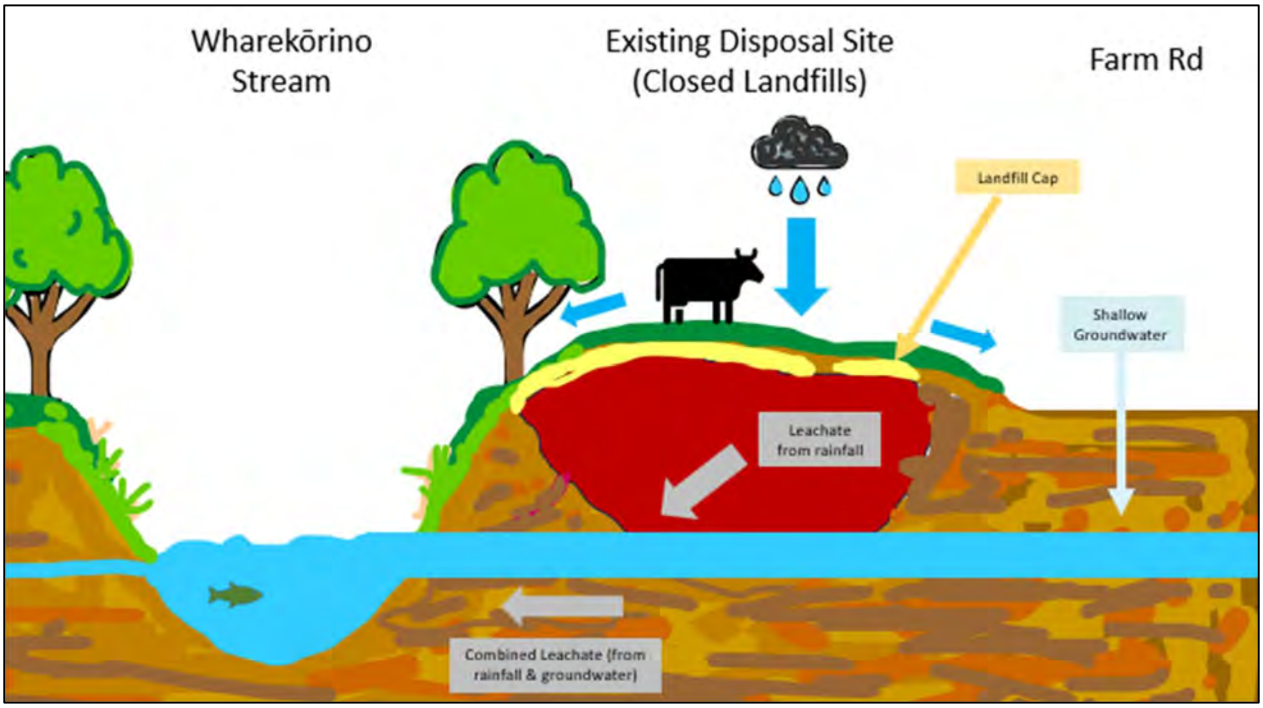


Figure 3: Current Boron Leaching Pathways to Stream

The proposed landfill upgrade and repair works will address both these issues, by:

(a) Installing an improved GCL (geosynthetic clay liner) cap that will significantly reduce rainfall infiltration into the landfill and hence leachate generation from rainfall.

(b) Installing a groundwater cutoff drain upgradient of the southern landfill area that will intercept shallow groundwater and divert it around the landfill to the stream. This will significantly reduce (and potentially eliminate) shallow groundwater contact with refuse in the southern landfill area.

The upgrade situation and the effects of this on boron leaching pathways to the stream are illustrated in Figure 4 below.

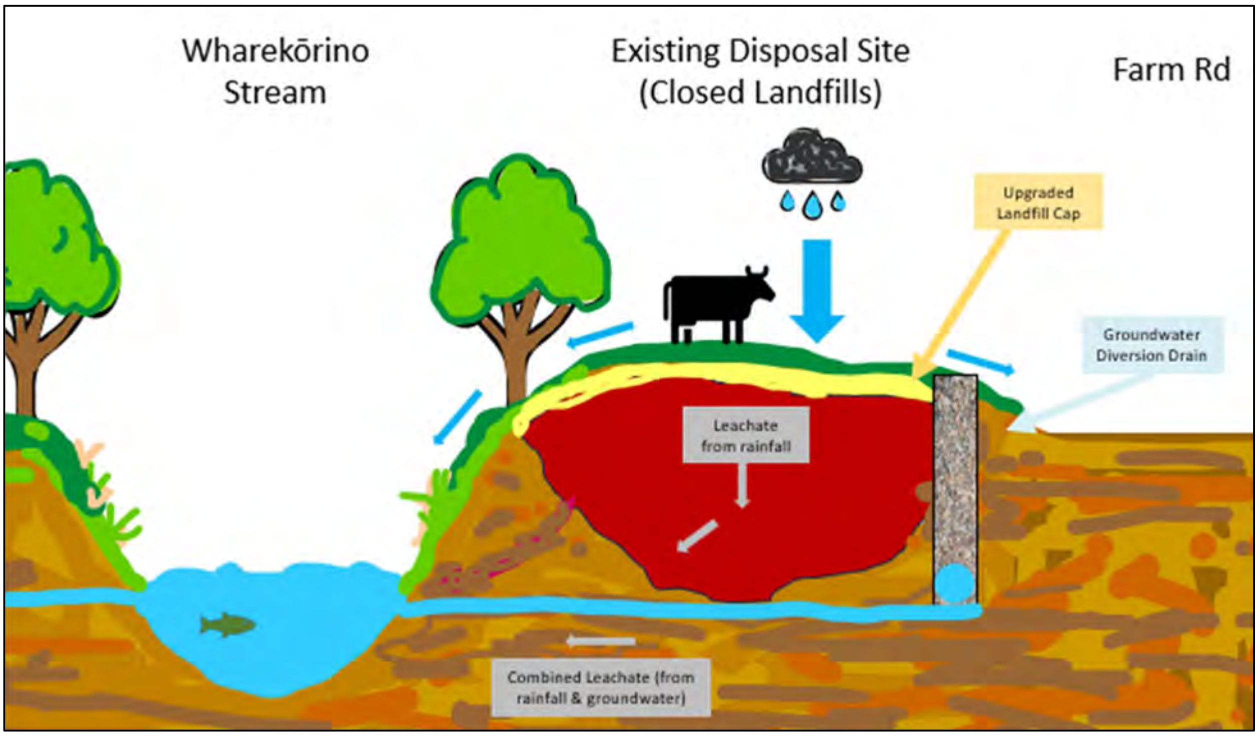


Figure 4: Post-Upgrade Works, Reduced Boron Leaching Pathways to Stream

3.0 METHODOLOGY

The methodology used in this assessment is set out below:

1. Estimate annual average stream flows in the Wharekōrino stream by the landfill, using two methods:
   (a) Catchment analysis, using average annual rainfall data (1,119mm) from the nearby NIWA Waikeria rain gauge – 30-year record (1991-2020).
   (b) Using Waikato Regional Council Pūniu River flow gauge data for mean stream flows to estimate corresponding stream flows in the Wharekōrino Stream on a pro rata area basis (440ha catchment vs 518.7km^2 catchment).
2. Analysing the long-term stream monitoring data over the last 10 years, calculating the difference in boron concentrations between upstream and downstream sampling locations for each sampling event and then calculating the average change (increase) in boron concentration in the stream.

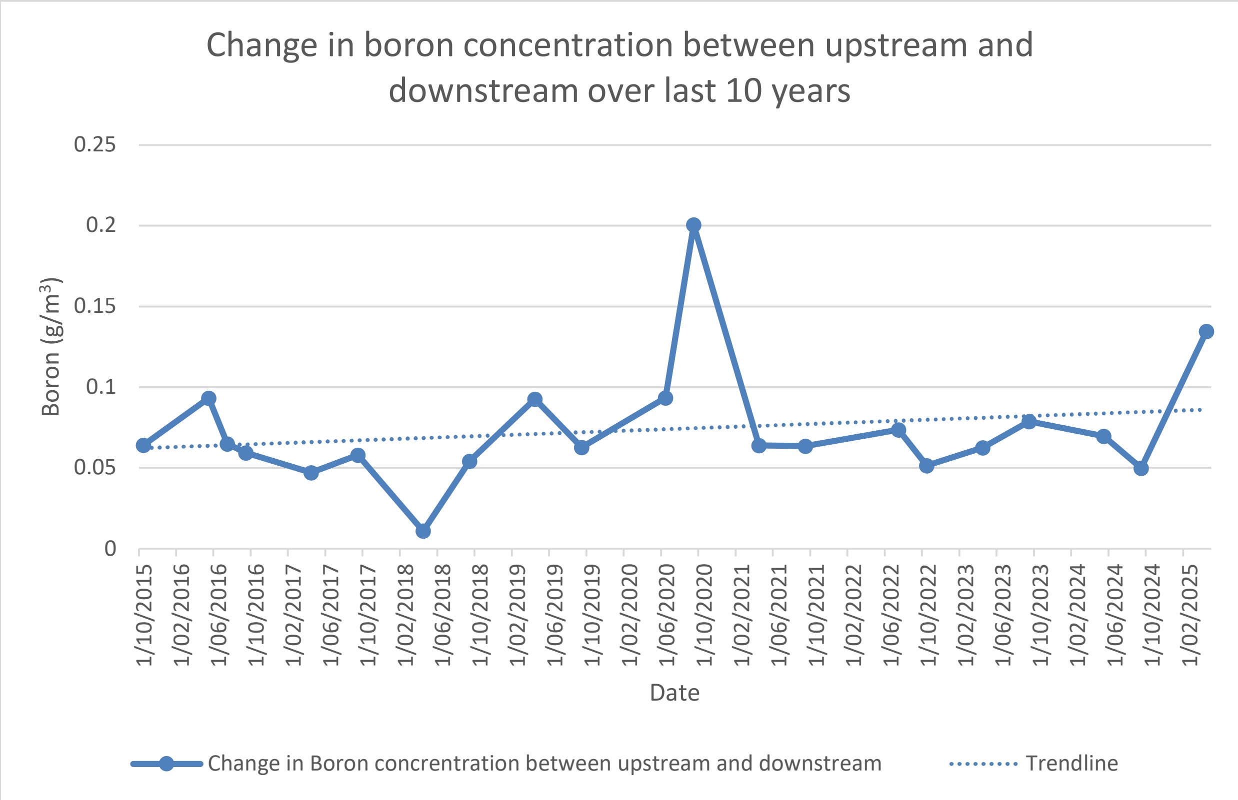


Figure 5: Change in boron concentration upstream and downstream of landfill over the last 10 years

3. Estimating the annual average boron discharge to the stream (kg/yr) as average annual stream flow x average change in concentration for each stream flow method.
4. Calculating the long-term boron concentration from monitoring data in the groundwater monitoring well, P2, and assuming this is representative of the average boron concentration in the groundwater discharge to the stream from the entire landfill.
5. Hence, calculate the average annual leachate flow to the stream as boron discharge to stream/boron concentration in groundwater.
6. Calculate the estimated annual average leachate volume from rainfall onto the landfill, based on measured landfill areas from site investigations, average annual rainfall (Waikeria rainfall gauge) and estimated infiltration rates of 10-25%.
7. Hence, calculate the estimated leachate volume from shallow groundwater flowing through the landfill by difference.
8. Check whether this makes sense by comparing estimated groundwater leachate volumes with theoretical volumes based on Darcy's Law (Q = kiA), where k = refuse permeability, i = hydraulic gradient of groundwater and A = cross-sectional area of groundwater in contact with refuse. Literature values of refuse hydraulic conductivity vary between around 1 x 10^{-3}m/s and 1x10^{-9}m/s (source: LANDSS). For Tokanui, the permeability is considered likely to be at the high end of this range, or even more permeable, based on the age of the landfill, anecdotal information on refuse placement and site observations. The hydraulic gradient was estimated by plotting groundwater level information on representative cross-sections through the landfill. Figure 6 shows a cross-section through the southern landfill area. This information was also used to estimate the average depth and width of groundwater in contact with refuse, thereby determining the cross-sectional area.
9. The effect of the landfill upgrade and repair works on leachate flows and boron discharges to the stream was then estimated, as follows:
   (a) Assume capping reduces the leachate infiltration rate to 2-5% and calculate the revised leachate volume from rainfall.
   (b) Assumed the groundwater intercept trench reduces the amount of groundwater in contact with refuse by 80-90%.
   (c) Calculate the revised average annual leachate volume as the sum of rainfall and groundwater-derived leachate.

(d) Assume that the average annual boron concentration in leachate remains the same as measured at P2.
(e) Hence, calculate the reduced boron discharge to the stream in kg/yr (reduced volume x same concentration).
(f) Calculate the percentage reduction in the boron discharge by comparison with the pre-works discharge.
(g) Calculate estimated revised boron concentrations in the stream, compared with the current situation.
(h) Estimate the time it will take for the reduced concentrations to be achieved, taking into account typical groundwater travel times.

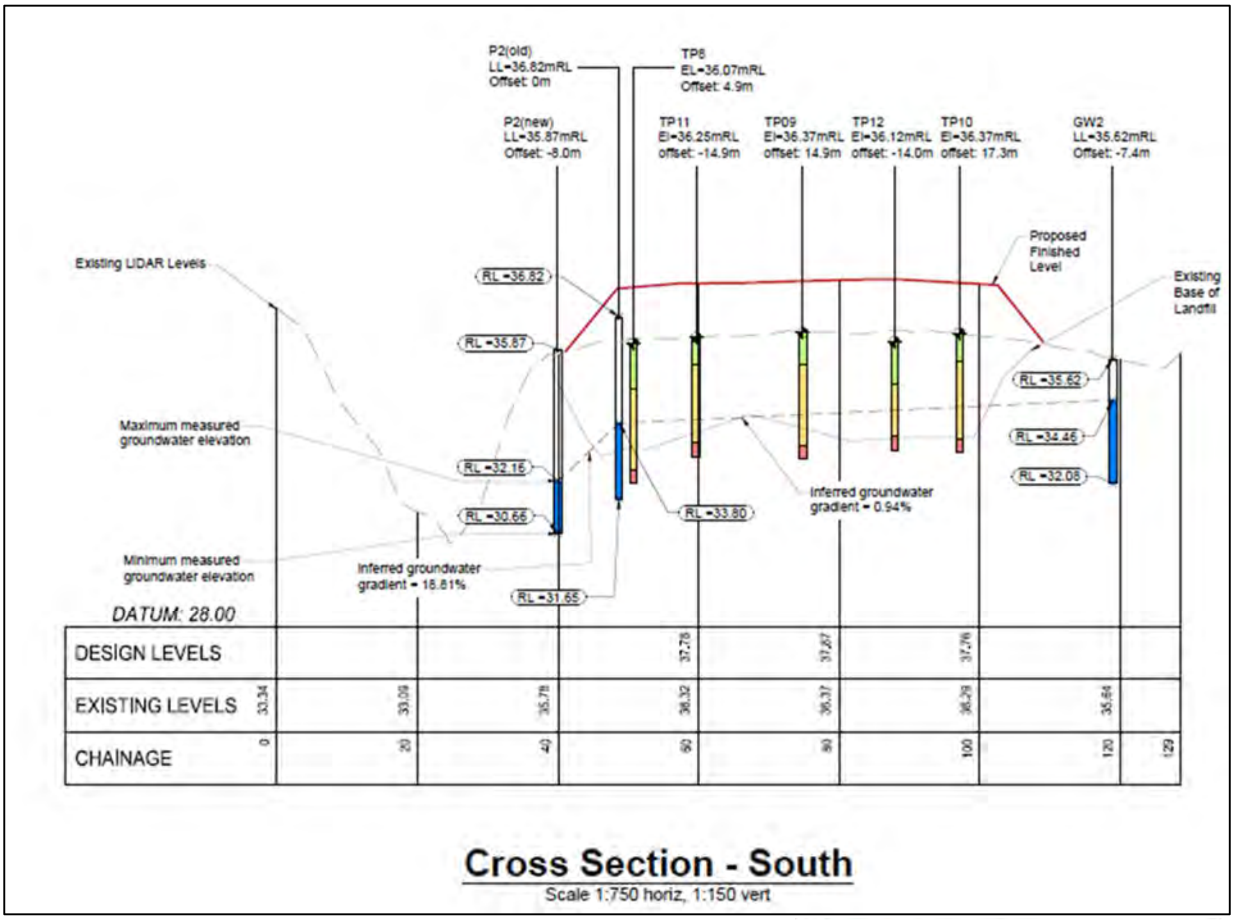


Figure 6: Cross-section – South showing refuse (yellow) and groundwater (blue) extents

4.0 RESULTS

4.1 Estimated Boron Discharge Reduction

The results are summarised in Table 1, with calculations attached in Appendix A. They show that current leachate discharges to the stream are estimated to be in the range of 5,787-11,260m^3/yr, representing 0.29% of average stream flows. The proposed landfill upgrade and repair works will reduce these to an estimated 468-2,700m^3/yr, equivalent to percentage reductions of 72-92% and equating to 0.02-0.07% of annual average stream flows.

Table 1: Summary of Boron Discharge Reduction Results

Item	Stream Flow Method 1 (from rainfall data)		Stream Flow Method 2 (from river flow data)	
Current Situation				
Average annual Stream Flow (m^3/yr)	1,970,261		3,833,394	
Average annual change in boron concentration in stream due to landfill (g/m^3)	0.0738		0.0738	
Average annual boron load to stream (kg/yr)	145		283	
Average Boron Concentration in GW Well, P2 (g/m^3)	25.1		25.1	
Annual average leachate flow to stream (m^3/yr)	5,787		11,260	
Rainfall infiltration rate through landfill (%)	10	25	10	25
Leachate from rainfall (m^3/yr)	1,709	4,273	1,709	4,273
Leachate from groundwater (m^3/yr)	4,078	1,514	9,551	6,987
Effect of Landfill Remedial Works				
Rainfall infiltration rate through landfill (%)	2-5	2-5	2-5	2-5
Leachate from rainfall (m^3/yr)	316-790	316-790	316-790	316-790
Groundwater diversion from landfill (%)	80-90	80-90	80-90	80-90
Leachate from groundwater (m^3/yr)	408-816	151-303	955-1,910	699- 1,397
Total reduced leachate discharge to stream (m^3/yr)	724-1,606	468-1,093	1,271-2,700	1,015-2,188
Reduction in Leachate Discharge to Stream (%)	**72-88**	**81-92**	**76-89**	**81-91**

4.2 Estimated Revised Boron Concentrations in Stream

Actual and estimated annual average boron concentrations in the stream are summarised below and illustrated in Figure 7:

- Existing average annual upstream concentration = 0.0022g/m^3
- Existing average annual downstream concentration = 0.0957g/m^3
- Average estimated downstream concentration post-upgrade works:
    - Rainfall method = 0.00082-0.0227g/m^3
    - Stream flow method = 0.00089-0.0199g/m^3

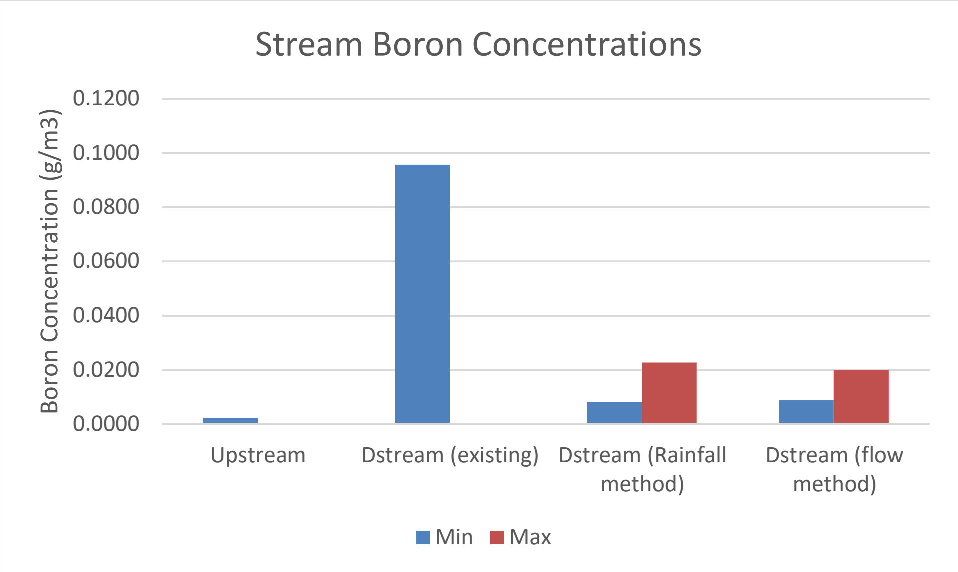


Figure 7: Estimated Downstream Boron Concentrations in Stream Compared with Existing Situation (Upstream and Downstream)

4.3 Estimated Time for Reduced Boron Concentrations to be Achieved

Groundwater travels relatively slowly through the ground, both horizontally and vertically, depending on a range of factors, including the hydraulic gradient and soil permeability. Estimated groundwater travel times have been calculated based on the following:

- A cross-section through the southern landfill, with groundwater having to travel 70m from monitoring well GW2 to the existing P2 well and then another 23m to the stream (refer Figure 6).
- An average hydraulic gradient between GW2 and P2 (old) of 0.94% and from P2 (old) to the stream of 10.4%.
- Variable permeabilities for groundwater to travel through refuse ranging from 0.01-0.001m/s and through natural ground, assuming relatively poor drainage conditions of 0.0001-0.000001m/s.

This gives an estimated groundwater travel time range of from 34 days to 7.2 years. Hence, it may take some months to years for the landfill upgrade and repair works to be reflected in corresponding reductions in boron concentrations reaching the stream.

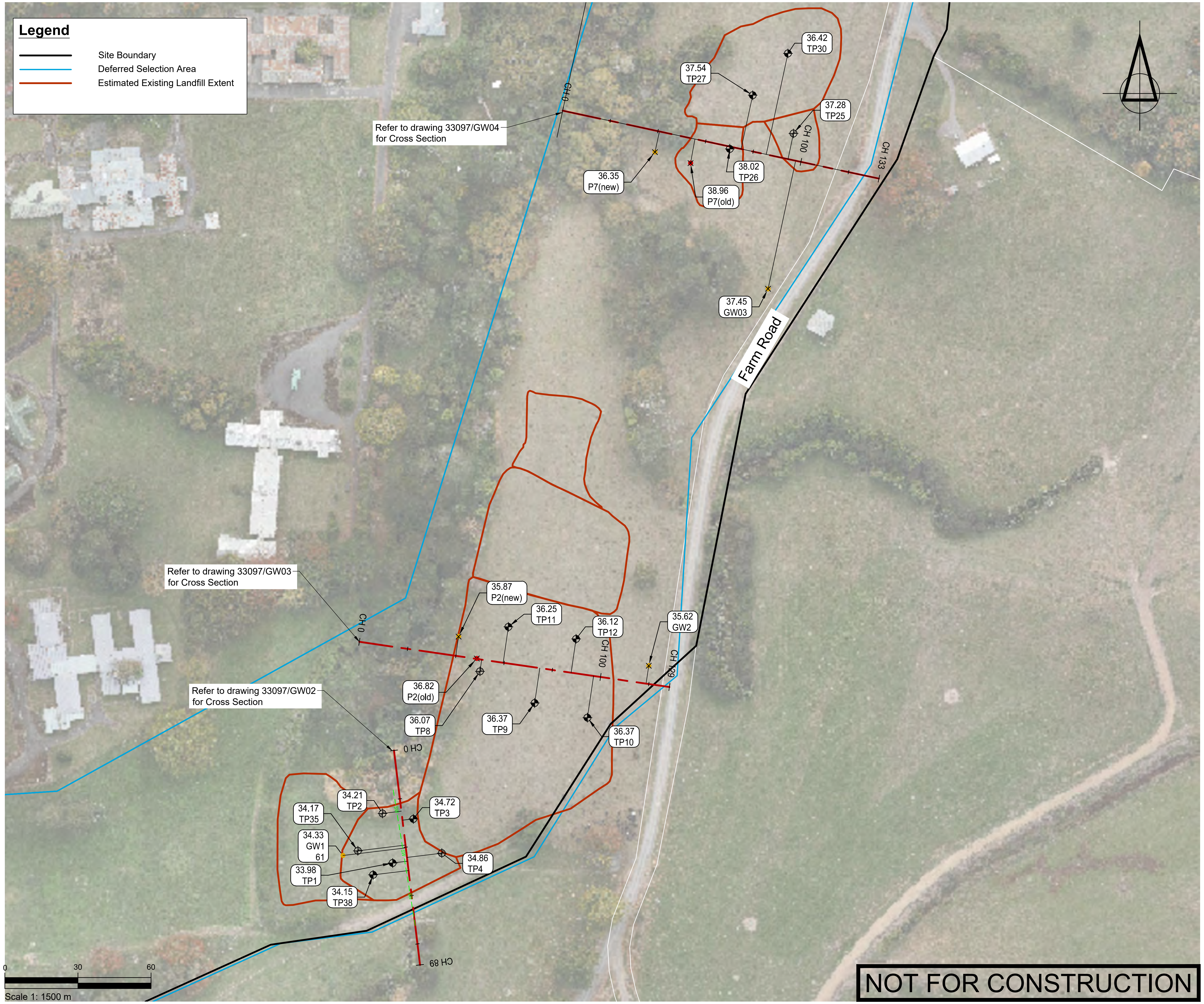
5.0 CONCLUSIONS AND RECOMMENDATIONS

Ongoing long-term consent compliance water quality monitoring has found that there are elevated dissolved boron levels within groundwater that passes through the landfill, leading to increased boron concentrations in the stream, but that the stream boron levels are well within ANZECC 95% freshwater trigger levels.

This assessment has found that boron discharges to the Wharekōrino Stream should significantly reduce by an estimated 72-92% as a result of proposed improved landfill capping and groundwater diversion from the landfill.

This should result in boron concentrations measured at the downstream sampling location in the stream reducing from their current annual average level of $0.0957g/m^3$ to in the range of $0.00082\text{-}0.0227g/m^3$. However, it may take somewhere between just over one month to an estimated 7 years for the landfill upgrade and repair works to be reflected in corresponding reductions in boron concentrations reaching the stream.

Drawings



SURVEYED			APPROVED	DATE
DESIGNED	GS	15/08/25	SF	
DRAWN	GS	15/08/25	15/08/25	
CHECKED	SF	15/08/25		

REVISION	CHANGES	CHECKED	DATE

NOTES

1. Landfill base estimated in Civil3D using ground level and test pit log data along cross-section.
2. Groundwater levels for groundwater boreholes P2(old) and P7(old) recorded in 2023, 2024 and 2025 - 7 readings.
3. Groundwater levels for groundwater boreholes GW1, P2(new), GW2, GW3 and P7(new) recorded in 2025 - 3 readings.

PROJECT DATUMS:
LEVEL: New Zealand Vertical Datum 2016
COORDINATE: New Zealand Transverse Mercator

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PROJECT
FORMER TOKANUI HOSPITAL DEMOLITION AND REMEDIATION PROJECT

TITLE
UPDATED GROUNDWATER MONITORING BORE CROSS SECTION PLAN

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STATUS
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Construction works shall commence only on receipt of and in accordance with the Council or Council organisation stamped approved drawings, unless otherwise indicated.

SCALE 1:1500 (A3)

DRAWING No 33097/GW01 REVISION -

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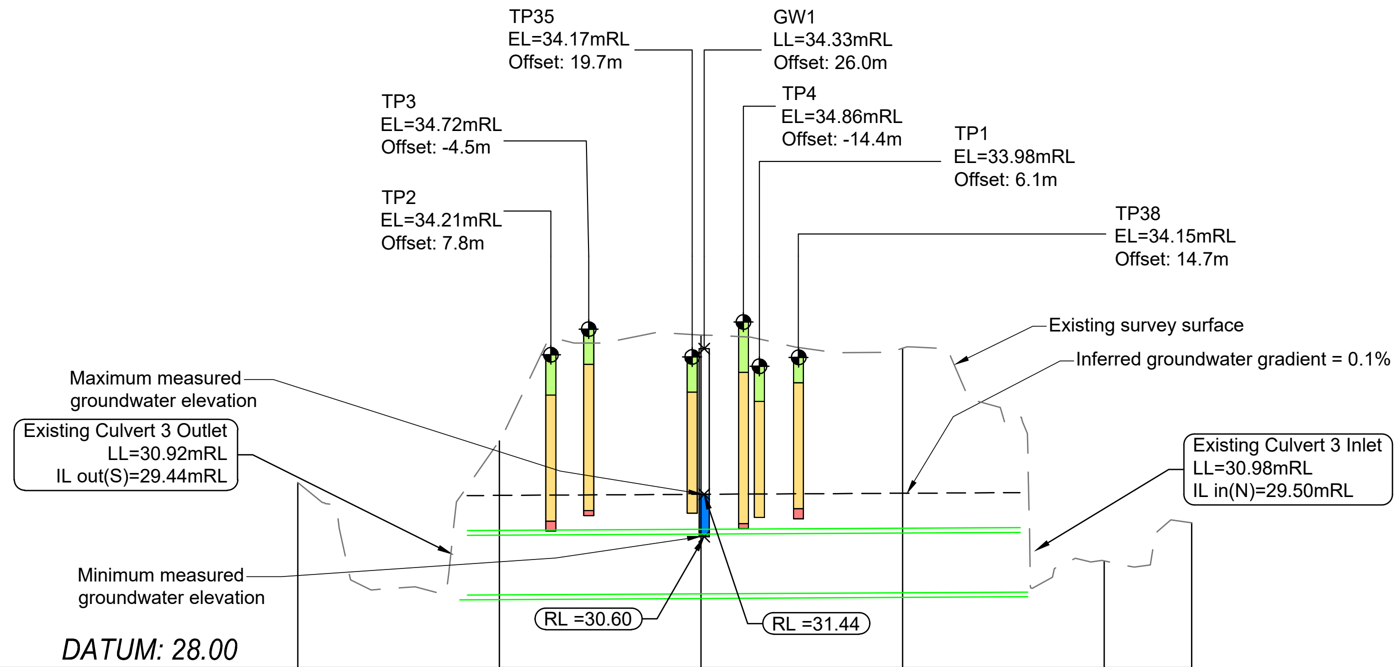
Legend

- Existing Survey level
- Existing Landfill Base
- Proposed Finished Level
- Ground Water Elevation
- Inferrred Groundwater Table

Testpit - Legend

- Topsoil/Silt/Capping Material
- Landfill Material
- Silt/Clay Material (Natural Ground)



EXISTING LEVELS	31.67	32.50	34.60	34.34	30.12	30.88
CHAINAGE	0	20	40	60	80	89

Cross Section - GW01

Scale 1:750 horiz, 1:150 vert

Note:
1. Due to ground stability issues, TP 1 and 35 did not reach natural ground.
2. GW01 monitoring well is offset from the C3 culvert, as shown on drawing 33097/GW01.

0 1.0 2.0 3.0 4.0 5.0 10
Scale 1:150

0 15 30
Scale 1: 750 m

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			APPROVED	DATE
SURVEYED			SF	
DESIGNED	GS	15/08/25	15/08/25	
DRAWN	GS	15/08/25		
CHECKED	SF	15/08/25		

REVISION	CHANGES	CHECKED	DATE

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PROJECT DATUMS:
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SCALE AS SHOWN (A3)

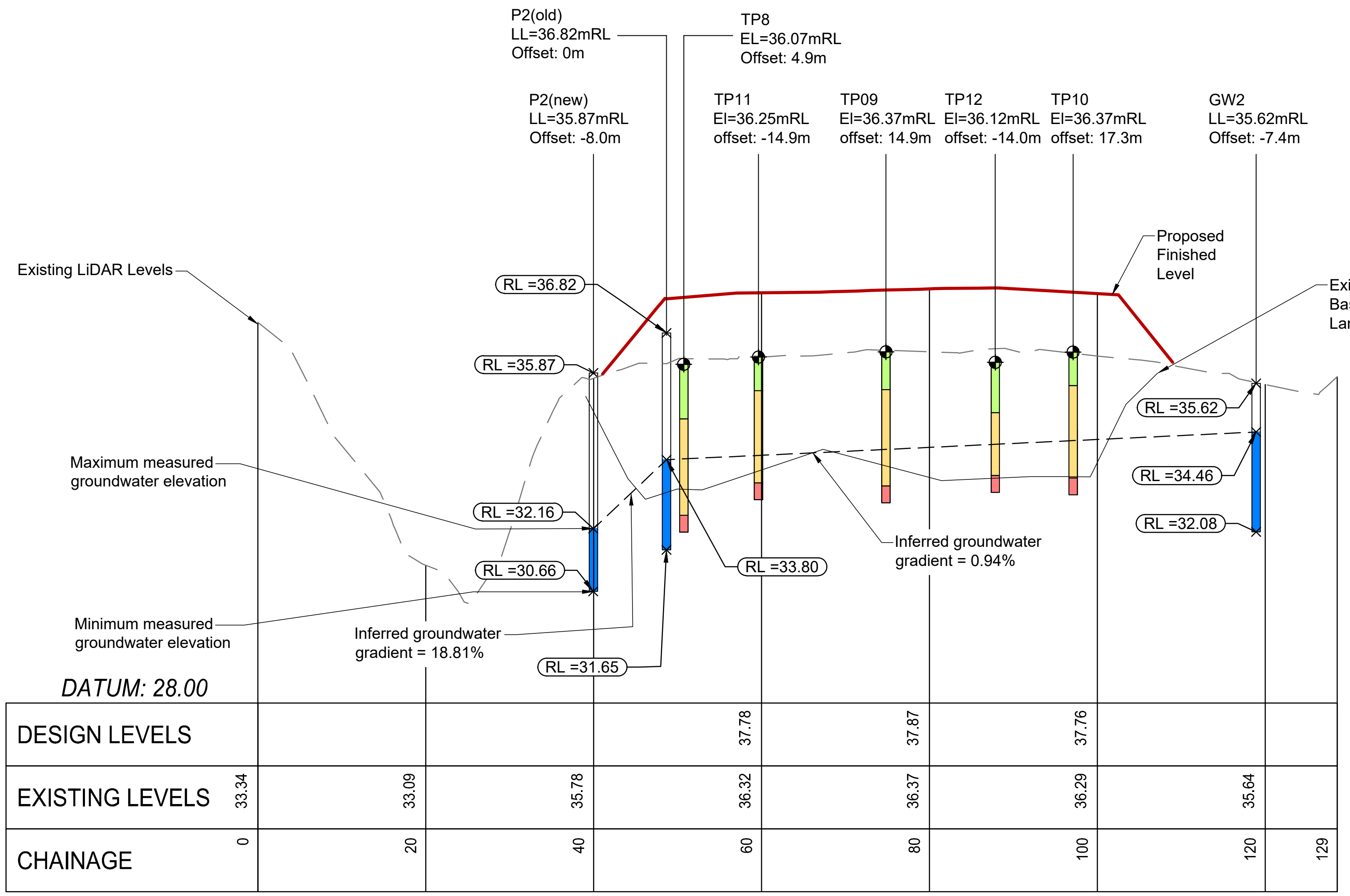
DRAWING No 33097/GW02
REVISION -

Legend

- Existing LiDAR level
- Existing Landfill Base
- Proposed Finished Level
- Ground Water Elevation
- Inferred Groundwater Table

Testpit - Legend

- Topsoil/Silt/Capping Material
- Landfill Material
- Silt/Clay Material (Natural Ground)



Cross Section - South

Scale 1:750 horiz, 1:150 vert

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Scale 1:150

0 15 30

Scale 1: 750 m

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DESIGNED	GS	15/08/25		
DRAWN	GS	15/08/25		
CHECKED	SF	15/08/25		

REVISION	CHANGES	CHECKED	DATE

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PROJECT DATUMS:

LEVEL: New Zealand Vertical Datum 2016

COORDINATE: New Zealand Transverse Mercator

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DRAWING No 33097/GW03

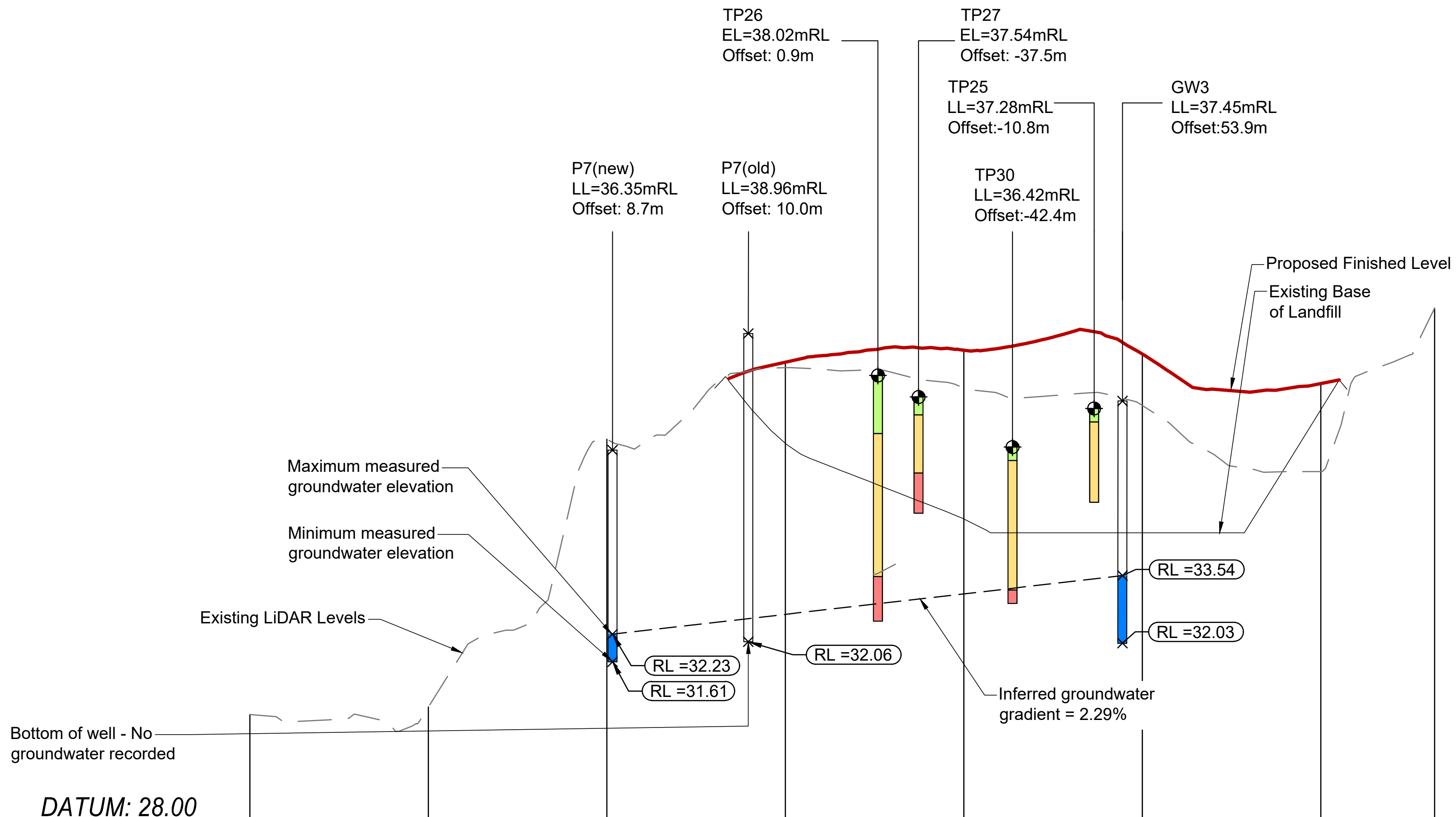
REVISION -

Legend

- Existing LiDAR level
- Existing Landfill Base
- Proposed Finished Level
- Ground Water Elevation
- Inferred Groundwater Table

Testpit - Legend

- Topsoil/Silt/Capping Material
- Landfill Material
- Silt/Clay Material (Natural Ground)



DATUM: 28.00

DESIGN LEVELS				38.32	38.59	38.50	37.84	
EXISTING LEVELS	30.43	30.60	36.59	38.20	37.75	37.35	35.87	39.53
CHAINAGE	0	20	40	60	80	100	120	133

Cross Section - North

Scale 1:750 horiz, 1:150 vert

0 1.0 2.0 3.0 4.0 5.0 10
Scale 1:150

0 15 30
Scale 1: 750 m

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DRAWN	GS	15/08/25		
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Appendix A

Calculations

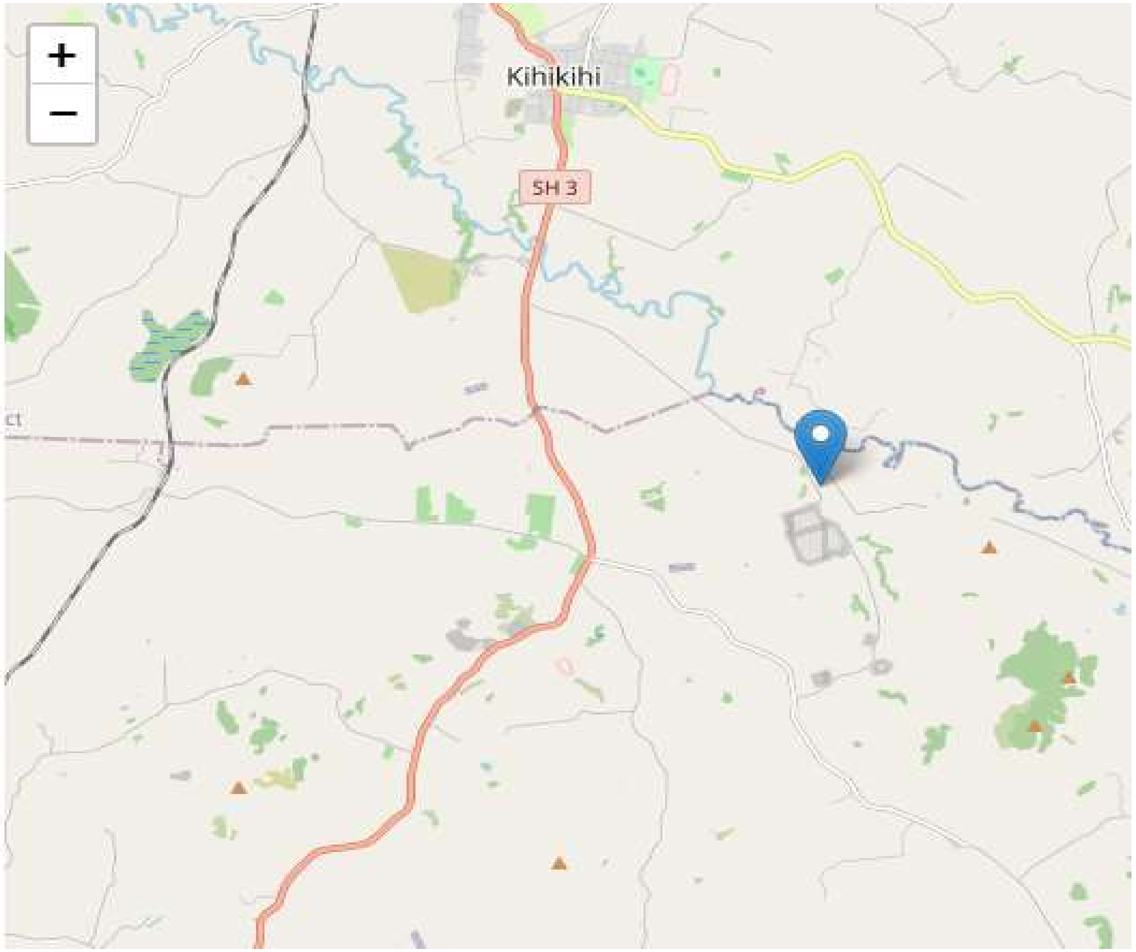
CLIMATE STATION NORMALS

Station: WAIKERIA EWS, parameter: Total rainfall [mm], Climate station normals

Version 0.1 (Updated 16 Dec 2024)

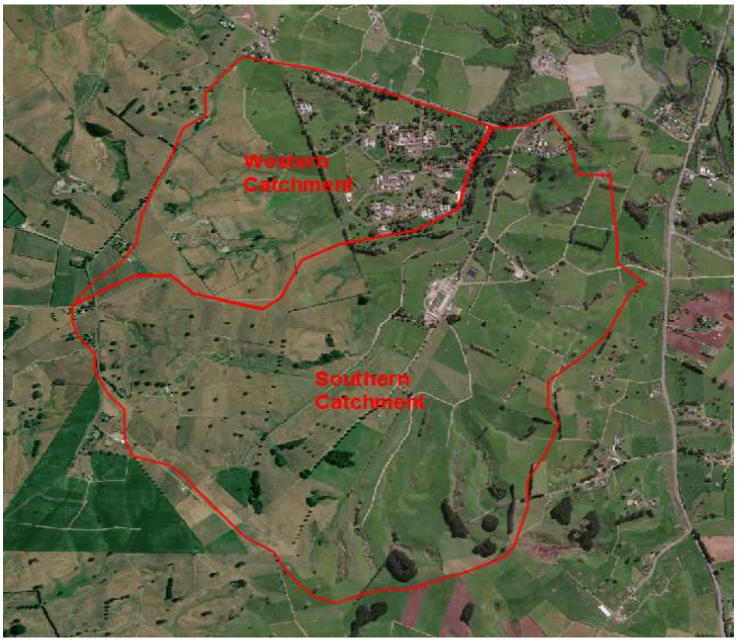
Data period: 1 Jan 1991 — 1 Jan 2021

PERIOD	mm
Annual	1118.7
January	69.8
February	70.9
March	72.2
April	87.5
May	106.4
June	112.3
July	122.4
August	110.1
September	101.2
October	92.9
November	79.7
December	93.3



Stream Flow Assessment
Method 1 (Catchment Runoff Basis)

	Landfill	Bartons Br	
Catchment area	440	51870	ha
Catchment slope	Moderate		
Land use	Mainly pasture		
Runoff coefficient	0.4	0.4	heavy clay soil type, 5-10% gradient (measured off contour plans)
Annual rainfall	1118.7	1118.7	mm
Average annual runoff	1968912	2.32E+08	m3/yr
Average flow per day	5394	635912	m3/d
Average flow per day	62.4	7360	L/s



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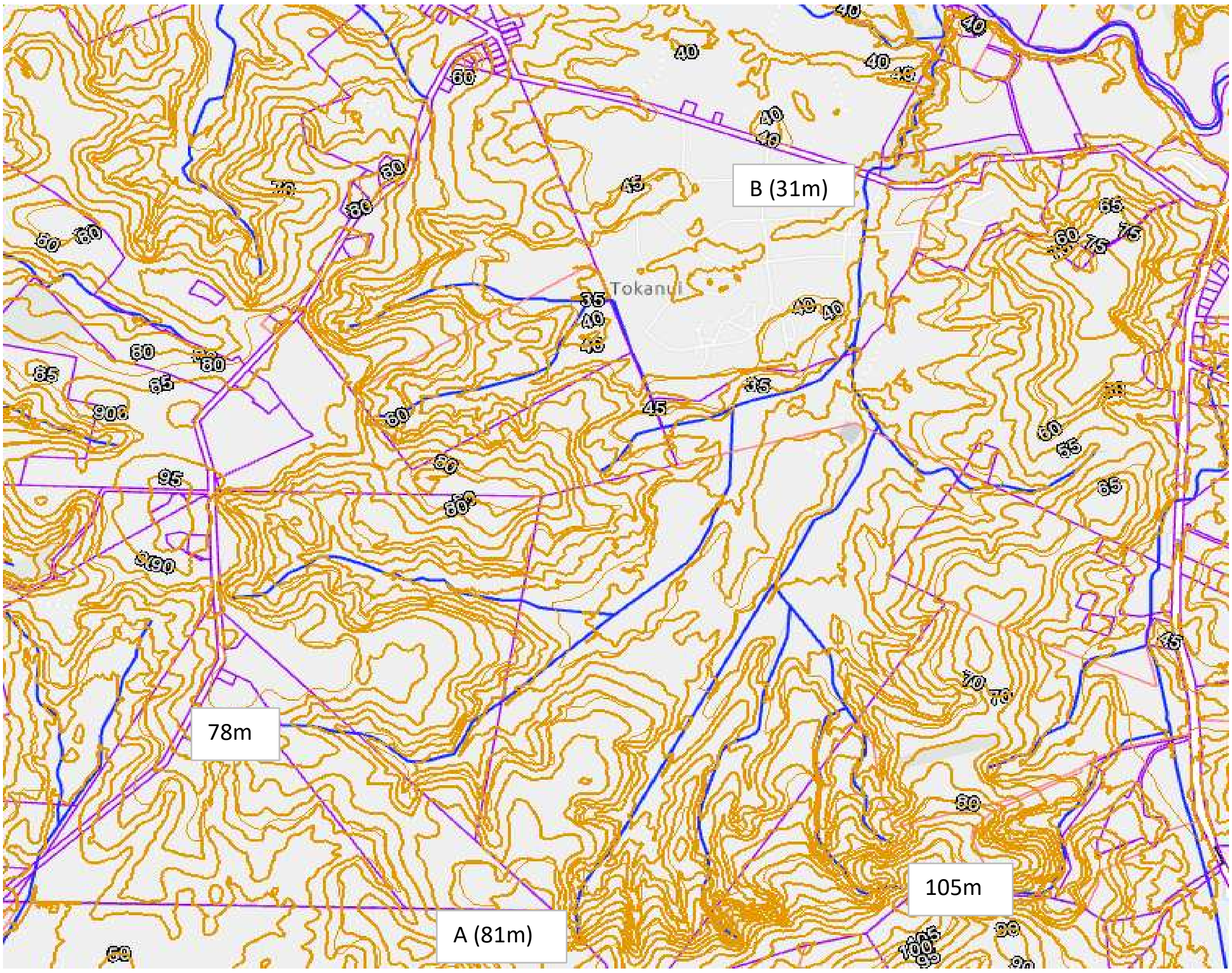


Distance AB = 2860m Gradient = 1.7% (along stream)

Measured overland flow gradients going anticlockwise: Generally in range 5-10%

Line	1	2	3	4	5	6
%	5.6	5.6	7.5	5.6	9.3	9.5

Method 2 (from comparison with WRC flow gauges)

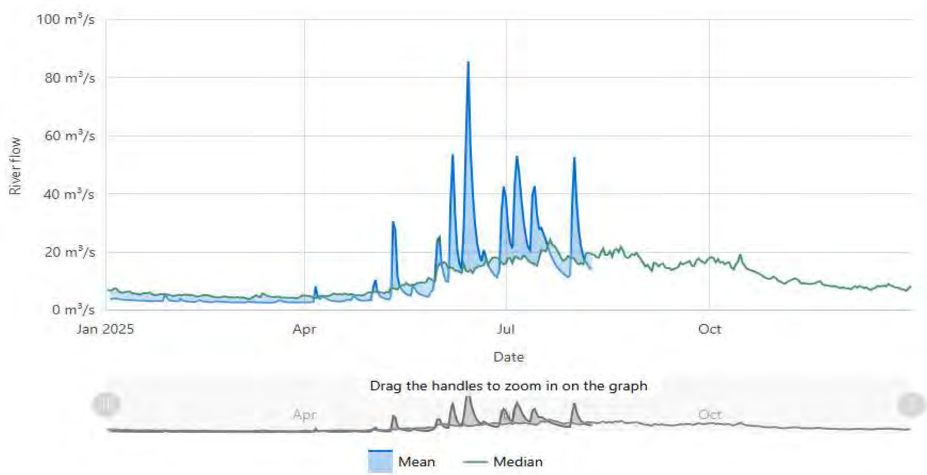
Location	Catch Area (km2)	Mean Q (m3/s)	Spec Q (m3/s/ km2)
Puniu (at Bartons Bridge)	518.7	14.32	0.028
Mangatutu Stream	122	3.79	0.031
Pro rata basis			
Wharekorino at Te Mawhai Rd	6	0.166	
Wharekorino at Landfill	4.4	0.121	

Site information

Site name:	Puniu River - Bartons Corner Rd Br
Site number	818
Station number	2

Additional Information

Mean flow (m³/s)	14.32
Continuous data since	06/05/1985
Highest recorded flow (m³/s)	322.19 on 16/10/1989
Lowest recorded flow (m³/s)	2.14 on 15/02/1992
Data download restriction	No
Altitude (m) above mean sea level (amsl)	30.95
Catchment size (km²)	518.70
Map reference	NZTM:1801295 - 5788365



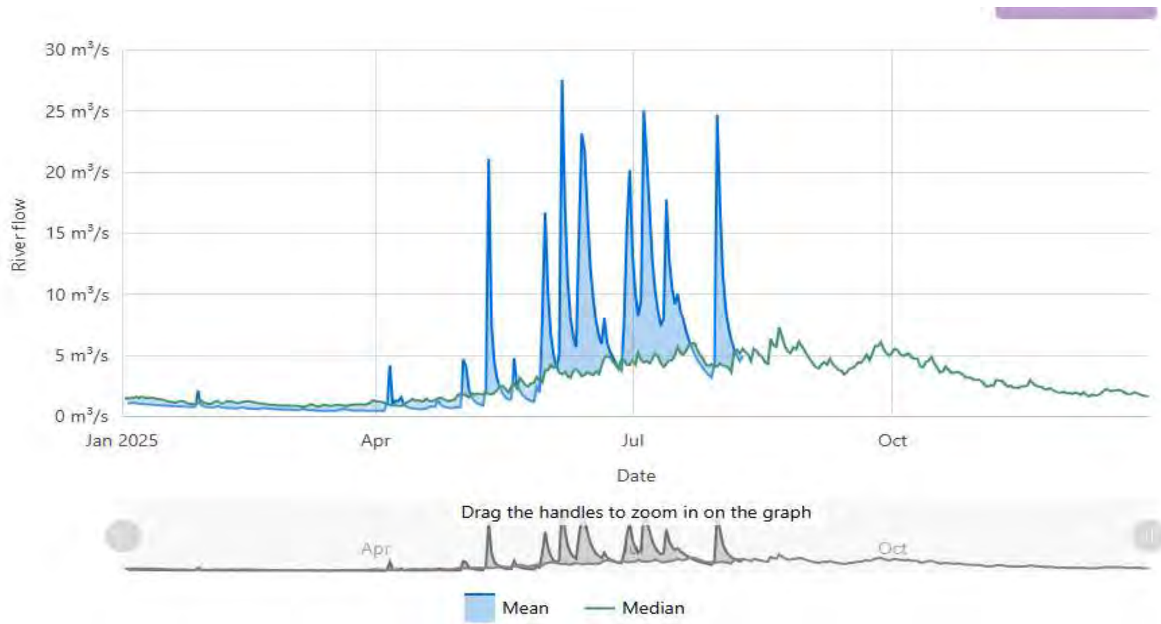
Second smaller stream comparison - Mangatutu Stm

Site information

Site name:	Mangatutu Stm (Waikeria) - Walker Rd Br
Site number	476
Station number	7

Additional Information

Mean flow (m^3/s)	3.79
Continuous data since	08/06/2004
Highest recorded flow (m^3/s)	38.19 on 01/01/2024
Lowest recorded flow (m^3/s)	0.48 on 27/03/2008
Data download restriction	No
Altitude (m) above mean sea level (amsl)	40
Catchment size (km^2)	122.00
Map reference	NZTM:1810109 - 5780575



Comparison

Method	Mean Q (L/s)
Catchment	62.4
WRC flow gauges	121.5

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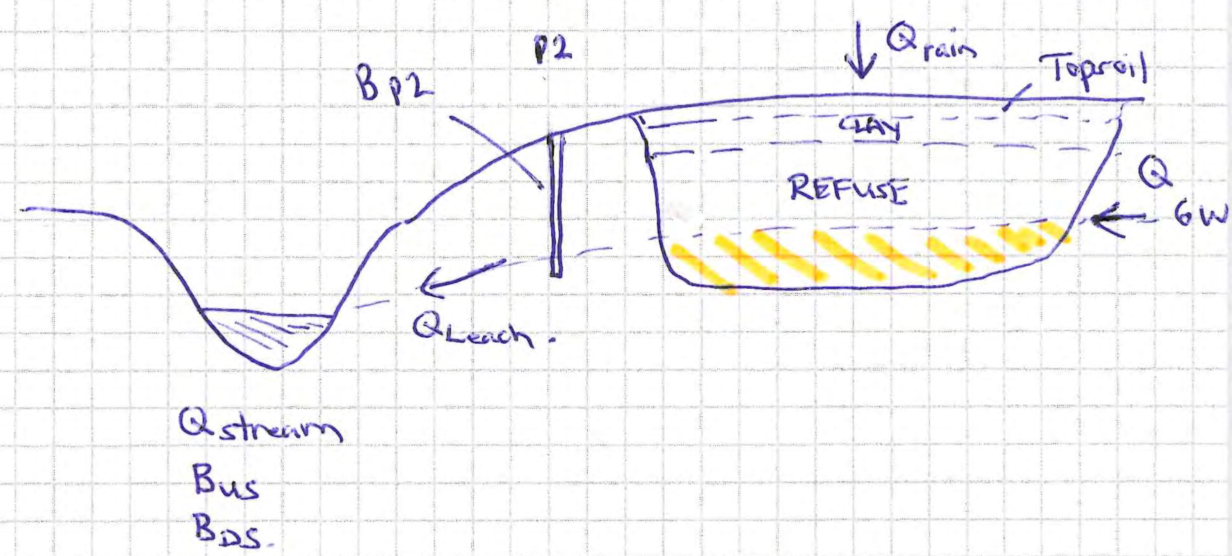

Boron Load from Landfill $= Q_{stream} \times ([B_{US}] - [B_{DS}])$

$Q_{Leach} = \dfrac{\text{Boron Load}}{[B_{P2}]} = Q_{rain} + Q_{GW}$.

$Q_{rain} = IR(\%) \times \text{rainfall} \times \text{landfill area}$.

$Q_{GW} = kiA$ (Darcy's Law)

$= \text{permeability} \times \text{GW gradient} \times$ Area of GW in contact with refuse

Results Summary

							Effect of Landfill Improvement Works						
	Q(stm (m3/yr)	QL (m3/yr)	% stm flow	Rainfall IR (%)	QL (rain)	QL (gw)	Rainfall IR (%)	Redn in GW thru refuse (%)	QL (rain)	QL (gw)	Total	% redn	% stream flows
B1	1970261	5787	0.29	10	1709	4078	2	90	316	408	724	87.5	0.037
B2	1970261	5787	0.29	10	1709	4078	5	90	790	408	1198	79.3	0.061
B3	1970261	5787	0.29	25	4273	1514	2	90	316	151	468	91.9	0.024
B4	1970261	5787	0.29	25	4273	1514	5	90	790	151	942	83.7	0.048
B5	1970261	5787	0.29	10	1709	4078	2	80	316	816	1132	80.4	0.057
B6	1970261	5787	0.29	10	1709	4078	5	80	790	816	1606	72.3	0.082
B7	1970261	5787	0.29	25	4273	1514	2	80	316	303	619	89.3	0.031
B8	1970261	5787	0.29	25	4273	1514	5	80	790	303	1093	81.1	0.055
B9	3833394	11260	0.29	10	1709	9551	2	90	316	955	1271	88.7	0.033
B10	3833394	11260	0.29	10	1709	9551	5	90	790	955	1745	84.5	0.046
B11	3833394	11260	0.29	25	4273	6987	2	90	316	699	1015	91.0	0.026
B12	3833394	11260	0.29	25	4273	6987	5	90	790	699	1489	86.8	0.039
B13	3833394	11260	0.29	10	1709	9551	2	80	316	1910	2226	80.2	0.058
B14	3833394	11260	0.29	10	1709	9551	5	80	790	1910	2700	76.0	0.070
B15	3833394	11260	0.29	25	4273	6987	2	80	316	1397	1714	84.8	0.045
B16	3833394	11260	0.29	25	4273	6987	5	80	790	1397	2188	80.6	0.057

Boron Discharge Calcs **Stream Flows - Lower Estimate + 90% Groundwater reduction**

	B1	B2	B3	B4	Units	Comments
Mean Stream Flow	62.4	62.4	62.4	62.4	L/s	
Mean Stream Flow	1970261	1970261	1970261	1970261	m3/yr	
Avg Change in B Concentration	0.0738	0.0738	0.0738	0.0738	g/m3	In stream between US & DS sampling locations, as total B; from long term lab results
Avg Boron Load from Landfill	145	145	145	145	kg/yr	
Avg [B] in gw at P2	25.125	25.125	25.125	25.125	g/m3	At P2, as dissolved B (assumed dissolved B similar to total B)
Leachate flow to stream	5787	5787	5787	5787	m3/yr	
	0.183	0.183	0.183	0.183	L/s	
	0.29	0.29	0.29	0.29	% stm flow	
Leachate contribution from rainfall						
Annual rainfall	1118.7	1118.7	1118.7	1118.7	mm	From Waikeria rain gauge, 30yr average (1991-2020)
Landfill surface areas	15278	15278	15278	15278	m2	From Civil 3D
Infiltration rate	10	10	25	25	%	Estimated infiltration rates (low to high)
Leachate from rainfall	1709	1709	4273	4273	m3/yr	
Leachate from groundwater	4078	4078	1514	1514	m3/yr	By difference
Effect of Proposed Upgrade Works						
Leachate from rainfall						
Adjusted landfill areas	14128	14128	14128	14128	m2	Assumes soils transferred from hospital into area EF contain natural levels of B
Modified infiltration rate	2	5	2	5	%	Estimate based on GCL liner
Leachate (rainfall)	316	790	316	790	m3/yr	
Leachate (groundwater)	408	408	151	151	m3/yr	Assumed 90 % eliminated
Total	724	1198	468	942	m3/yr	
Boron concentration in leach	25.125	25.125	25.125	25.125	g/m3	Assumed unchanged
Boron load into stream	18.2	30.1	11.7	23.7	kg/yr	
Reduction in boron Load	87.5	79.3	91.9	83.7	%	
Avg change in boron conc'n	0.0092	0.0153	0.0060	0.0120	g/m3	
Avg upstream concn	0.0022	0.0022	0.0022	0.0022	g/m3	From lab results
Estimated new DS concn	0.0115	0.0175	0.0082	0.0143	g/m3	
Vs Existing DS concn	0.0957	0.0957	0.0957	0.0957	g/m3	From lab results

Notes:

1. Landfill areas:

	Existing	Post-works	
D (North)	2200	2200	
ABC	10300		A1+B+C (including Agresearch)
A2	1275		
H	1503		
South		11928	Area ABC + A2 + H - 1150, measured from CAD
Total	15278	14128	

GW Flow Check using Darcy's Law

Use Darcy's equation, Q = k.i.A

k, coeff of permeability	0.001	0.01	0.02	0.05	m/s	Note: typical k value for refuse (lower range): 0.001 m/s (low end)
I, hydraulic pressure gradient	0.01	0.01	0.01	0.01	m/m	Estimate I from Civil3D GW table measurements of water level in US & DS wells
A, area of flow	253	253	253	253	m2	Estimate Area from Civil3D cross-sections of gw depths vs refuse
Q	0.00253	0.0253	0.0506	0.1265	m3/s	
	80	798	1597	3992	m3/yr	

Groundwater travel times **Cross-section - south**

Section	Distance	Permeability (m/s)		Hydraulic gradient	v (m/s)		Travel time (days)		
	(m)	Low	High	(m/m)	Low	High	Low	High	
GW2 to P2 (old)	70	0.001	0.01	0.0094	0.0000094	0.000094	86.2	8.6	
P2 (old) to stream	23	0.000001	0.0001	0.1043	1.043E-07	1.04E-05	2552.3	25.5	
Combined							2638.5	34.1	
							7.2	0.09	yrs

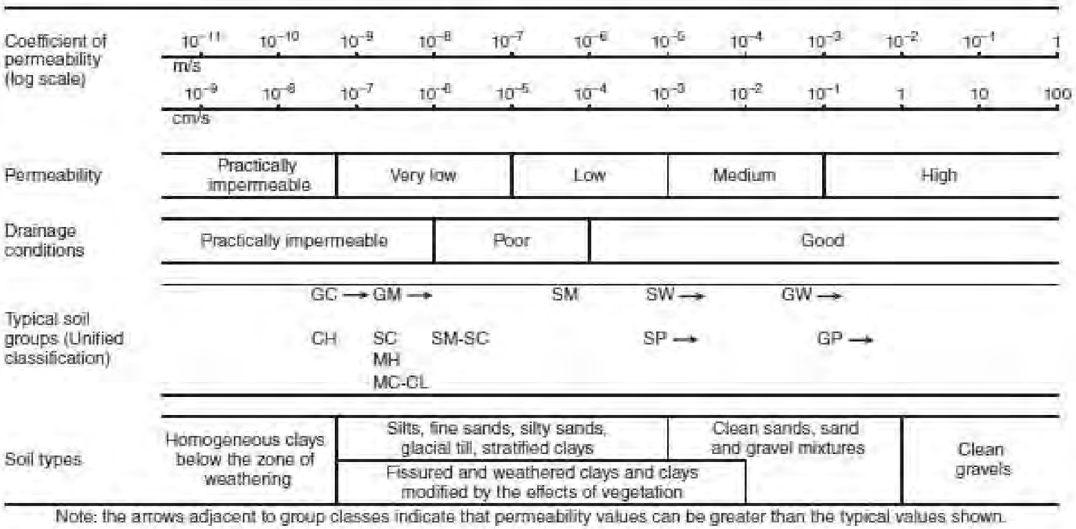

Figure 4.1 Typical permeability values for soils. Adapted from Casagrande and Fadum (1940).

Boron Discharge Calcs **Stream Flows - Lower Estimate + 80% Groundwater reduction**

	B5	B6	B7	B8	Units	Comments
Mean Stream Flow	62.4	62.4	62.4	62.4	L/s	
Mean Stream Flow	1970261	1970261	1970261	1970261	m3/yr	
Avg Change in B Concentration	0.0738	0.0738	0.0738	0.0738	g/m3	In stream between US & DS sampling locations, as total B; from long term lab results
Avg Boron Load from Landfill	145	145	145	145	kg/yr	
Avg [B] in gw at P2	25.125	25.125	25.125	25.125	g/m3	At P2, as dissolved B (assumed dissolved B similar to total B)
Leachate flow to stream	5787	5787	5787	5787	m3/yr	
	0.183	0.183	0.183	0.183	L/s	
	0.29	0.29	0.29	0.29	% stm flow	
Leachate contribution from rainfall						
Annual rainfall	1118.7	1118.7	1118.7	1118.7	mm	From Waikeria rain gauge, 30yr average (1991-2020)
Landfill surface areas	15278	15278	15278	15278	m2	From Civil 3D
Infiltration rate	10	10	25	25	%	Estimated infiltration rates (low to high)
Leachate from rainfall	1709	1709	4273	4273	m3/yr	
Leachate from groundwater	4078	4078	1514	1514	m3/yr	By difference

Effect of Proposed Upgrade Works

	B5	B6	B7	B8	Units	Comments
Leachate from rainfall						
Adjusted landfill areas	14128	14128	14128	14128	m2	Assumes soils transferred from hospital into area EF contain natural levels of B
Modified infiltration rate	2	5	2	5	%	Estimate based on GCL liner
Leachate (rainfall)	316	790	316	790	m3/yr	
Leachate (groundwater)	816	816	303	303	m3/yr	Assumed 80 % eliminated
Total	1132	1606	619	1093	m3/yr	
Boron concentration in leach	25.125	25.125	25.125	25.125	g/m3	Assumed unchanged
Boron load into stream	28.4	40.3	15.6	27.5	kg/yr	
Reduction in boron Load	80.4	72.3	89.3	81.1	%	
Avg change in boron conc'n	0.0144	0.0205	0.0079	0.0139	g/m3	
Avg upstream concn	0.0022	0.0022	0.0022	0.0022	g/m3	From lab results
Estimated new DS concn	0.0167	0.0227	0.0101	0.0162	g/m3	
Vs Existing DS concn	0.0957	0.0957	0.0957	0.0957	g/m3	From lab results

Boron Discharge Calcs **Stream Flows - Upper Estimate + 90% Groundwater reduction**

	B9	B10	B11	B12	Units	Comments
Mean Stream Flow	121.5	121.5	121.5	121.5	L/s	
Mean Stream Flow	3833394	3833394	3833394	3833394	m3/yr	
Avg Change in B Concentration	0.0738	0.0738	0.0738	0.0738	g/m3	In stream between US & DS sampling locations, as total B; from long term lab results
Avg Boron Load from Landfill	283	283	283	283	kg/yr	
Avg [B] in gw at P2	25.125	25.125	25.125	25.125	g/m3	At P2, as dissolved B (assumed dissolved B similar to total B)
Leachate flow to stream	11260	11260	11260	11260	m3/yr	
	0.357	0.357	0.357	0.357	L/s	
	0.29	0.29	0.29	0.29	% stm flow	
Leachate contribution from rainfall						
Annual rainfall	1118.7	1118.7	1118.7	1118.7	mm	From Waikeria rain gauge, 30yr average (1991-2020)
Landfill surface areas	15278	15278	15278	15278	m2	From Civil 3D
Infiltration rate	10	10	25	25	%	Estimated infiltration rates (low to high)
Leachate from rainfall	1709	1709	4273	4273	m3/yr	
Leachate from groundwater	9551	9551	6987	6987	m3/yr	By difference

Effect of Proposed Upgrade Works

	B9	B10	B11	B12	Units	Comments
Leachate from rainfall						
Adjusted landfill areas	14128	14128	14128	14128	m2	Assumes soils transferred from hospital into area EF contain natural levels of B
Modified infiltration rate	2	5	2	5	%	Estimate based on GCL liner
Leachate (rainfall)	316	790	316	790	m3/yr	
Leachate (groundwater)	955	955	699	699	m3/yr	Assumed 90 % eliminated
Total	1271	1745	1015	1489	m3/yr	
Boron concentration in leach	25.125	25.125	25.125	25.125	g/m3	Assumed unchanged
Boron load into stream	31.9	43.9	25.5	37.4	kg/yr	
Reduction in boron Load	88.7	84.5	91.0	86.8	%	
Avg change in boron conc'n	0.0083	0.0114	0.0067	0.0098	g/m3	
Avg upstream concn	0.0022462	0.0022462	0.0022462	0.0022462	g/m3	From lab results
Estimated new DS concn	0.0106	0.0137	0.0089	0.0120	g/m3	
Vs Existing DS concn	0.0957	0.0957	0.0957	0.0957	g/m3	From lab results

Boron Discharge Calcs **Stream Flows - Upper Estimate + 80% Groundwater reduction**

	B13	B14	B15	B16	Units	Comments
Mean Stream Flow	121.5	121.5	121.5	121.5	L/s	
Mean Stream Flow	3833394	3833394	3833394	3833394	m3/yr	
Avg Change in B Concentration	0.0738	0.0738	0.0738	0.0738	g/m3	In stream between US & DS sampling locations, as total B; from long term lab results
Avg Boron Load from Landfill	283	283	283	283	kg/yr	
Avg [B] in gw at P2	25.125	25.125	25.125	25.125	g/m3	At P2, as dissolved B (assumed dissolved B similar to total B)
Leachate flow to stream	11260	11260	11260	11260	m3/yr	
	0.357	0.357	0.357	0.357	L/s	
	0.29	0.29	0.29	0.29	% stm flow	
Leachate contribution from rainfall						
Annual rainfall	1118.7	1118.7	1118.7	1118.7	mm	From Waikeria rain gauge, 30yr average (1991-2020)
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Leachate from rainfall	1709	1709	4273	4273	m3/yr	
Leachate from groundwater	9551	9551	6987	6987	m3/yr	By difference

Effect of Proposed Upgrade Works

Leachate from rainfall						
Adjusted landfill areas	14128	14128	14128	14128	m2	Assumes soils transferred from hospital into area EF contain natural levels of B
Modified infiltration rate	2	5	2	5	%	Estimate based on GCL liner
Leachate (rainfall)	316	790	316	790	m3/yr	
Leachate (groundwater)	1910	1910	1397	1397	m3/yr	Assumed 80 % eliminated
Total	2226	2700	1714	2188	m3/yr	
Boron concentration in leach	25.125	25.125	25.125	25.125	g/m3	Assumed unchanged
Boron load into stream	55.9	67.8	43.1	55.0	kg/yr	
Reduction in boron Load	80.2	76.0	84.8	80.6	%	
Avg change in boron conc'n	0.0146	0.0177	0.0112	0.0143	g/m3	
Avg upstream concn	0.0022462	0.0022462	0.0022462	0.0022462	g/m3	From lab results
Estimated new DS concn	0.0168	0.0199	0.0135	0.0166	g/m3	
Vs Existing DS concn	0.0957	0.0957	0.0957	0.0957	g/m3	From lab results