Levin Landfill Annual Compliance Report July 2023 - June 2024

As required by Resource Consents ATH-2002003982.03 (formerly DP6009), ATH-2002003983.02 (formerly DP6010), ATH-2002003984.02 (formerly DP6011) and ATH-2002009801.02 (formerly DP102259).

Prepared for:
Horowhenua District Council

29 October 2024

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Project/File:
310003411

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Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
0	Draft for Client Comment	R. Ruiterkamp, P. Landmark	24/09/24	P. Landmark	24/09/24	K. Halder	30/09/24
1	Final	R. Ruiterkamp, P. Landmark	21/10/24	P. Landmark	21/10/24	K. Halder	29/10/24

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Executive Summary

Horowhenua District Council is required to carry out compliance monitoring for the Levin Landfill as part of Resource Consents ATH-2002003982.03, ATH-2002003983.02, ATH-2002003984.02 and ATH-2002009801.02. This report summarises the findings for the July 2023 to June 2024 annual monitoring period ('the reporting period'), including monitoring results for:

- Background groundwater bores;
- The landfill leachate pond;
- Groundwater bores around the new landfill (now closed) and within the old leachate irrigation area;
- Shallow aquifers, down-gradient of the old landfill;
- Deep aquifer, down-gradient of the landfill;
- Hōkio Stream;
- Stormwater, and
- Landfill gas and odour.

Monitoring results for other aspects of the landfill operations, such as sampling of the landfill gas flare and collection wells, are reported separately as per additional resource consent requirements.

Figure 0-1: Aerial photograph of Levin Landfill property and surrounds, showing approximate locations of groundwater monitoring bores and surface water sampling locations (source: Google Earth Pro, 12/2022)

Background Groundwater Bores (Bores G1S, G1D)

The quality of the background groundwater up-hydraulic gradient from the landfill site is not subject to any resource consent conditions. However, for comparison purposes, both the ANZECC 2000 Livestock Drinking Water (LDW) trigger values and the Drinking Water Standards New Zealand (DWSNZ) guidelines were used to benchmark the quality of this upgradient groundwater. As has been reported in previous years, background groundwater quality in bore G1S continues to be characterised by low pH levels and elevated chloride, iron, and aluminium concentrations in the shallow aquifer. Bore G1D also had elevated iron concentrations.

It is understood leachate has historically been irrigated in the area to the south-east of the site only (not in the south-west of the site). Bores D5, F2 and F3 may be considered representative of background groundwater quality due to their location outside of this previously irrigated area, and therefore have been used to monitor compliance with relevant guidelines and to assess if the landfill is impacting groundwater quality. Samples obtained from these bores during the reporting period did not exceed LDW trigger values or the DWSNZ guidelines with the exception of *E.coli* (faecal coliforms) for which the results are unable to be assessed against the DWSNZ due to the high detection limit of 100 CFU/100mL, which is applied to all samples from the shallow aquifer bores, including D5, F2 and F3.

New landfill (now closed) and Irrigation Bores (Bores D1, D2, D3rs, D4, D5, D6, E1S, F1, F2, F3)

In bores hydraulically up-gradient of the old landfill and down-gradient of the new landfill, concentrations of leachate indicators were below ANZECC LDW trigger values for the reporting period. The results indicate that there is no leachate from the new lined landfill impacting on groundwater down-gradient of the landfill.

Groundwater quality observed down-gradient of the old irrigation area (F-series bores) was comparable to or better than the background shallow groundwater quality up-gradient of the old landfill during this reporting period. It should be noted that no irrigation of leachate has occurred on the site since 2008.

Shallow Aquifer Down-gradient of Old Landfill (Bores E2S, B1, B2, B3, C1, C2, C2DS, G2S, Xs1, Xs2)

Bores B1, B2, B3, C1, C2, G2S and Xs1 all appear to be located and screened within the leachate plume, though C1, G2S and Xs1 appear much less affected. This leachate plume appears to have a confined radius northward and is not extending to the north-west and the north-east. The plume width is estimated at 300-500 m; a key model assumption which has been retained since 2014.

Results of leachate indicators have been graphed for the various groupings of groundwater bores. In assessing the graphs for the sand aquifer downstream of the old landfill, it is evident that concentrations of the leachate indicator parameters indicate a somewhat stable, slightly reducing trend in some contaminant concentrations over time (e.g., chloride, sodium and conductivity), whereas other parameters, such as ammoniacal-N in bores B2, B3 and C2, show clear increased levels, and B1 and C1, which show slight increases recently. Additionally, boron now appears to be increasing in all bores, even though it reduced quite considerably for many years in bores B1 and B2.

Boron is the only leachate indicator with an assigned LDW trigger value (5 mg/L), and despite the increasing trends, this was not exceeded in any of the shallow aquifer down-gradient bores.

These trends are being further investigated by Earthtech Consultants Ltd through monitoring of additional groundwater bores to intercept the leachate plume within the northern vicinity of the old landfill. This work is part of the Leachate BPO project for which HDC has committed a significant financial budget.

Selected down-gradient bores were also analysed for VOCs and SVOCs throughout the reporting period. Of the five detected substances, none exceeded the guideline values. It is noted that the detection limit for some of the VOCs and SVOCs is higher than the 99th percentile limits.

Stormwater Impact Monitoring (Bores E1D, E1S, D2, D3rs, D4 and F3)

With respect to the stormwater soakage area on site, sodium, chloride, and conductivity were elevated in the down-gradient bores compared with up-gradient bores. However, ammoniacal-N, nitrate-N and boron were generally similar in the upstream and downstream bores, with iron being higher in the upstream bores. Comparing the down-gradient bores with G1S, the shallow background bore, some parameters are generally more elevated in the background bore (e.g., conductivity, sodium, nitrate-N, and chloride), whereas other parameters are generally lower in the background bore (e.g., ammoniacal-N, boron, and iron). Overall, there does not appear to be a significant decrease in water quality down-gradient of the stormwater soakage area which indicates that discharges of stormwater from the landfill are not having a significant impact on the quality of groundwater down-gradient.

Deep Aquifer Bores Deep (Gravel) Aquifer (Bores E1D, C2DD, E2D, D3rd, Xd1)

Groundwater quality in the deep gravel aquifer bores exceeded consent limits for some parameters. Faecal coliforms were above the DWSNZ MAV of nil for all sites, due to the variability between detection limits, and a detection limit considerably higher than the consent limit, the exact level of exceedance is unknown. Hardness, manganese, and arsenic levels were exceeded in bore D3rd; and manganese was exceeded in bores E2D, Xd1 and C2DD. Iron was exceeded at bore G1D.

Such results are not exceptional for those bores. Given this and given the environmental setting with the deep aquifer being separated from the shallow aquifer by an aquiclude, and there being an upward gradient of flow between the deep and shallow aquifers, the exceedances are extremely unlikely to be on account of landfill activities.

Deep bores were also analysed for VOCs and SVOCs throughout the reporting period with no contaminants being recorded above the laboratory detection limit.

Mass Loading Evaluation

Mass load calculations were undertaken to predict a range of contaminant concentrations in the Hōkio Stream for specific indicator parameters (ammoniacal-nitrogen, boron, chloride, sodium, nitrate-nitrogen and dissolved reactive phosphorus). The mass load calculation compares these predicted concentrations with median and maximum concentrations (averaged over five years) in the bores which are most representative of the leachate plume, these being bores B2, B3, C1, C2, C2DS, G2S, and Xs1. The predicted range of concentrations from the 2023 - 2024 mass contaminant load assessment shows reasonably close agreement with actual monitoring results obtained from HS3 for all parameters except for ammoniacal-N, where the predicted range is some three to twelve times higher than the actual.

Earthtech Consultants Ltd conducted a mass contaminant loading assessment using a more sophisticated model than the current methodology that has been approved to meet consent conditions. That work has modelled the effect of having a cut-off drain to capture contaminated groundwater and has also checked what the concentration of ammoniacal-N is likely to be in the future at both HS2 and HS3. Based on this work a decision has been made to develop a solution that will deal with the contaminated groundwater, either by abstraction, treatment or both.

Given the outcome of Earthtech Consultant's work, it is recommended that the purpose of doing the mass contaminant loading assessment by the current conservative methodology has been somewhat superseded and it is recommended that the need to do so in the future be discussed with HRC, which may require a change in the methodology.

Hōkio Stream (Surface Water Sampling Locations: HS1A, HS1, HS2, HS3)

Samples collected at the upstream and downstream locations within Hōkio Stream generally met the consent trigger values for all parameters, except for total-ammoniacal nitrogen at HS2. Annual median values for nitrate-N levels at all sites exceeded the ANZECC (95%) trigger values.

Concentrations of nitrate-N increased downstream from HS1A/HS1 to HS2/HS3 which implies that some activity occurs between these monitoring locations to cause this. Whilst it is well documented that there is a plume of contaminated groundwater arising from the old, unlined landfill, (and this is being assessed through the Leachate BPO project), nitrate-N levels at the shallow groundwater bores, which are the assumed source of contamination, show low levels of nitrate-N compared to the Hōkio Stream. So, there is little to no evidence of the elevated nitrate-N levels in the Hōkio Stream originating from a landfill leachate source. Bores B1 and B2, however, do show elevated levels of nitrate-N, as do other bores on-site, such as D1 and D6, but these elevated levels do not appear to be related to the landfill activity.

Northern Farm Drain (Surface Water Sampling Location TD1)

The drain on the Tatana property (known as the "Northern Farm Drain") appears to be intercepting a low level of leachate-contaminated shallow groundwater prior to discharging to the Hōkio Stream. The key leachate parameters ammoniacal-N, conductivity and chloride were generally lesser in concentration within this drain than in the shallow groundwater bores which are screened in the leachate plume. Annual median values for ammoniacal-N and nitrate-N levels exceeded the ANZECC (95%) trigger values.

Remediation of the groundwater entering the drain is being addressed through the Leachate BPO project. However, nitrate-N is not elevated in the shallow groundwater bores considered to be the source of the groundwater contamination, and so the high nitrate-N concentrations measured in the Northern Farm Drain are most likely to be on account of the farming activities which occur in the paddock through which the drain runs.

However, in some of the shallow groundwater bores high levels of ammoniacal-N have been detected, and it is quite possible that this is causing the elevated ammoniacal-N measurements in the

Northern Farm Drain. As noted above, remediation of the groundwater entering the drain is subject to specific resource consent conditions which are being addressed through the Leachate BPO project.

Landfill Leachate

The quality of the leachate is not subject to any trigger levels, but it is noted that the concentrations observed for all parameters analysed are mostly within the range reported for Class 1 landfills, except for mercury, which was not detected. Ammoniacal-N, TOC, alkalinity and arsenic were slightly higher than the maximum range value. Consent conditions require that leachate be tested for SVOCs and VOCs annually. This was not done in the reporting period which is a non-compliance.

Number of Samples

Appendix D provides a summary of the number of samples taken at each monitoring location.

In general, the correct number of samples were taken for the groundwater bores and surface water monitoring locations. However, arsenic was not sampled in the comprehensive sampling round at bores D3rs, D4, D6, E1s and E2s.

Additionally, all surface water sampling locations (i.e., HS1, HS1A, HS2, HS3, TD1 and the Leachate Pond) had one monthly comprehensive sampling round missed during the reporting period.

Waste Compaction

Since no waste disposal operations have occurred during the reporting period, no assessment of in-situ density can be done or is needed.

Old Landfill Settlement and Remediation

Re-shaping and remediating the top of the old landfill with clay capping was carried out in the previous reporting period.

Since then, new monitoring pegs have been established across the newly capped surface of the Old Landfill and the pegs were re-surveyed after approximately 8 months. The results showed that there has been between 3mm and 19mm of settlement across the top of the Old Landfill in that period, which is a nominal amount and is of no consequence.

A site inspection in August 2024 showed that good grass cover has been established across the Old Landfill, though a minor, very shallow depression was identified close to monitoring location IS3. It is likely caused by settlement of topsoil that had been placed in this area to remediate a low spot that was identified previously. It is recommended that this area be filled in again with topsoil and then re-seeded.

Odour Monitoring at Boundary

Over the 2023-204 reporting period fifty-five separate odour monitoring events were conducted at various locations about the landfill property.

No odour was detected for fifty of the monitoring events. For the events where odour was noted, it was not considered to be objectionable for any duration or frequency, and no further action was deemed necessary. HDC should, however, confirm with HRC about the frequency of odour monitoring in the future.

Gas Monitoring in Bores

Concentrations of methane, carbon dioxide, hydrogen sulphide and oxygen (CH_4, CO_2, H_2S and O_2) were monitored quarterly during the 2023- 2024 monitoring period, with no to low concentrations of CH_4 being detected. Low concentrations (1 to 2 ppm) of H_2S were reported on five occasions, and moderately low levels of CO_2 were detected in all bores, with slightly higher levels in bore B2.

Given the potential for landfill gas emissions on the site (particularly of CH_4 and H_2S), sampling personnel must take specific health and safety precautions to avoid inhaling or igniting the gases from the bores when measurements are being taken. No smoking should be permitted when personnel undertake groundwater sampling and when in the vicinity of the groundwater monitoring wells, or in fact anywhere else on the Levin Landfill site. For sake of safety a personal gas detector should be worn by all staff when working in the vicinity of the landfill. Additionally, the gas monitoring should be conducted when the groundwater sampling is being done, which has not been the case recently. Doing so will provide an additional safeguard when sampling the groundwater.

Surface Gas Monitoring of New landfill (now closed)

Monthly surface methane emissions monitoring is required over all temporary and capped areas of the landfill. The bio-filter was decommissioned in September 2021, and so no further monitoring of that facility is required.

During the 2023-2024 reporting period, monthly surface emissions monitoring has been carried out on fifteen occasions.

Aside from July 2023, November 2023 and February 2024, CH_4 concentrations exceeded relevant trigger levels. On all occasions when this occurred, the locations were remediated using bentonite granules and water and, on re-testing, CH_4 concentrations had reduced to below the relevant trigger levels at all locations. So, HDC is compliant with its resource consent requirements for surface monitoring.

Bio-filter

The bio-filter was decommissioned prior to the reporting period, and so no inspections and maintenance of the bio-filter were required.

Meteorological Data

HDC is required to collect meteorological data from an on-site weather station. This has been undertaken throughout the reporting period. The weather station records data at 1-minute intervals, as required by the consent conditions. However, the data derived from the weather station has some gaps, with the rainfall and relative humidity data records being faulty for lengthy periods of the reporting year.

Recommendations for improvements to annual monitoring programme

A series of recommendations are made below, which will assist in improving the environmental monitoring that is done at and around the landfill site, as well as the general maintenance of the site.

1. As noted last year, it is recommended that all samples that require comparison against the DWSNZ be tested to a level of detection of 1 CFU/100mL.

2. Surface water samples require the detection limits for testing of $scBOD_5$ to be 1 mg/L so that results can be compared to the appropriate trigger value.

3. The use of bore G1S as a background bore has been reviewed, and Bores F2, F3 and D5 should be used as the primary background reference bores. G1S should still be monitored in conjunction with these bores.

4. Earthtech Consultants Ltd has undertaken a mass contaminant loading assessment using a more sophisticated model than that currently approved to meet resource consent conditions. It is recommended that the purpose of doing the mass contaminant loading assessment by the current conservative methodology be reviewed, especially given that the assessment considers only HS3 and not HS2, and that the need for future mass contaminant assessments be discussed with HRC.

5. Now that the landfill is closed for disposal of municipal solid waste and has been capped permanently, Council should discuss the ongoing need for undertaking odour monitoring with HRC to determine what frequency of inspections, if any, should be undertaken.

6. Gas sampling of the groundwater monitoring bores should be done in conjunction with the groundwater sampling (i.e., at the same time), and not on separate occasions.

7. With the capping of the landfill the ongoing frequency of surface gas emissions testing should be discussed with HRC.

8. The minor shallow area observe on the Old Landfill should be filled in with topsoil and then re-seeded.

9. Increase the frequency of spraying for gorse.

10. Assess in the next reporting period the need for continuing with monthly monitoring of leachate and discuss this with HRC.

Acronyms / Abbreviations

DWSNZ	Drinking Water Standards New Zealand
GVs	Guideline value
HDC	Horowhenua District Council
HRC	Horizons Regional Council
IANZ	International Accreditation New Zealand
LDW	ANZECC 2000 Livestock Drinking Water
MAVs	Maximum acceptable values
mBGL	Metres below ground level
NLG	Neighbourhood Liaison Group
Stantec	Stantec New Zealand
SVOC	Semi-volatile organic compounds
VOC	Volatile organic compounds
WWTP	Wastewater Treatment Plant

1 Introduction

1.1 Background

Levin Landfill has been operating on the Hōkio Beach Road site for over 50 years. The current resource consents for the new lined and old un-lined landfills were granted in 2002 and have been subject to two reviews since then. The latest review commenced in 2015 and was concluded in December 2019.

As consent holder for the discharge permits related to the activities that occur at the Levin Landfill, the Horowhenua District Council (HDC) is required to prepare and submit an Annual Report to Horizons Regional Council (HRC). Stantec New Zealand (Stantec) has been commissioned to prepare the Annual Report for HDC.

Table 1-1 summarises the reporting requirements and indicates where in this report the required information may be accessed. Appendix A details the consent conditions[1] that require reporting on annually. This consent is the operative consent for this reporting period.

Table 1-1: Summary of Consent Reporting Requirements

Discharge Permit & Condition No.	General Description	Section in the Annual Report
ATH-2002003982.03 – condition 8	Special and hazardous waste disposal	Sections 16 and 17
ATH-2002003982.03 – condition 14	Condition of the old landfill	Section 11
ATH-2002003982.03 – condition 35	Forward annual report to the NLG	Not applicable
ATH-2002003983.02 – condition 5	Groundwater, surface water and leachate environmental monitoring	Sections 4 and 5
ATH-2002003983.02 – condition 11(d)	Contaminant mass load projections	Section 6
ATH-2002003983.02 – condition 11(e)	Significance of contaminant mass load projections	Section 6
ATH-2002003983.02 – condition 14	Refuse density	Section 10
ATH-2002003983.02 – condition 15(f)	Remediation of the old landfill	Section 11
ATH-2002003983.02 – condition 27	Leachate irrigation	Section 12
ATH-2002003984.02 – condition 3	Odour investigations at landfill boundary	Section 8.1
ATH-2002003984.02 – condition 5(a) and 8	Landfill gas monitoring in groundwater monitoring wells	Section 8.2
ATH-2002003984.02 – condition 5(e), 5(g) and 8	Monthly methane surface monitoring of capped areas and bio-filter	Section 8.3
ATH-2002003984.02 – condition 5(j)	Measure and record bio-filter parameters and maintain it	Section 8.3

[1] Reviewed consent conditions as finalised on 19 December 2019.

Discharge Permit & Condition No.	General Description	Section in the Annual Report
ATH-2002003984.02 – condition 5(p)	Meteorological data	Section 8.4
ATH-2002009801.02 – condition 16	Stormwater monitoring	Section 7

1.2 Scope

This report is for the period of July 2023 to June 2024 (herewith referred to as 'the reporting period'). Stantec staff carried out an assessment of the monitoring results and have prepared this monitoring report.

Groundwater, surface water and gas sampling (of groundwater bores) is undertaken by Downer throughout the compliance year as required by the current consent conditions. HDC has engaged environmental consultants to undertake gas sampling across the landfill. Laboratory analyses have been undertaken by Eurofins ELS in Lower Hutt. ELS is an IANZ (International Accreditation New Zealand) approved laboratory for the tests conducted.

2 Context

2.1 Geology and Hydrogeology

Local geology surrounding Levin landfill (the site) consists of dune sands at the surface with a wedge of coastal sand deposits (which thicken towards the coast) interlaid with gravels beneath. The sands are generally uniform, grey, brown, fine to medium grained. The overlying topsoil comprises of dark grey and brown fine-grained sand.

Between the site and Hōkio Stream there is an area of developed pasture which is underlain by peats of unknown thickness. In recent years the owner of this land has been progressively filling the area with cleanfill, levelling and re-planting. Towards the coast there are areas of swamp. Excavations carried out on a property west of the site on Hōkio Beach Road showed at least one metre of peat containing large logs.

Depressions between dunes show evidence of being below the winter water table in some areas. These areas generally are underlain by organic silts, peats, or silty sands. To the south of the site some depressions appear to be permanently below the water table.

HRC hydrology staff have advised in the past that "*the general confined groundwater flow direction is towards the west*". A conceptual model of shallow groundwater in the general region of the landfill is shown in Figure 2-1.

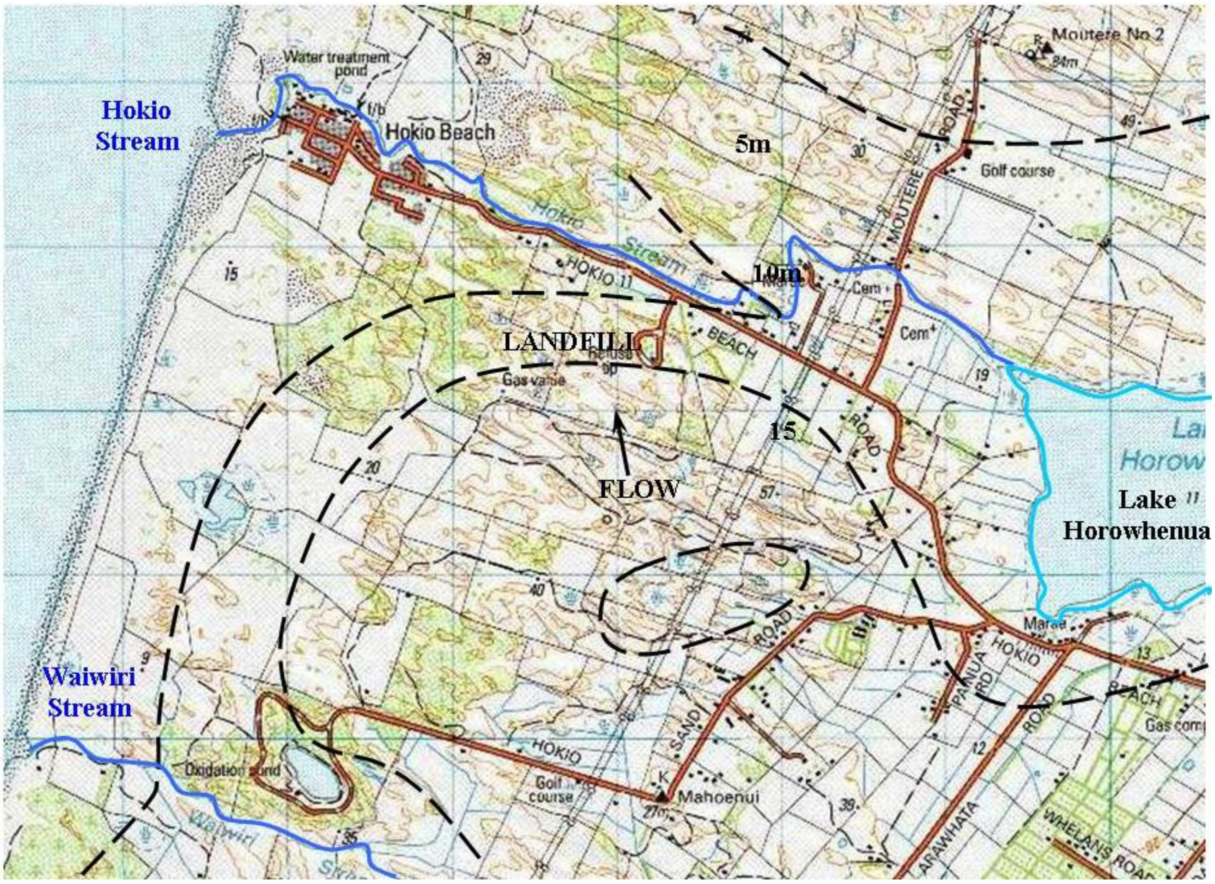


Figure 2-1 Shallow Groundwater Flow Direction

Shallow groundwater flow is in a northerly to westerly direction. Drainage patterns in the coastal strip are influenced by sand dune dominated topography. This considerably complicates the shallow groundwater flow pattern. While deeper aquifers will flow towards the coast, shallow groundwater flow will be affected by surface watercourses and topography.

The sand aquifer is shallow and has low to moderate permeability. It contains lenses of peat from swamps overlain by aeolian sand deposits.

There are several private bores within a 1.5km radius of the site. Sampling of groundwater on a private property was last undertaken in March 2014. The results were made available to the property owners and HRC.

2.2 Timeline for Landfill Development

Key milestones in the history of the Levin Landfill are outlined as follows:

- 1970s – Old landfill accepting municipal solid waste.
- 1994 – Commenced installation of groundwater monitoring bores.
- 2002 – Resource consents granted for old, unlined landfill and new landfill operations on the site.
- May 2004 – New landfill commenced operation with Stage 1A.
- 2004 – 2008 – Leachate irrigated on site.
- 2008 – Stage 2 is constructed.
- May 2008 – Leachate irrigation ceased.
- 2009 – 2010 – Resource consent review process.
- 2009 – Four new groundwater monitoring bores installed (G1D; G1S; G2S, and D3r, as a replacement for bore D3)

- 2013 – Stage 3A is constructed.
- 2015 – Stage 3B is constructed.
- 2015 – Initiation of resource consent review process.
- 2016 – Biofilter is installed.
- 2017 – Stage 3C is constructed.
- 2017 – Landfill gas flare is commissioned.
- 2019 – Finalisation of resource consent review process.
- November 2020 – Bores Xd1, Xs1 and Xs2 were developed.
- June 2021 – Replacement bores D3rs and D3rd were developed to replace bore D3r which had been in the proposed footprint area of Stage 1B, but that stage was not constructed.
- September 2021 – bio-filter was decommissioned and gas pipe from the leachate sump was connected to the main landfill gas pipe network that feeds the landfill gas flare.
- October 2021 – Disposal operations ceased within the Stage 1A, 2 and 3 footprint area, with that area filled.
- November 2021 to March 2022 – permanent capping of the whole lined landfill surface except for the west-facing front face which has a temporary capping, and under the access road.
- April 2023 to May 2023 – reshape and recap the old landfill.
- January 2024 to February 2024 – cap the front face and access road of the lined landfill.

3 Monitoring Programme

The sampling program carried out in the 2023-2024 reporting period for discharge permits ATH-2002003982.03, ATH-2002003983.02 and ATH-2002009801.02 is summarised in the table in Appendix B.

Gas monitoring is carried out in July, October, January, and April each year at the groundwater bore locations, as per consent ATH-2002003984.02.

Additional gas emission sampling was carried out on the surface of the landfill, as per consent ATH-2002003984.02.

Since January 2010, water samples collected from the groundwater boreholes have been tested for dissolved nutrients and metals rather than total concentrations. Dissolved metals are analysed for in samples from the Hōkio Stream and the Northern Farm Drain. For simplicity, results from groundwater monitoring prior to January 2010 (when samples were tested for total metal and nutrient concentrations) have not been compared to the results from January 2010 onwards. Refer to the Site Plan in Appendix C for borehole locations.

3.1 Interpretation of Median Values and Ranges

The monitoring data collected over the 2023-2024 reporting period covered by this report are typically analysed in terms of median values, in comparison with the relevant guidelines or trigger values identified in the applicable discharge consent. It is important to note that due to the sampling programme schedule (Appendix B), some monitoring locations are sampled only once or twice each year (i.e., annual, or 6-monthly sampling) for specific parameters. In these cases, a single result or range has been presented for comparison with guidelines / trigger values, rather than a calculated median. This is because it is inappropriate to calculate median values where there are less than three data points available. Sampling frequencies for all parameters at each monitoring location have been included in the reporting tables, to provide context for the results and interpretation of trends.

All results have been rounded to two decimal places for conciseness and ease of interpretation, unless otherwise indicated.

3.2 Note regarding Interpretation of "Non-Detected" Results

For those chemical constituents that were found to be present in concentrations below laboratory detection limits during the reporting period, the results have been assumed to be 50% of the laboratory limit, and a median calculated on this basis. Where all results were below detection limits, the result has been reported as "ND" in the summary tables. This is standard practice when dealing with chemical concentrations in water. However, the same rule cannot be applied for faecal coliforms in the context of the Levin Landfill.

The laboratory detection limit for Faecal Coliforms (sampled as *E.coli*) varies between 4 CFU/100mL and 100 CFU/mL, however is typically the higher value. The resource consent requires that groundwater from the deep aquifer be compared against the DWSNZ for compliance purposes. The NZDWS for Faecal Coliforms (*E.coli*) is <1 CFU/100mL (i.e., NIL / 0 CFU/100mL). Due to the inconsistency in detection limit between samples, any value below the higher detection limit of 100 CFU/mL has been considered 'not detected' whereas any value at or above this threshold has been shown. This method has been applied in all instances where faecal coliforms (*E.coli*) are assessed for compliance with the DWSNZ. It should be noted that due to the high detection limit of Faecal Coliform sampling, results are unable to be compared to the DWSNZ. It is recommended that, in future, all samples that require comparison against the DWSNZ be tested to a level of detection of 1 CFU/100mL. This was previously identified in the 2022-2023 report, however the recommended lower detection limit of 1CFU/100mL has been inconsistently applied since.

Similarly, the laboratory detection limit applied to $ScBOD_5$ has varied from 1, 3 and 6 mg/L. For the surface water sampling (i.e., Hōkio Stream and Northern Farm Drain), results need to be compared against a trigger level of < 2 mg/L. So, an appropriate level of detection for the surface water sampling locations is 1 mg/L.

4 Groundwater Monitoring

4.1 Monitoring Rationale

From 1994 onwards, groundwater monitoring bores have been installed at the Levin Landfill site to determine:

- The background groundwater quality.
- The direction of groundwater flow.
- Groundwater quality down-gradient of each of the two landfilling areas and other activities on site, such as the discontinued leachate irrigation area and the leachate pond.

There are presently 27 groundwater monitoring bores that are being sampled regularly, as required by the consent conditions.

No monitoring has been carried out within the old unlined landfill footprint. Measurement of actual effects at various distances down-gradient of the landfill and comparison with background groundwater quality provides the most relevant information to assess effects of the landfill on groundwater quality.

Leachate from the old unlined landfill migrates in a downward direction and will mix with groundwater which flows beneath the landfill area. The chemical composition of the groundwater is expected to be affected to a greater degree immediately down-gradient (hydraulically) of the old unlined landfill due to cumulative leachate loading.

The results of the 2023 – 2024 reporting period have been discussed in the following sections and have been grouped based on groundwater depth and the way in which bores have been grouped in the resource consent conditions. Shallow bores have also been grouped by their location relative to the old unlined landfill and new lined landfill.

The number of samples taken per site has varied through the monitoring period and thus this will affect the comparability of averages. Where this differs, it is noted. However, for reference purposes, a complete list of the number of samples per site can be found in Appendix D.

4.2 Description of Monitoring Bores

A Site Plan showing the location and depth of the monitoring bores has been included in Appendix C. A description of the bores and their function is provided below.

Deep Bores

Bore G1D is located hydraulically up-gradient of both the old and new landfills in the deep aquifer. This bore, which is at the southeast corner of the site, indicates background deep groundwater quality. Deep aquifer bore E1D is located to the west of the old, closed landfill, up-gradient of the closed landfill, and somewhat down- and cross-gradient of the new landfill (now closed). Deep aquifer bores C2DD and E2D are located hydraulically down-gradient from both old landfill and the new landfill. Bore Xd1 was installed at the end of 2020 at the north-western corner of the site, downgradient from bore E2D and so downgradient of both the closed landfill and the new landfill (now closed). Bore D3rd was installed in June 2021, together with bore D3rs, as a replacement for bore D3r which was located within the footprint of the proposed new stage 1B. It is hydraulically down-gradient from the (previously) operational new landfill.

Shallow Bores

Bore G1S is located hydraulically up-gradient of both the old and new landfills in the shallow aquifer. The bore at the southeast corner of the site is representative of background shallow groundwater quality.

Bores D1, D2, D3rs (new replacement bore for bore D3r, installed in June 2021), D6 and E1S are located hydraulically up-gradient of the old unlined landfill. Therefore, they represent groundwater uninfluenced by leachate from the old landfill. These boreholes are located hydraulically down-gradient of the new landfill (now closed) and irrigation areas. The new landfill (now closed) is lined and has a leachate collection system which significantly reduces the potential for leachate to enter groundwater. Bores D4 and D5 are across or hydraulically up-gradient of the new landfill and the old landfill and are away from any areas irrigated between 2004 and 2008. Sampling from D4 and D5 began in December 2004.

Bore F1 is located hydraulically down-gradient of the area where leachate from the new landfill was irrigated in the south-east of the site. This area is identified in the Site Plan in Appendix C by the soil sampling locations A – D, shown in green on the Site Plan. Bores F2 and F3 are in the vicinity of areas originally planned for leachate irrigation. Irrigation did not occur on the western side of the site and hence these bores can be used to represent background groundwater quality. Leachate has not been irrigated at the site since May 2008 at which time the pumping of leachate to the Levin Wastewater Treatment Plant (WWTP) began. It is most unlikely that the leachate will be irrigated to land in the future. Given that irrigation has not occurred over the past 12 years, the F-series bores are used as across-gradient bores for the new landfill.

Bores B1, B2 and B3 are located on a line parallel to the northern-most extent of tipping for the unlined old landfill (refer to Site Plan, Appendix C). They are all within 50 metres of the old landfill. The B series bores are on the down-gradient edge of the old landfill, with the age of adjacent fill reducing from sample location B1 to B3. Bore B3 is in the swampy area and, in the 2013 annual report, was suspected to be inadequately sealed because of high faecal coliform counts. However, the results for faecal coliforms at B3 were stable between January 2016 and April 2020, after which a subset of faecal coliforms were sampled (Faecal coliforms – *E.coli*) . Following the change in sampling parameter, results have similarly remained relatively stable.

The C series bores are located further hydraulically down-gradient from the old unlined landfill towards Hōkio Beach Road (refer to Site Plan, Appendix C). Bore C1 is located hydraulically down-gradient of bore B1. It is adjacent to a peaty swamp area, which may affect its water quality. Bore C2 is in the vicinity of bores B2 and B3 but further hydraulically down-gradient of the old unlined landfill. It is located hydraulically down-gradient of a swampy area, which may also affect groundwater quality in this bore.

Bore C2DS, which is also down gradient of the old unlined landfill, is screened deeper than the other shallow bores within the coastal sands, although an influence from recharge through peats is still possible.

Bore E2S is located northwest of the old landfill to detect if there is any groundwater which contains leachate moving directly towards the nearest houses downstream of the site. This bore is across gradient to the west of the B and C series bores which are within the known plume.

Bore G2S was installed in late 2009 and is located to the north hydraulically down-gradient of the old landfill by Hōkio Beach Road and the entrance road to the landfill property.

Bores Xs1 and Xs2 were installed in late 2020 within the Hōkio Beach Road reserve. Bore Xs1 is adjacent to Tatana's property and represents groundwater quality close to Hōkio Stream. Bore Xs2 is hydraulically up-gradient from the old landfill site.

Bore D3r was replaced in June 2021 by two bores (D3rs and D3rd) located approximately 140 metres northwards of the old D3r bore. The replacement occurred since the old D3r bore was located within the footprint of the proposed (at that time) future Stage 1B of the landfill.

4.3 Background Groundwater Results

Groundwater is collected from two background bores (G1S and G1D) situated hydraulically up-gradient from the new and old landfills to the southeast of the site (See Site Plan, Appendix C). These two bores were constructed in late 2009 to enable groundwater samples to be collected from the shallow and deep aquifers. Both bores were first sampled in January 2010. Results from bores F2, F3 and D5 may also be used to characterise background shallow groundwater quality. The suitability of the reference background water quality bores has been reviewed below.

Analysis shows that bore G1S is unsuitable as a reference background water quality monitoring bore, as results indicate (Figure 4-1 to Figure 4-4) that the bore has higher concentrations of some parameters, such as ammoniacal-N, chloride and conductivity, compared to bores F2, F3 and D5. The bore does typically show lower concentrations of boron than the other background bores, with lower median and 75th percentile concentrations, however the 95th percentile results are higher than that of the other bores. Bore G1D has been included in the results below, as a background bore, however, is noted to not be directly comparable to the other graphed bores because it is in the deep aquifer, and the other bores are in the shallow aquifer.

Bore G1D indicates ammoniacal-N results higher than the other bores. Boron, conductivity and chloride are relatively similar at G1D to bores F2, F3, and D5. Bores F2, F3, and D5 display more consistency between the bores and have lower values for parameters, such as ammoniacal-N, chloride and conductivity, than bores G1S or G1D. It is considered that bores F2, F3 and D5 are more suitable for use as reference background bores than G1S and G1D, however G1S and G1D should still be used for comparison because they are upgradient of the landfill, though ostensibly impacted by other activities remote from the landfill.

The water quality results (medians) for the 2023-2024 sampling year from these background bores are presented in Table 4-1. Results for key indicators (ammoniacal-N, chloride, boron, and electrical conductivity) have been coloured to highlight more elevated values (with colour intensity increasing with concentration), to assist in identifying areas with potential contamination issues spatially across the site (i.e., west to east).

Water quality from the natural background water hydraulically up-gradient from the landfill site is not subject to any water quality limits in the existing resource consent. However, for comparison purposes, both the ANZECC LDW trigger values and the NZDWS maximum acceptable values (MAVs) and guideline values (GVs) for aesthetic determinants were used to benchmark the quality of water up-gradient from the landfill site.

Please note, there are differences between the numbers of samples taken at each site. For more information, please see Appendix D.

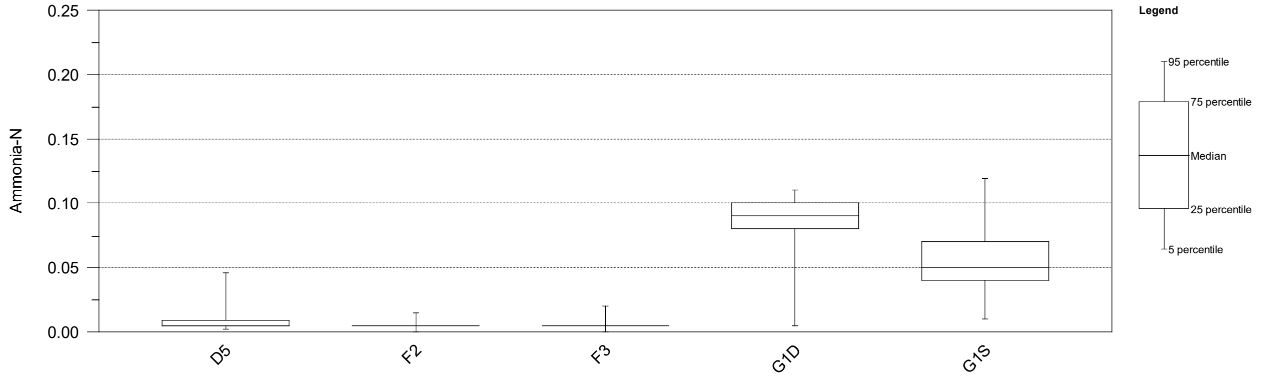


Figure 4-1 Ammoniacal-N (mg/L) in the background water quality bores

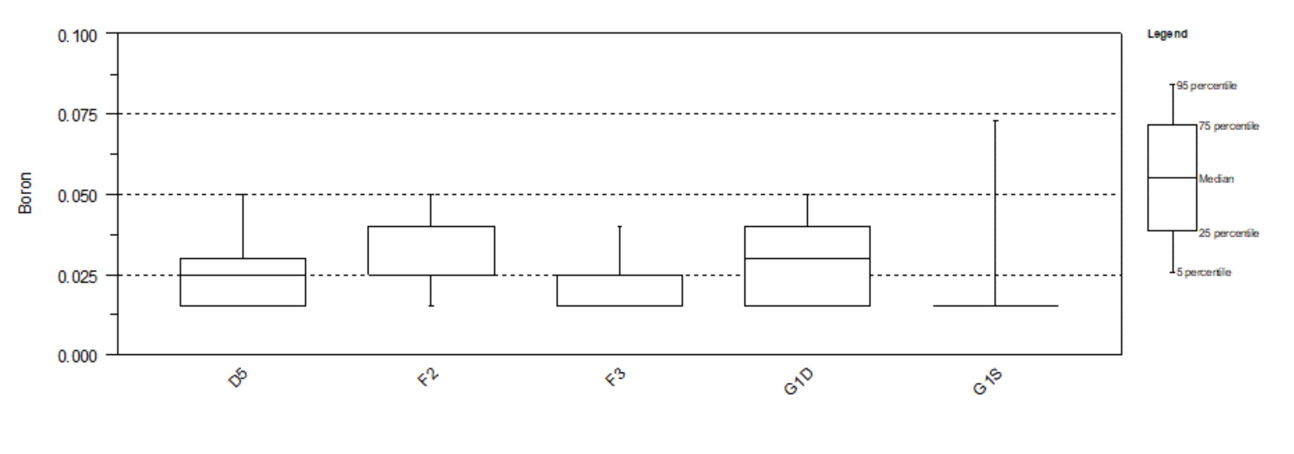


Figure 4-2 Boron (mg/L) in the background water quality bores

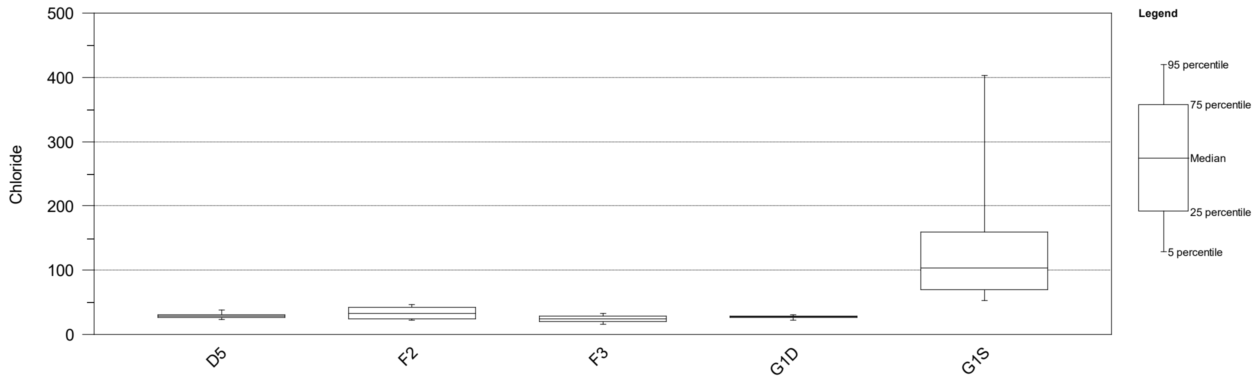


Figure 4-3 Chloride (mg/L) in the background water quality bores

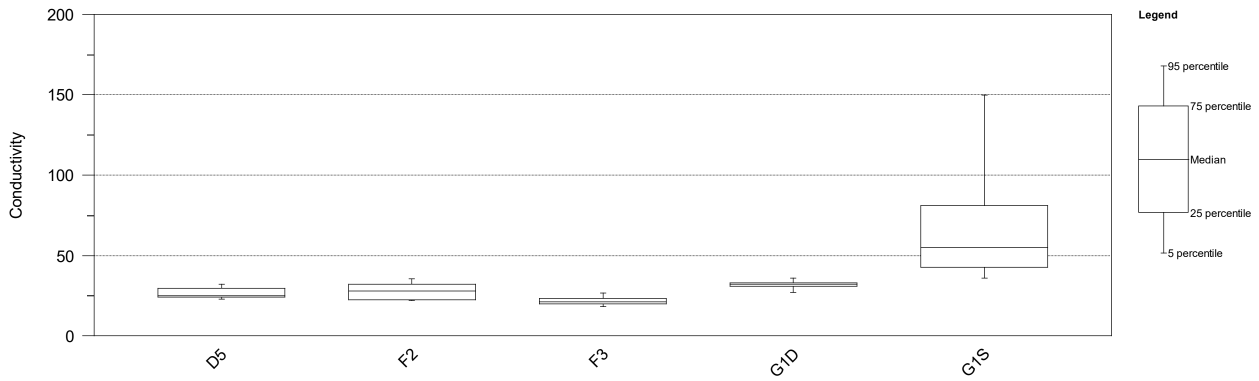


Figure 4-4 Conductivity (mS/m) in the background water quality bores

Table 4-1: Background monitoring bores median results (2023-2024 monitoring period)

Determinant	Units	DWSNZ (MAV)	ANZECC LDW	Detection Limit	D5	F2	F3	G1S	G1D
Leachate indicators									
Ammoniacal-N	mg/L	1.17		0.01	0.0075	ND	ND	0.04	0.095
Boron	mg/L	1.4	5	0.03	0.05	0.05	0.035	0.04	0.05
Chloride	mg/L	250*		0.02	29.45	23.3	16.55	111.0	31.35
Conductivity	mS/m			0.1	30.4	22.3	18.95	55.1	27.5
Other Determinants									
Water level	mBGL				8.95	2.3	5.25	13.78	14.34
E. coli (Faecal coliforms)	CFU/100mL	NIL	100	100	**ND**	**ND**	**ND**	**ND**	**ND**
pH	-	7 to 8.5*	6 to 9		7.10	7.15	7.15	**6.6**	7.05
Suspended Solids	mg/l			Varies – 6, 5, 3, 1	2.5	7	2.5	13.0	8.0
Phenol	mg/l			0.05	ND	ND	ND	ND	ND
VFA	mg/L			5	ND	ND	ND	ND	ND
TOC	mg/L				1.9	1.5	1.1	25.7	1.8
Alkalinity	mg $CaCO_3$/L				73	57	52	70	61
COD	mg/l			15	12.3	7.5	7.5	35.5	7.5
scBOD	mg/L			1	ND	ND	ND	ND	ND
Nitrate-N	mg/L	11.3	90.3	0.01	0.98	0.515	1.65	0.11	0.01
Sulphate	mg/L	250*	1000		18.0	11.3	4.7	9.1	18.3
Hardness	mg $CaCO_3$/L	200*			73	41	34	39	58
Calcium	mg/L		1000	0.01	12.3	6.5	5.2	7.3	8.9
Magnesium	mg/L				10.3	5.94	5.2	5.1	8.7

Determinant	Units	DWSNZ (MAV)	ANZECC LDW	Detection Limit	D5	F2	F3	G1S	G1D
Potassium	mg/L				6.9	5.12	4.3	3.5	5.5
Sodium	mg/L	200*			23.50	25	24.85	62.95	33.60
DRP	mg/L			0.005	0.11	0.144	0.15	0.10	0.04
Aluminium	mg/L	0.1*	5	0.002	0.002	0.003	0.002	0.046	ND
Arsenic	mg/L	0.01	0.1	0.001	0.001	0.002	0.002	0.002	0.002
Cadmium	mg/L	0.004	0.01	0.0002	ND	ND	ND	ND	ND
Chromium	mg/L	0.05	1	0.001	0.001	0.003	0.003	0.002	0.002
Copper	mg/L	2	0.4#	0.0005	0.0007	0.0071	0.0011	0.0072	0. ND
Iron	mg/L	0.2*		0.005	0.010	0.03	0.005	**1.81**	**0.37**
Lead	mg/L	0.01	0.1	0.0005	ND	ND	ND	ND	ND
Manganese	mg/L	0.4		0.0005	0.0167	0.00545	ND	0.0567	0.0708
Mercury	mg/L			0.0005	ND	ND	ND	ND	ND
Nickel	mg/L	0.08	1	0.0005	ND	ND	ND	0.0007	ND
Zinc	mg/L	1.5*	20	0.002	ND	0.002	0.003	ND	ND

Notes:
** denotes guideline values for aesthetic determinants (G.V.), # copper trigger values range from 0.4 mg/L for sheep, up to 5 mg/L for poultry.*
***Bold red text** – denotes an exceedance of the relevant DWSNZ standard.*
ND indicates the value was below the laboratory detection limit – Note that as the reported results are the annual median results, some results listed as ND may have been detected, however the annual median is below the detection limit.

The median *E.coli* counts cannot be compared to the DWSNZ limits (except for bore G1D), since the other four bores, being shallow bores, have a higher sampling detection limit of 100 CFU/100mL. G1D is a deep aquifer bore and so has a detection limit of 1 CFU/100mL. Median results at all the shallow aquifer sites fell below the ANZECC LDW value.

For the 2023-2024 monitoring period, the median pH from the samples taken from the shallow borehole (G1S) was below the DWSNZ MAV range of 7 to 8.5, at 6.6 pH units. The pH recorded in this bore has been consistently low since monitoring began in 2010. The median pH values for the deeper borehole (G1D) and boreholes F2, F3 and D5 were within the DWSNZ MAV range and the LDW range.

The iron concentration at G1D was sampled once during the reporting period, but at 0.37 mg/L exceeded the DWSNZ MAV of 0.2 mg/L, this trend being consistent with historical data. The median concentration of iron at G1S was well above the DWSNZ MAV at 1.81 mg/L. Iron concentration at G1S has produced a decreasing trend over the past six reporting periods, however, this appears to have slowed somewhat from the significant decrease seen from 2018 to 2020.

Table 4-2: Iron (mg/L) concentration at G1S over the past 6 reporting periods

Reporting year	Iron concentration (mg/L)
2023-2024	1.81
2022-2023	2.43
2021-2022	3.43
2020-2021	3.5
2019-2020	6.03
2018-2019	13.1

Key leachate parameters boron, chloride and ammoniacal nitrogen recorded results below the relevant guideline values. The results demonstrate that G1S has by far the highest median concentration of chloride (111.0 mg/L), as well as the highest conductivity (median of 55.1 mS/m). The highest median concentration of ammoniacal nitrogen (0.095 mg/L) was found in G1D. D5, F2 and G1D shared the highest median concentrations of boron – 0.05 mg/L – demonstrating that boron concentrations are relatively consistent across these bores.

4.4 Shallow Groundwater Results

This section discusses groundwater quality hydraulically up and down-gradient of the old unlined landfill footprint in the shallow unconfined aquifer (referred to as the 'sand aquifer'). The D-series, F-series, E1S and G1S bores are all hydraulically up-gradient of the old landfill. In addition, bores D1, D2, D3rs, D6 and E1S are hydraulically upgradient of the old unlined landfill but down-gradient of the new lined landfill. These bores can therefore be used as 'early detection' bores for leachate breakouts from the new landfill (now closed). D1 and D6 bores are also located down-gradient of the leachate pond and therefore may provide some indication of leachate leakage from the pond. It should be noted, however, that the 'leachate pond' has not been used for storing leachate for several years. Leachate is pumped directly from the collection manhole at the toe of the landfill to a manhole situated next to the leachate pond, from where it is pumped to the wastewater treatment plant. The liquid in the leachate pond is stormwater that has accumulated over time.

The B-series, C-series, E2S and G2S bores are all hydraulically down-gradient of the old landfill and are therefore used to assess the impact from the old unlined landfill on groundwater.

The resource consent requires results from these bores to be compared against the LDW trigger values. The results from the reporting period for these bores are presented in Table 4-3 along with the shallow background bore results (G1S – from Table 4-1). Results for key indicators have been coloured to highlight more elevated values (with colour intensity increasing with concentration), to assist in identifying areas with potential contamination issues spatially across the site (i.e., west to east, and down-gradient to up-gradient). A complete table of results for the bores over the last 5 years is presented in Appendix E.

Table 4-3: Groundwater hydraulically up-gradient of Old Landfill and down-gradient of New Landfill: median or singular results (2022-2023 monitoring period).

Determinant	Units	ANZECC LDW	Detection Limit	D5 (B/G)	D3rs	E1S	D4	D2	D6	D1	F1	G1S (B/G)
Leachate Indicators												
Ammoniacal-N	mg/L		0.01	ND	0.755	0.17	0.235	0.745	ND	ND	ND	0.04
Boron	mg/L	5	0.03	0.05	0.035	ND	0.03	0.05	0.06	0.055	0.045	0.04
Chloride	mg/L		0.02	29.45	15.9	27.15	30.3	63.1	29.6	22.4	51.85	111
Conductivity	mS/m		0.1	30.4	21.8	24.55	27.4	57.6	46.4	46.7	45.5	55.1
Other Determinants												
Water level	mBGL			8.95	5.6	11.1	7.55	21.2	16.3	16.6	7.56	13.78
E. coli (Faecal coliforms)	CFU/100mL	100	100	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	-	6 to 9		7.1	6.45	7.1	7.05	6.4	6.8	6.7	7.05	6.6
Suspended Solids	mg/l		Varies – 6, 5, 3, 1	2.5	3	2.5	2.5	53	2.5	2.5	2.5	13
Phenol	mg/l		0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND
VFA	mg/L		5	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOC	mg/L			1.9	22.85	3.5	4	16.3	1.1	1.1	4.4	25.7
Alkalinity	mg $CaCO_3$/L			73	79.5	69	83	187	68	200	134	70
COD	mg/l		15	12.25	66.5	19.5	23.5	49	7.5	7.5	11.75	35.5
BOD	mg/L		1 or <6	ND	1	ND	ND	1	ND	ND	ND	ND
Nitrate-N	mg/L	90.3	0.01	0.975	0.0275	ND	ND	ND	18.15	6.325	1.81	0.11
Sulphate	mg/L	1000		18	1.37	6.87	5.61	6.15	7.85	17.9	2.97	9.07
Hardness	mg $CaCO_3$/L			73	46	46	49	160	186	166	166	39
Calcium	mg/L	1000	0.01	12.3	10.1	7.4	9.2	26.8	32.2	29.4	24	7.3
Magnesium	mg/L			10.3	4.83	6.62	6.34	22.6	25.7	22.5	25.8	5.05

Determinant	Units	ANZECC LDW	Detection Limit	D5 (B/G)	D3rs	E1S	D4	D2	D6	D1	F1	G1S (B/G)
Potassium	mg/L			6.85	4.4	5.63	5.63	11.7	10.6	12.4	8.2	3.5
Sodium	mg/L			23.5	22.25	25.3	28.95	45.4	39.2	46.3	40.6	62.95
DRP	mg/L		0.005	0.107	0.0835	0.087	0.052	0.033	0.078	0.089	0.161	0.097
Aluminium	mg/L	5	0.002	0.002	0.067	0.007	0.003	0.003	ND	ND	0.002	0.046
Arsenic	mg/L	0.1	0.001	ND	0.001	NS	ND	0.0005	ND	0.001	0.002	0.002
Cadmium	mg/L	0.01	0.0002	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/L	1	0.001	ND	0.003	ND	ND	ND	ND	ND	0.001	0.002
Copper	mg/L	0.4[#]	0.0005	0.0007	ND	ND	ND	ND	ND	ND	0.0021	0.0072
Iron	mg/L		0.005	0.01	14.45	4.13	1.745	12.25	0.005	0.005	0.01	1.805
Lead	mg/L	0.1	0.0005	ND	ND	0.00075	ND	ND	ND	ND	ND	ND
Manganese	mg/L		0.0005	0.01665	0.3475	0.2085	0.2065	0.4955	0.00185	0.000475	0.00705	0.0567
Mercury	mg/L		0.0005	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	1	0.0005	ND	ND	ND	ND	ND	ND	ND	0.0006	0.00065
Zinc	mg/L	20	0.002	ND	0.0035	ND	ND	0.005	0.004	0.011	0.005	ND

Notes:

The counts for faecal coliforms should be used with caution as a high result for one sample will appear misleading as the other samples were not detected.
NS indicates that no sample was taken for this parameter.
ND indicates the value was below the laboratory detection limit.
B/G denotes "Background Bore".

4.4.1 Groundwater Quality Hydraulically Up-Gradient of the Old Landfill

Bores hydraulically up-gradient of the old landfill include bores which are down-gradient of the new landfill (now closed).

None of the applicable ANZECC LDW trigger values were exceeded at groundwater bores up-gradient of the old landfill during the 2023-2024 reporting period. The results indicate that there is no leachate from the new lined landfill impacting on groundwater down-gradient of the landfill.

Concentrations of ammoniacal-N have been consistently elevated within bore D2 when compared to background bore G1S since monitoring began in both bores. A slight increasing trend has been continuing with fluctuations since 2015 – with April 2024 having the highest quarterly concentration of 0.76 mg/L since then, followed by January 2024 with a concentration of 0.76 mg/L. This trend continues to be evaluated annually. Bore D2 is located down-gradient of the new landfill and therefore elevated concentrations of key leachate indicator parameters such as ammoniacal-N could indicate a break-out of leachate. It is noted however that the concentration of ammoniacal-N has been consistently elevated at bore D2 compared to other surrounding bores since monitoring began in 1997, seven years before the new landfill began operation.

Bore G1S exhibited a return to historic chloride concentrations, with a median of 111 mg/L for the reporting period, compared to 76.2 mg/L in the prior year.

Both D2 and G1S recorded the highest conductivities at 57.6 mS/m and 55.1 mS/m, respectively.

Bores D1 and D6 are both down-gradient of the leachate pond and were noted in the 2019-2020 annual report as having increased concentrations of nitrate-N since 2008. This increase slowed in October 2018 and, since then, typically shown a decreasing trend. Concentrations at both sites increased during the 2023-2024 reporting period, in comparison to the prior year, which demonstrated a decline. The concentrations observed are discussed further in Section 4.7.2.

Bore F1 is located down-gradient of the leachate irrigation area and recorded similar concentrations of DRP to prior years. Irrigation of leachate to land ceased in 2008 and therefore it is considered unlikely these slightly elevated concentrations are a result of the discharge of leachate to land in this area. The concentration of DRP recorded in this bore has been mostly consistent since 2007.

Please note, there are differences between the number of samples taken at each site. For more information, please see Appendix D.

4.4.2 Groundwater Quality Hydraulically Down-Gradient of the Old Landfill

Water sampling was carried out to characterise the groundwater quality in a series of shallow bores situated hydraulically down-gradient of the old landfill.

Results for all parameters were below the ANZECC LDW trigger values in the reporting period. Therefore, all bores hydraulically down-gradient of the old landfill complied with the resource consent conditions.

Results for key indicators in Table 4-4 have been coloured to highlight more elevated values (with colour intensity increasing with concentration), to assist in identifying areas with elevated contaminant concentrations indicating the presence of the leachate plume from the old landfill spatially across the site (i.e., west to east).

Elevated concentrations were observed as follows:

- Leachate indicator concentrations (ammoniacal-N, boron, chloride, and conductivity) remained elevated in the western-most down-gradient bores (B1, B2, B3, and C2) – similarly to the previous three reporting periods
- Concentrations often varied significantly between the bores, although, bores E2S and Xs2 yielded consistently lower results than the other sites. This indicates the leachate plume is **not** moving directly towards the nearest houses downstream of the site. Bores Xs1 and G2S also recorded low results, however conductivity and chloride (respectively) were somewhat elevated.

Whilst results for all parameters were below the ANZECC LDW trigger values in the reporting period, it is instructive to look at how the results vary over time. The graphs presented in Appendix F show trends of leachate indicators for all groundwater bores.

Considering those graphs that represent the sand aquifer downstream of the old landfill (Appendix F), concentrations of the leachate indicator parameters are somewhat stable, and declining for some parameters (chloride, ammoniacal-N) at all downgrade monitoring bores, except for bore C1, where there is a discernible increase in boron concentrations and at bore C2, where there are marked increases in boron and ammoniacal-N.

These trends have been identified by Earthtech Consultants Ltd who have conducted additional investigations of the shallow groundwater within the northern vicinity of the old landfill. Based on their work drawings have been prepared that show the extent of the leachate plume down-gradient from the old landfill through plots of concentrations of conductivity, chloride, boron and ammoniacal-N. These drawings are provided in Appendix C.

Please note, there are differences between the number of samples taken at each site. For more information, please see Appendix D.

Selected down-gradient bores were also analysed for volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC) throughout the reporting period. Of the five detected substances, two exceeded the guideline value. The range of concentrations detected above laboratory detection limits at each location are detailed in Table 4-5.

- SVOC-029 Carbofuran exceeded the DGVs for 99th percentile species protection against toxic effects at site C2ds. This should be interpreted with caution as the 99th percentile value for Carbofuran is below the laboratory testing threshold. Due to the higher laboratory detection limit, further samples may exceed the 99th percentile threshold. Due to testing limitations the extent to which this may occur is unknown.
- VOC-058 Chlorobenzene exceeded the 99th percentile DGV at site B2.

Table 4-4: Median or singular result for hydraulically down-gradient groundwater monitoring bores (2023-2024 monitoring period) – bores listed L to R (west to east)

Determinant	Units	ANZECC LDW	Detection Limit	E2S	B3	Xs1	C2	C2DS	B2	C1	B1	G2S	G1S (B/G)	Xs2
Leachate indicators														
Ammoniacal-N	mg/L		0.01	0.29	146	13.4	181.5	1.6	72.1	12.55	11.5	0.03	0.04	0.02
Boron	mg/L	5	0.03	0.0275	1.41	0.405	1.645	0.815	2.18	0.88	1.94	0.63	0.04	0.04
Chloride	mg/L		0.02	40.25	124	80.8	137	99.8	153	145.5	318	204	111	16.45
Conductivity	mS/m		0.1	34.25	263	125.5	264	149.5	198	127	233	114	55.1	20.1
Other Determinants														
Water level	mBGL			5.3	0.23	0.64	0.32	2.95	1.23	0.62	1.06	2.2	13.78	2.53
E. coli (Faecal coliforms)	CFU/100mL	100	Varies, 50, 100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	-	6 to 9		7.7	7	7	6.95	6.85	7	6.95	7	6.9	6.6	6.7
Suspended Solids	mg/l		Varies – 6, 5, 3, 1	16	454	54.5	173	118	201	43	178	11	13	10.75
Phenol	mg/l		Varies - 0.05, 0.01	0.005	0.005	0.025	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.025
VFA	mg/L		5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOC	mg/L			2.1	69.1	25.2	48.8	31	45.3	21.8	27.6	9.7	25.7	2.15
Alkalinity	mg $CaCO_3$/L			92	1250	520	1200	684	900	380	677	324	70	59.5
COD	mg/l		15	11.25	141	71.5	152	68	94	89.5	109	39	35.5	7.5
BOD	mg/L		Varies 1 or <6	ND	1	1	1.25	0.75	ND	ND	ND	ND	ND	ND

Determinant	Units	ANZECC LDW	Detection Limit	E2S	B3	Xs1	C2	C2DS	B2	C1	B1	G2S	G1S (B/G)	Xs2
Nitrate-N	mg/L	90.3	0.01	ND	0.05	0.0125	0.05	0.0275	8.21	0.0275	14.255	ND	0.11	0.695
Sulphate	mg/L	1000		13.4	0.01	2.405	0.19	0.01	12.78	26.4	4.05	11.6	9.07	8.54
Hardness	mg $CaCO_3$/L			76	307	333	282	678	529	180	309	224	39	57
Calcium	mg/L	1000	0.01	20.5	54.7	72.35	51.3	148	128	33.5	54.7	40.5	7.3	11.75
Magnesium	mg/L			6.13	41.3	33.8	37.3	74.8	50.9	23.4	41.8	30	5.05	6.665
Potassium	mg/L			5.71	109	20.35	82.2	15.8	126	26.5	41.7	10.5	3.5	4.73
Sodium	mg/L			27.5	100	75.8	136	101	105	129	250	156	62.95	17.15
DRP	mg/L		0.005	0.233	0.026	0.016	0.013	0.041	0.018	0.014	0.112	0.022	0.097	0.022
Aluminum	mg/L	5	0.002	0.0035	0.0055	0.004	0.0195	ND	0.008	0.022	0.016	0.003	0.046	0.007
Arsenic	mg/L	0.5	0.001	NS	0.028	ND	0.002	0.001	0.004	0.001	0.001	ND	0.002	ND
Cadmium	mg/L	0.01	0.0002	ND	0.0003	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/L	1	0.001	ND	0.004	ND	0.002	ND	0.001	ND	0.002	ND	0.002	ND
Copper	mg/L	0.4	0.0005	ND	0.0491	ND	0.0023	ND	0.005	0.0011	0.0276	0.0073	0.0072	0.00135
Iron	mg/L		0.005	0.085	0.36	3.935	0.48	2.54	0.11	1.74	0.08	0.06	1.805	0.095
Lead	mg/L	0.1	0.0005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L		0.0005	0.2555	3.42	1.102	0.1495	2.115	3.45	0.2655	4.64	0.25	0.0567	0.0741
Mercury	mg/L		0.0005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	1	0.0005	ND	0.0085	0.0019	0.0045	0.0024	0.0029	0.0012	0.0058	0.00195	0.00065	ND
Zinc	mg/L	20	0.002	0.002	0.006	0.0035	0.022	0.003	0.012	0.006	0.02	0.009	ND	0.0045

Notes:
ND indicates the value was below the laboratory detection limit.
NS indicates that a parameter was not sampled during the reporting period.
B/G denotes a Background Bore.

Table 4-5: SVOCs and VOCs detected in samples from down-gradient groundwater bores, 2023-2024.

Date	**Determinant**	**Laboratory detection limit (from Eurofins-ELS) mg/L**	**ANZECC 2000 DGV (mg/L)**	**Detected concentrations at down-gradient bores (mg/L)**				**Common source/usage of determinant (from relevant ANZECC 2000 Volume 2, Section 8.3.7 technical briefs)**
				B3 (B3s)	**C2**	**B2**	**C2ds**	
10/04/2024	SVOC-029 Carbofuran	0.001	0.00006 (99th percentile) 0.0012 (95th percentile)[2] 0.004 (90th percentile) 0.015 (80th percentile)	ND	ND	ND	0.001	Insecticide and nematicide
10/04/2024	VOC-003 Benzene	0.0005	0.6 (99th percentile) 0.95 (95th percentile) 1.3 (90th percentile) 2.0 (80th percentile)	0.0020	0.0010	0.0012	0.0005	Adhesives, resins, pesticides, ink, industrial cleaners/degreasers, thinners and fuel additives.
10/04/2024	VOC-058 Chlorobenzene	0.0005	0.005 (99th percentile) 0.055 (95th percentile) 0.1 (90th percentile) 0.19 (80th percentile)	0.0033	ND	0.0180	ND	Industrial solvents for waxes, gums, resins, rubbers, oil, asphalt, degreasing and intermediates for pesticides/herbicides
10/04/2024	VOC Cis-1,2-Dichloroethene	0.0005	1.0 (99th percentile) 1.9 (95th percentile) 2.6 (90th percentile) 4.0 (80th percentile)[3]	0.0007	0.0008	0.0007	0.0007	Industrial solvents, dry cleaning agents, anesthetics, and production of other organochlorides, textiles, plastics.
10/04/2024	VOC Isopropylbenzene (Cumene)	0.0005	0.02 (99th percentile) 0.03 (95th percentile) 0.04 (90th percentile) 0.07 (80th percentile)	0.0012	ND	ND	ND	Production of phenol, acetone, industrial chemicals

Notes:
ND indicates the value was below the laboratory detection limit.

[2] Due to the detection limit, all detected samples are above the 99th and 95th percentile guidelines. There is a possibility the non-detected samples are also above these guideline values.
[3] Note that the DGV limits identified for the parameter are "Low reliability" protection levels

4.4.3 Groundwater Quality Hydraulically Down-Gradient of the Old Irrigation Area

It is appropriate to use the F-series bores (Table 4-6) as cross-gradient monitoring bores for the new lined landfill (now closed) because irrigation has not occurred for the past 14 years.

The water quality results for the F series bores are slightly variable – F1 producing the highest concentrations of leachate indicators (conductivity, and chloride). A median chloride concentration of 51.85 mg/L and conductivity of 45.5 mS/m was recorded in F1 – approximately twice that of both F2 and F3. Both boron and ammoniacal nitrogen were similar at all three F series sites.

Whilst the F series results are not elevated when compared against the background shallow groundwater quality up-gradient of the old landfill, the variability within the F series could be indicative of some influence of leachate irrigation on the shallow groundwater. It should be noted that no irrigation of leachate has occurred on the site since 2008, so if it is because of this, it is likely to dissipate with time. This should continue to be monitored in the future.

Table 4-6 Median or singular result for groundwater monitoring bores hydraulically down-gradient of the old irrigation area (2023-2024 monitoring period)

Determinant	Units	ANZECC LDW	Detection Limit	F1	F2	F3
Leachate indicators						
Ammoniacal-N	mg/L		0.01	ND	ND	ND
Boron	mg/L	5	0.03	0.045	0.05	0.035
Chloride	mg/L		0.02	51.85	23.3	16.55
Conductivity	mS/m		0.1	45.5	22.3	18.95
Other Determinants						
Water level	mBGL			7.56	2.3	5.25
E.coli (Faecal coliforms)	CFU/100mL	100	100	ND	ND	ND
pH	-	6 to 9		7.05	7.15	7.15
Suspended Solids	mg/l		Varies – 6, 5, 3, 1	2.5	7	2.5
Phenol	mg/l		Varies - 0.05, 0.01	ND	ND	ND
VFA	mg/L		5	ND	ND	ND
TOC	mg/L			4.4	1.5	1.1
Alkalinity	mg $CaCO_3$/L			134	57	52
COD	mg/l		15	11.75	7.5	7.5
BOD	mg/L		Varies 1 or <6	ND	ND	ND
Nitrate-N	mg/L	90.3	0.01	1.81	0.515	1.65
Sulphate	mg/L	1000		2.97	11.3	4.7
Hardness	mg $CaCO_3$/L			166	41	34
Calcium	mg/L	1000	0.01	24	6.5	5.2
Magnesium	mg/L			25.8	5.94	5.2
Potassium	mg/L			8.2	5.12	4.3
Sodium	mg/L			40.6	25	24.85

Determinant	Units	ANZECC LDW	Detection Limit	F1	F2	F3
DRP	mg/L		0.005	0.161	0.144	0.15
Aluminum	mg/L	5	0.002	0.002	0.003	0.002
Arsenic	mg/L	0.5	0.001	0.002	0.002	0.002
Cadmium	mg/L	0.01	0.0002	ND	ND	ND
Chromium	mg/L	1	0.001	0.001	0.003	0.003
Copper	mg/L	0.4	0.0005	0.0021	0.0071	0.0011
Iron	mg/L		0.005	0.01	0.03	0.005
Lead	mg/L	0.1	0.0005	ND	ND	ND
Manganese	mg/L		0.0005	0.00705	0.00545	ND
Mercury	mg/L		0.0005	ND	ND	ND
Nickel	mg/L	1	0.0005	0.0006	ND	ND
Zinc	mg/L	20	0.002	0.005	0.002	0.003

Notes:
ND indicates the value was below the laboratory detection limit.
NS indicates that a parameter was not sampled during the reporting period.

4.5 Deep Gravel Aquifer Results

The resource consent requires results from gravel (deep) aquifers to be compared against the DWSNZ MAVs. A complete table of results for the gravel aquifer bores over the last 5 years is presented in Appendix E.

Median concentrations for parameters analysed during the reporting period for the six bores intercepting the gravel aquifer (Xd1, E1D, C2DD, E2D and D3rd) are provided in Table 4-7.

Results for the background deep-bore G1D have also been included in Table 4-7 for comparison. This is the only background bore in the deep aquifer. Results for key indicators have been coloured to highlight more elevated values (with the highest being a darker shade) to assist in identifying areas with potential contamination issues spatially across the site (i.e., west to east, and down-gradient to up-gradient).

The DWSNZ MAVs (consent limits) were **exceeded** for five parameters as follows:

- Hardness at bore D3rd; median of 200.5 mg $CaCO_3$/L. This was also exceeded during the 2022/2023 reporting period
- Arsenic at bore D3rd; median of 0.0195 mg/L. This was also exceeded during the 2022/2023 reporting period
- Iron at G1D; median of 0.37 mg/L was higher than the DWSNZ MAV of 0.2 mg/L. This was also exceeded during the 2022/2023 reporting period
- Manganese was exceeded by bores D3rd, E2D, Xd1 and C2DD with concentrations of 0.477, 0.432, 0.506, and 0.689 mg/L respectively.
- *E.coli* was exceeded at all sites, technically, due to the higher detection limit of 100CFU/100mL. A detection limit of 1CFU/100mL should be used for comparison to the DWSNZ MAVs (consented limits).

Please note, there are differences between the number of samples taken at each site. For more information, please see Appendix D.

Deep bores were also analysed for VOCs and SVOCs throughout the reporting period. No contaminants recorded results above the laboratory detection limit.

Table 4-7: Gravel aquifer median or singular results (2023-2024 monitoring period) – bores listed L to R (west to east)

Determinant	Units	DWSNZ (MAV)	Detection Limit	Xd1	E2D	E1D	C2DD	D3rd	G1D (B/G)
Leachate Indicators									
Ammoniacal-N	mg/L	1.17	0.01	0.38	0.24	0.195	0.33	0.39	0.095
Boron	mg/L	1.4	0.03	0.055	0.05	0.06	0.08	0.04	0.05
Chloride	mg/L	250*	0.02	56.45	41.6	39.35	41.7	31.45	31.35
Conductivity	mS/m		0.1	53.65	44.35	44.75	57.45	53.05	27.5
Other Determinants									
Water level	mBGL			2.35	4.58	11.01	2.75	5.94	14.34
E.coli (Faecal coliforms)	CFU/100mL	NIL	Varies, 1, 50, 100	**50**	**ND**	**ND**	**ND**	**50**	**ND**
pH	-	7 to 8.5*		7.6	7.5	7.5	7.6	7.6	7.1
Suspended Solids	mg/l		Varies – 6, 3, 1	17	2.5	72	7	16	8
Phenol	mg/l		0.05	ND	ND	ND	ND	ND	ND
VFA	mg/L		5	ND	ND	ND	ND	ND	ND
TOC	mg/L			4.45	2.7	2.9	5.5	5.9	1.8
Alkalinity	mg CaCO3/L			185	161	164	241	224	61
COD	mg/l		15	13.75	ND	ND	23	11.25	ND
BOD	mg/L		1 or <6	ND	ND	ND	ND	ND	ND
Nitrate-N	mg/L	11.3	0.01	ND	ND	ND	0.0075	ND	ND
Sulphate	mg/L	250*		0.01	0.01	0.01	0.01	0.01	18.3
Hardness	mg CaCO3/L	200*		152.5	116	146	197	**200.5**	58
Calcium	mg/L		0.01	34.25	24.8	34.9	46.6	56.7	8.9

Determinant	Units	DWSNZ (MAV)	Detection Limit	Xd1	E2D	E1D	C2DD	D3rd	G1D (B/G)
Magnesium	mg/L			16.2	13.1	14.3	19.7	13.9	8.66
Potassium	mg/L			5.33	6.45	5.08	7.21	6.635	5.51
Sodium	mg/L	200*		46.9	39.5	36.3	51.5	21.7	33.6
D.R. Phosphorus	mg/L		0.005	0.117	0.612	0.421	0.663	1.18	0.035
Aluminium	mg/L	0.1*	0.002	ND	ND	ND	0.0095	0.003	ND
Arsenic	mg/L	0.01	0.001	ND	0.001	0.007	0.004	**0.0195**	0.002
Cadmium	mg/L	0.004	0.0002	ND	ND	ND	ND	ND	ND
Chromium	mg/L	0.05	0.001	ND	ND	0.002	0.002	ND	0.002
Copper	mg/L	2	0.0005	ND	ND	ND	0.0014	ND	ND
Iron	mg/L	0.2*	0.005	0.045	0.03	0.03	0.13	0.025	**0.37**
Lead	mg/L	0.01	0.0005	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.4	0.0005	**0.506**	**0.432**	0.222	**0.689**	**0.477**	0.071
Mercury	mg/L		0.0005	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.08	0.0005	ND	ND	ND	0.00075	ND	ND
Zinc	mg/L	1.5*	0.002	ND	0.003	0.003	0.009	ND	ND

Notes:
** denotes guideline values for aesthetic determinants (G.V.);*
***Bold red** – denotes an exceedance of the DWSNZ.*
ND indicates the value was below the laboratory detection limit.
B/G denotes a Background Bore.

4.6 Leachate

The leachate pond has not been used to store leachate for several years. The leachate pumping system has been connected so that leachate is pumped to a manhole next to the leachate pond from where it is pumped to the Levin WWTP. Samples of leachate are now taken directly from the manhole next to the leachate pond.

The monitoring results for the leachate are **not subject to any specific limits in the resource consent**. However, typical leachate characteristics for Class 1-type landfills published by the Waste Management Institute of New Zealand (*Technical Guidelines for Disposal to Land*, September 2023, WasteMINZ) have been included to contextualise the observed state of the leachate (Table 4-8).

Table 4-8: Median results for Leachate Pond Manhole (2023-2024 monitoring period)

Determinant	Units	Typical Leachate Characteristics*	Leachate
Leachate indicators			
Ammoniacal-N	mg/L	3.4 -1,440	**1,525**
Boron	mg/L	0.54 – 20	7.17
Chloride	mg/L	45 – 2,584	1,205
Conductivity	mS/m	308 – 27,900	1,690
Other Determinants			
E.coli (Faecal coliforms)	CFU/100mL	-	100
pH	-	5.9 - 8.5	7.8
Suspended Solids	mg/l	-	47
Phenol	mg/l	-	0.025
VFA	mg/L	-	2.5
TOC	mg/L	17.2 - 822	**828**
Alkalinity	mg CaCO3/L	264 – 6,820	**7,480**
COD	mg/l	84 – 5,090	3,325
$scBOD_5$	mg/L	12 – 3,867	105
Nitrate-N	mg/L	0.1 – 50**	0.5
Sulphate	mg/L	1 - 780	27.2
Hardness	mg CaCO3/L	300 – 11,500**	457
Calcium	mg/L	20 – 600***	95.4
Magnesium	mg/L	40 – 350***	54.7
Potassium	mg/L	10 – 2,500**	714
Sodium	mg/L	50 – 4,000**	965
DRP	mg/L	-	15.2
Aluminium	mg/L	-	0.834
Arsenic	mg/L	0.006 – 0.191	**0.283**
Cadmium	mg/L	0.0005 – 0.140**	**0.0001**

Determinant	Units	Typical Leachate Characteristics*	Leachate
Chromium	mg/L	0.005 – 50.4	0.78
Copper	mg/L	0.004 – 1.4**	0.0066
Iron	mg/L	1.6 - 220	7.52
Lead	mg/L	0.001 – 0.42	0.00165
Manganese	mg/L	0.03 – 45***	1.16
Mercury	mg/L	0.0002 – 0.05***	0.00025
Nickel	mg/L	0.02 – 2.05**	0.1265
Zinc	mg/L	0.015 – 24.2	0.067

Notes:
Red bold *implies median values exceed the maximum typical leachate characteristic values.*
Green bold *implies median values are less than the minimum typical leachate characteristic values*
**for Class 1-type landfills, Table 5-5, p60, Technical Guidelines for Disposal to Land.*
***Data taken from Table 5-4, p59 of the same guideline, for determinants for which no differences in concentrations between the phases of landfill development could be observed in the table.*
****Data taken from Table 5-4, p59 of the same guideline, for determinants during the methanogenic phase.*

The median results (or observed ranges) for leachate sampled from the leachate pond manhole were mostly within the typical leachate composition range for Class 1 landfills published in the *Technical Guidelines for Disposal to Land* (WasteMINZ, 2022). The only exceedances were the median values for ammoniacal-Nitrogen, TOC, alkalinity and arsenic (shown in **bold**). Values for cadmium were lower than the typical leachate characteristics (shown in **bold**).

Leachate samples were not analysed for VOCs or SVOCs during the reporting period which represents a non-compliance. VOCs and SVOCs are supposed to be tested for at six-monthly intervals whilst comprehensive monthly sampling occur. It is likely that the monthly sampling regime “masked” the need to test for the VOCs and SVOCs at six-monthly intervals.

Additionally, leachate is supposed to be tested for the full comprehensive suite of parameters, as the other surface water samples are presently being tested. The leachate was not tested for the full suite of parameters in January 2024, or for Phenol from December 2023 onwards. This is a non-compliance.

4.7 Groundwater Quality Discussion

4.7.1 Background

Key trends observed in the bores which are representative of background groundwater quality during this reporting period, based on the monitoring results detailed in Section 4.3 above, included:

- Shallow background groundwater quality in G1S continues to be characterised by low pH.
- Faecal coliform counts were elevated above the consented limit (nil) in the deeper aquifer bores. Due to the high laboratory detection limit used in most samples it was not possible to compare faecal coliform results to the guideline or consented values. Faecal coliform/ *E.coli* samples should be assessed with the lowest possible laboratory detection limit available.
- The iron concentrations measured in both G1S and G1D continue to fluctuate above the consent limit. The presence of iron is likely due to hydrogeological conditions found at the site and is common in groundwater in this area.

Historically (and within this report) bores G1S and G1D have been used to represent reference background conditions, for comparison with the down-gradient bores. It is noted however the D2, F2 and F3 bores are also screened up-gradient within the shallow aquifer and record lower concentrations of key leachate indicators. As noted in Section 4.3 It is considered that bores F2, F3 and D5 are more suitable than G1S for reference as background bores.

4.7.2 Shallow Aquifer Hydraulically Up-Gradient of the Old Landfill

Key trends observed in the shallow aquifer bores up-gradient of the old landfill during this reporting period, based on the monitoring results detailed in Section 4.4.1 above, included:

- In previous years, concentrations of nitrate-N concentrations have been highest in bores D1 and D6. Despite continual declines from 2019/2020 to 2022/2023, increases were noted in the 2023/2024 reporting period, with a minor increase at D1 (remaining lower than sampling between 2019/2020 and 2021/2022) and a significant increase at D6
- Concentrations for other leachate indicators such as chloride and ammoniacal nitrogen were relatively consistent with background concentrations and historic results. Ammoniacal-N was slightly elevated at bore D2. Boron was slightly elevated compared to background concentrations, but not significantly.

Table 4-9: Comparison of median nitrate-N concentrations in up-gradient bores with previous four reporting periods (2019-2020, 2020-2021, 2021-2022 and 2022-2023).

Reporting period	Median concentration of nitrate-N (mg/L) in up-gradient groundwater bores	
	D1	D6
2023/24	6.33	18.15
2022/23	5.12	11.11
2021/22	9.26	15.20
2020/21	10.44	18.95
2019/20	11.50	14.30

4.7.3 Shallow Aquifer Hydraulically Down-Gradient of the Old Landfill

Key trends observed in the shallow aquifer bores down-gradient of the old landfill during this reporting period, based on the monitoring results detailed in Section 4.4.2 above, included:

- Leachate indicators (such as chloride, conductivity, ammoniacal-N, and boron) were detected at elevated concentrations, particularly in bores B1, B2, B3, C2 and for chloride at G2S. Boron is the only leachate indicator with an assigned consent limit (5 mg/L, ANZECC LDW), and this was not exceeded in any of the shallow aquifer down-gradient bores.
- The water quality samples from E2S have concentrations of landfill leachate indicators (e.g., chloride and boron) in much lower concentrations than at the other downgradient bore sites. It is therefore likely that this bore is not intercepting the leachate plume originating from the old unlined landfill.
- Bore Xs2 recorded similar, or lower concentrations of leachate indicators to E2S, indicating that Xs2 is also not intercepting the leachate plume.
- No bores exceeded the ANZECC LDW for *E.coli*.

Bores B1, B2, B3, C1, C2, G2S and Xs1 all appear to be located and screened within the leachate plume, though C1, G2S and Xs1 appear much less unaffected. Whilst there has historically been some variability in the concentration of the key leachate indicators individually, when assessed as a whole, results indicate a slightly decreasing to stabilising trend in some leachate indicators across these bores (e.g., chloride, sodium and conductivity), whereas other parameters, such as ammoniacal-N in bores B2, B3 and C2, show clear increased levels, and B1 and C1, which show slight increases recently. Additionally, boron now appears to be increasing in all bores, even though it reduced quite considerably for many years in bores B1 and B2.

These trends are being further investigated by Earthtech Consultants Ltd through monitoring of additional groundwater bores to intercept the leachate plume within the northern vicinity of the old landfill.

It was recommended in the 2019-2020 annual report that groundwater levels were recorded at the same time as any scheduled groundwater quality monitoring events from October 2019 onwards, to enable further assessment of groundwater flow directions. Groundwater levels continue to be measured during monitoring events and typically show variations consistent with historic data.

4.7.4 Deep Gravel Aquifer

Key trends observed in the deep gravel aquifer bores during this reporting period, based on the monitoring results detailed in Section 4.5 above, included:

- In July 2023 faecal coliforms were detected within bores E2D and G1D, and in April 2024 at bore Xd1. However, since a laboratory detection limit of 100CFU/100mL has been applied to bores Xd1 and D3rd on three of the four monitoring occasions throughout the 2023 – 2024 reporting period, the presence of *E.coli* is unknown, and so this represents a non-compliance.
- Bore D3rd had median levels of hardness and arsenic which were above consented limits, with annual median values of 200.5 mg CaCO3/L and 0.0195 mg/L, respectively. Bore D3rd has been monitored since July 2021 and the results have consistently shown slightly elevated levels of arsenic and hardness, which are not considered related to landfill activities.
- The consented limit for manganese was exceeded by the median results within bores D3rd (0.4765 mg/L), Xd1 (0.506 mg/L), E2D (0.432 mg/L) and C2DD (0.689 mg/L). Bores D3rd, Xd1 and C2DD have consistently yielded high levels of manganese, which are not considered related to landfill activities.
- Bore G1D had a median of 0.37 mg/L for iron, which was higher than the DWSNZ MAV of 0.2 mg/L. Bore G1D has had elevated levels of iron since monitoring began in 2010, which is not considered related to landfill activities.

4.7.5 Overall Groundwater Quality

Conductivity, boron, chloride and ammoniacal nitrogen are all indicators of the presence of landfill leachate in surface water and groundwater. These indicators were not generally observed at elevated concentrations hydraulically up-gradient of the old landfill, however chloride and conductivity (the latter inferred from elevated calcium and sulphate results) were elevated in several bores on the eastern side of the site. Leachate indicators were detected at elevated concentrations within the groundwater down gradient of the old landfill. A leachate plume originating from the old unlined landfill has been detected extending in a northeast direction from the old landfill, as noted in 4.4.2 with drawings attached in Appendix C. Groundwater quality results generally indicate a somewhat stable, slightly reducing trend in most leachate indicator contaminant concentrations over time, except for ammoniacal-N in bores B3 and C2, and boron, which is increasing in most bores, except bore B2.

The four leachate indicator parameters have been graphically plotted for all groundwater bores and this is presented in Appendix F.

4.8 Leachate Quality Discussion

The concentrations observed for all parameters analysed within the leachate sampled from the leachate pond manhole are generally within the range reported for Class 1 landfills in the Land Disposal Guidelines. Ammoniacal-N, TOC, and alkalinity exceeded the guideline values. Cadmium and mercury were both below the guideline values, with results at or below the detections limits. Ammoniacal-N has typically been above the guideline values within the leachate, similarly, mercury has typically been below the guideline values.

Similarly to the 2022-2023 reporting period, SVOCs and VOCs were not sampled for the leachate in the 2023-2024 reporting period, and this is considered to be a non-compliance.

5 Hōkio Stream

5.1 Description of Sampling Locations

Hōkio Stream is sourced from Lake Horowhenua (within the Lake Horowhenua Water Management Zone [Hōkio sub-zone *Hoki_1b*], under Schedule A of the HRC One Plan (2014)) and flows through a rural farming area for much of its course. The stream passes through the Hōkio Beach settlement near the coast and has a small estuary at its mouth.

The Hōkio Stream catchment forms a narrow band through the coastal dunes from Lake Horowhenua to the Tasman Sea. The length of the stream itself is approximately 8 km. The stream is associated with several areas of swampy ground throughout its length. These areas are generally covered in a thick growth of flax making the stream largely inaccessible in these regions but providing excellent cover and habitat for eels and whitebait. Hōkio Stream is classified as having a stream order of four, with “warm, dry” climate and low elevation under the New Zealand River Environment Classification (REC2, NIWA 2010).

Stream samples were taken by grab sampling at sites HS1A, HS1, HS2 and HS3 (Figure 5-1) to investigate if landfill leachate present within the shallow groundwater down-gradient of the landfill is affecting the water quality of Hōkio Stream. Sites HS1A and HS1 are situated up-stream of the old landfill, HS2 is situated alongside the old landfill and up-stream of the Tatana Property Drain discharge, and HS3 is located approximately 50m down-stream of the landfill site property boundary and the Tatana Property Drain discharge.

The physico-chemical conditions measured at HS1A and HS1 are assumed to be representative of the combined ‘background’ (i.e., originating from upstream of the landfill), while HS2 and HS3 include landfill discharge-related flows in the Hōkio Stream. Since April 2020, sampling location HS1A has been monitored with the purpose of completely replacing sampling location HS1 after 24 months. Sampling location HS1A is located further upstream than HS1 and has been sampled to provide greater certainty in comparisons between upstream and downstream sites of the landfill. The monthly monitoring was started in April 2020 and was continued for 15 months until June 2021, when there was a break in monitoring of three months between July 2021 and September 2021. So, a decision was made to continue the monthly monitoring from October 2021 through to September 2023 to provide a continuous record of 24 months. In fact, at the time of preparing this report (September 2024) HDC has continued with the monthly monitoring and will do so until agreement has been reached with HRC regarding the ongoing monitoring.

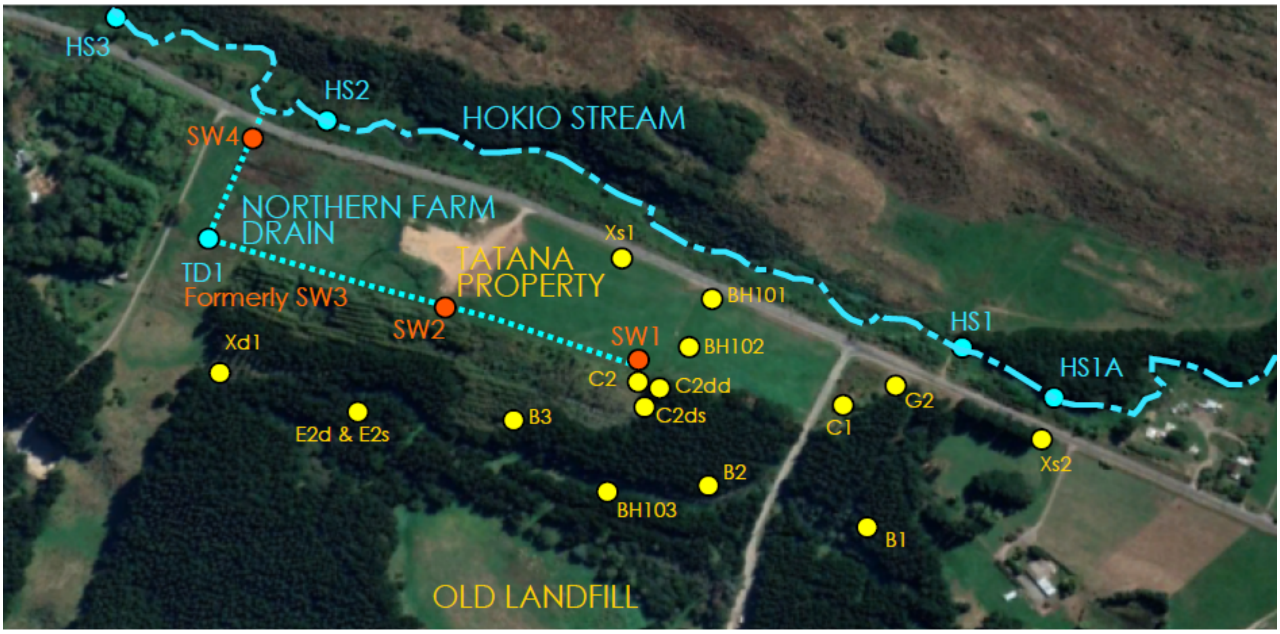


Figure 5-1: Hōkio Stream Sampling Locations (HS1A, HS1, HS2 and HS3)

5.2 Sampling Results

Median water quality monitoring results recorded for all tested parameters during the reporting period are presented in Table 5-2, and selected median, maximum and average results are compared against the trigger values from Discharge Permit ATH-2002003983.02 (Table C1). A full dataset for Hōkio Stream over the last 10 years is presented in Appendix E.

Water quality at all Hōkio Stream locations complied with the consent trigger values (see Table 5-1 below) for all determinants except for HS2 where the maximum and average results for total ammoniacal-N exceeded the consent trigger value. Note that consent conditions 3 I to L of Discharge Permit ATH-2002003983.02 (formerly DP 6010) refer to comparisons between the upstream monitoring location (i.e., HS1A) and the downstream monitoring location (i.e., HS3). The results of monitoring location HS2 are not included in the comparison, so are not strictly required. However, they are useful as indicators and should be retained to indicate possible trends.

Samples were not analysed for the full suite of parameters during January 2024 (HS2 & HS3), this is a non-compliance.

Table 5-1 Comparison of monitoring results for Hōkio Stream locations with consent trigger values (Table C1, ATH-2002003983.02), 2022-2023 reporting period

Determinant	Units [a]	No. of samples per site	Consent trigger value (Table C1); g/m^3	HS1A	HS1	HS2	HS3
Total ammoniacal-N	g/m^3	11 - 12	Maximum ≤ 2.1	0.17	0.18	**2.71***	0.39
	g/m^3		Average ≤ 0.4	0.063	0.077	0.337	0.161
ScBOD$_5$ [b]	g/m^3	12	Monthly average ≤ 2	0.5	0.5	0.5	0.5
Aluminium	g/m^3	12	0.055	0.021	0.015	0.012	0.016
Arsenic	g/m^3	11- 12	0.024	ND	ND	ND	ND

Determinant	Units [a]	No. of samples per site	Consent trigger value (Table C1); g/m³	HS1A	HS1	HS2	HS3
Cadmium	g/m^3	11- 12	0.0002	ND	ND	ND	ND
Copper	g/m^3	11- 12	0.0014	0.00105	0.0011	0.00095	0.00105
Lead	g/m^3	12	0.0034	ND	ND	ND	ND
Nickel	g/m^3	12	0.011	ND	ND	ND	ND
Zinc	g/m^3	12	0.008	0.002	ND	0.002	ND
Mercury	g/m^3	11- 12	0.0006	ND	ND	ND	ND

Notes:
Red bold *indicates exceedance of consent trigger values. * The result for HS2 is not strictly a non-compliance with trigger values since consent conditions do not require an evaluation of the results at HS2, but it is useful to do so.*
Only annual maximum and average values are reported for total ammoniacal-N; annual medians are reported for all other parameters.
[a] reported in Appendix E with units as mg/L which is equivalent to g/m³; this applies to all parameters in this table.
[b] reported in Appendix E as "BOD".

Annual median values exceeded the ANZECC AE 95% protection level trigger values for nitrate-N levels at all sites which exceeded the ANZECC (95%) DGV of 0.16 mg/L (see Table 5-2).

Table 5-2: Annual median for range of water quality results from Hōkio Stream (2023-2024 reporting period)

Determinant	Units	Detection Limit	ANZECC DGV (95%ile species protection)	HS1A	HS1	HS2	HS3
Leachate Indicators							
Ammoniacal-N	mg/L	0.01	2.1	0.05	0.05	0.1	0.14
Boron	mg/L	0.03	0.370	0.06	0.06	0.07	0.07
Chloride	mg/L	0.02		23.8	24.9	26	26.1
Conductivity	mS/m	0.1		24.3	24.7	25.4	25.8
Other Determinants							
E.coli (Faecal coliforms)	CFU/100mL	100		100	200	100	82
pH	-			7.5	7.5	7.5	7.5
Suspended Solids	mg/L	Varies – 6, 3, 1		25	9	10.5	23.5
Phenol	mg/L	0.05		0.015	0.015	0.015	0.015
VFA	mg/L	5		2.5	2.5	2.5	2.5
TOC	mg/L			5.45	5.3	5.5	5.3
Alkalinity	mg CaCO3/L			57.5	58	62	62
COD	mg/L	15		34	27	42	36
$ScBOD_5$	mg/L	1 or <6	2	0.5	0.5	0.5	0.5
Nitrate-N	mg/L	0.01	0.16	**0.26**	**0.19**	**0.30**	**0.36**
Sulphate	mg/L			18.55	17.7	18.4	18.05
Hardness	mg CaCO3/L			61.5	63	65	67

Determinant	Units	Detection Limit	ANZECC DGV (95%ile species protection)	HS1A	HS1	HS2	HS3
Calcium	mg/L	0.01		13.2	13.2	13.65	14.5
Magnesium	mg/L			7.34	7.64	7.585	7.87
Potassium	mg/L			2.845	2.73	3	3.265
Sodium	mg/L			20.8	21.3	22.35	23.15
DRP	mg/L	0.005		0.04	0.044	0.0435	0.047
Aluminium	mg/L	0.002	0.055	0.021	0.015	0.012	0.016
Arsenic	mg/L	0.001	0.024	ND	ND	ND	ND
Cadmium	mg/L	0.0002	0.0002	ND	ND	ND	ND
Chromium	mg/L	0.001	0.001	ND	ND	ND	ND
Copper	mg/L	0.0005	0.0014	0.00105	0.0011	0.00095	0.00105
Iron	mg/L	0.005		0.075	0.07	0.075	0.085
Lead	mg/L	0.0005	0.0034	ND	ND	ND	ND
Manganese	mg/L	0.0005	1.9	0.0243	0.0156	0.0257	0.0214
Mercury	mg/L	0.0005	0.0006	ND	ND	ND	ND
Nickel	mg/L	0.0005	0.011	ND	ND	ND	ND
Zinc	mg/L	0.002	0.008	0.002	ND	0.002	ND

Notes:
Red bold *denotes an exceedance of the ANZECC AE 95% protection level trigger values.*
Note: Where the number of samples collected was 3 or more, a median of all samples for the monitoring period is reported.
ND indicates the median value was below the laboratory detection limit.

Nitrate-N exceeded the ANZECC AE (95%) trigger value for all median results at all locations. The fact that the concentrations increased downstream from HS1A/HS1 to HS2/HS3 implies that there is some activity occurring between these monitoring locations which is causing an increase in nitrate-N concentrations. It is known that there is a plume of contaminated groundwater arising from the old, unlined landfill. This is well documented and is being further assessed through the Leachate Best Practical Option (BPO) project. However, the nitrate-N levels at the shallow groundwater bores, which are the assumed source of contamination (i.e., C1, C2, B3), show low levels of nitrate-N compared to the Hōkio Stream. Therefore, there is little to no evidence of the elevated nitrate-N levels in the Hōkio Stream originating from a landfill leachate source. Bores B1 and B2, however, do show elevated levels of nitrate-N, as do other bores on-site, such as D1 and D6, but these elevated levels do not appear to be related to the landfill activity.

Ammoniacal-nitrogen, conductivity, chloride, and boron are used as indicators of the presence of leachate in Hōkio Stream and have been monitored since 1994. On review of the historical records, it appears that all four parameters are relatively stable, however HS2 shows evidence of recent increases for all parameters. Overall, there is no clear change across the sites over the long-term (with the exclusion of the recent increases at HS2). This is evident in the series of figures below.

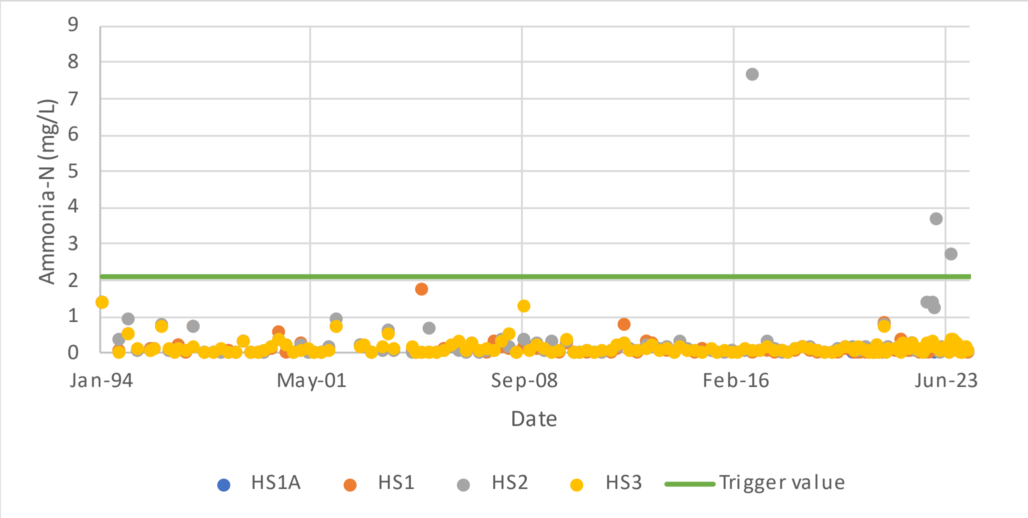


Figure 5-2: Ammoniacal-Nitrogen Concentrations measured in Hōkio Stream, since 1994.

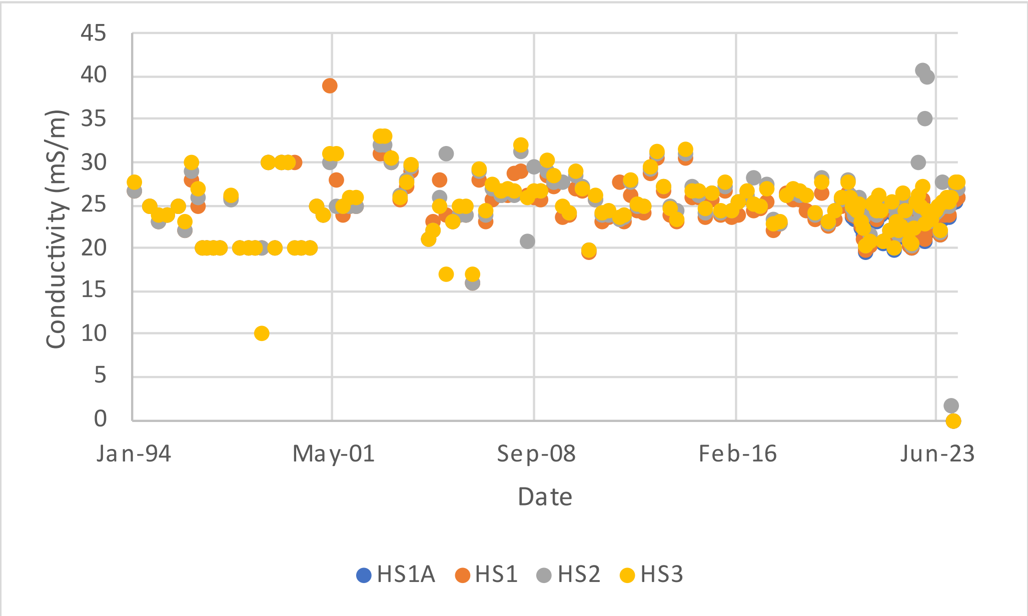


Figure 5-3 Conductivity measured in Hōkio Stream since 1994.

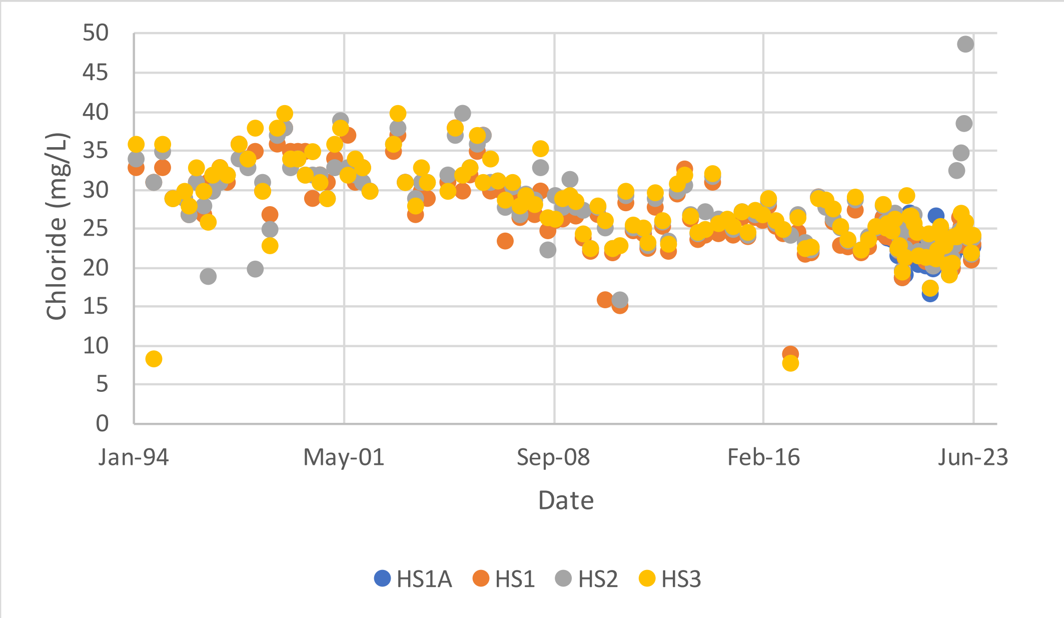


Figure 5-4 Chloride measured in Hōkio Stream since 1994.

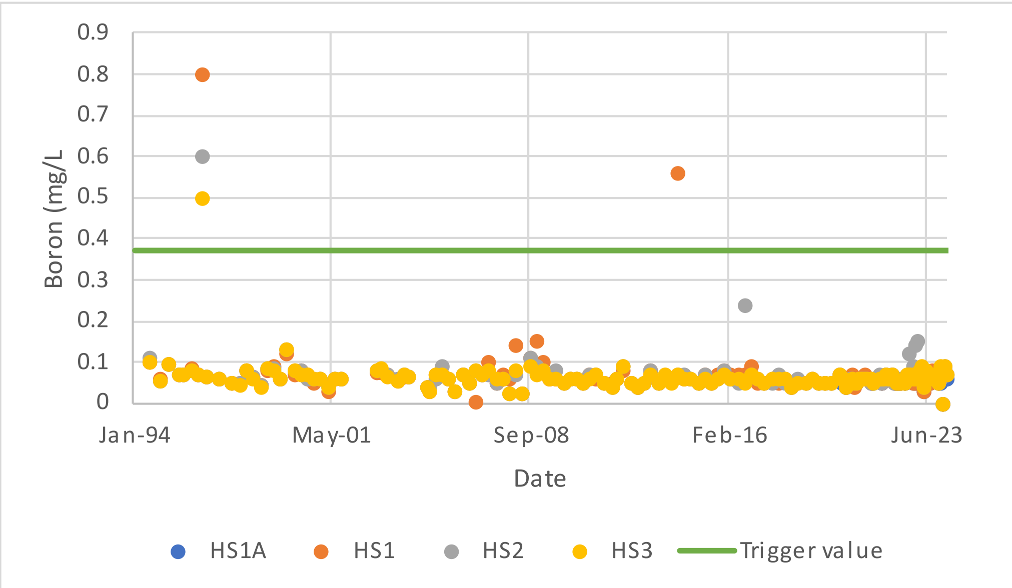


Figure 5-5 Boron measured in Hōkio Stream since 1994.

5.3 Surface Water Quality Analysis

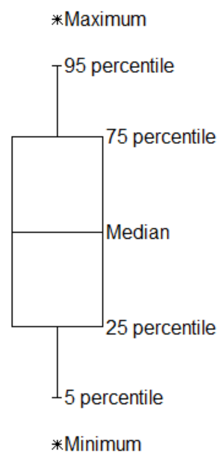
Water quality trends at upstream monitoring locations within Hōkio Stream upstream (HS1A and HS1) have been compared with those from downstream (HS3) of the landfill for selected contaminants based on samples collected over the twelve-year period from July 2012 to June 2024 inclusive. This included the generation of box plots (Figure 5-6 to Figure 5-12) to enable a visual assessment of the data. In general, there are minor increases in results from HS1 (upstream) to HS3 (downstream). However, the opposite was observed for pH, and faecal coliforms, with these parameters decreasing from HS1 to HS3. In the next reporting period, i.e., 2024 – 2025, Council will be assessing the results of the monthly sampling of the

Hōkio Stream monitoring locations, to determine if there is a statistical significance between the upstream and downstream results.

Since April 2020, sampling location HS1A has been monitored with the purpose of replacing sampling location HS1 completely after 24 months. Sampling location HS1A is located further upstream than HS1 and has been sampled with the intention of providing greater certainty in comparison between upstream and downstream sites of the landfill. Whilst results for HS1A have been included below for visual comparison to the other background location HS1, there is some variability between them but given the significant overlap between the 25% - 75% "boxes" for HS1 and HS1A, the results are unlikely to be statistically different, and they are easily explained by the considerably shorter sampling period history for HS1A.

In the next reporting period, i.e., 2024-2025, Council will be comparing the results for HS1A against HS1 to determine whether sampling needs to continue at both upstream sampling locations, and whether the frequency of sampling may be reduced from monthly to quarterly.

The following guide should be used to interpret the box plots in Figure 5-6 to Figure 5-12 [4].



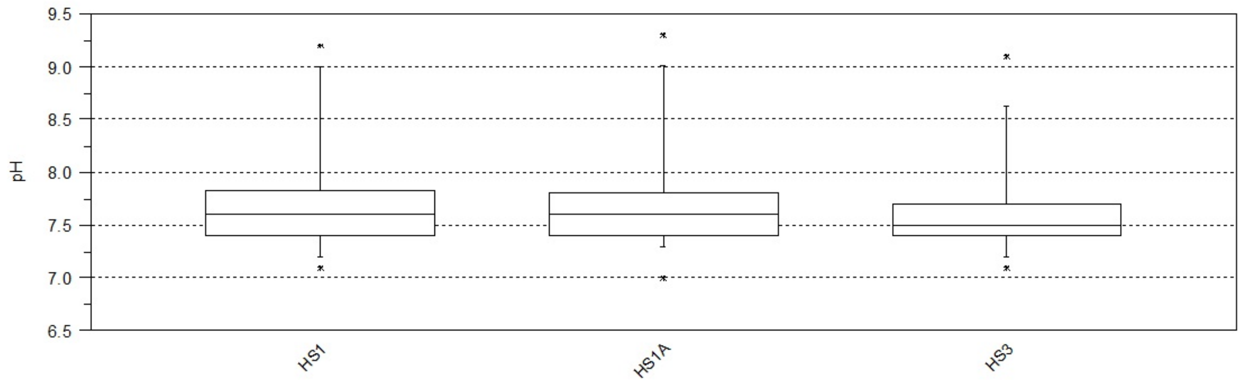


Figure 5-6 Box plot of pH water quality results for Hōkio Stream sites HS1A[5], HS1 and HS3, 2012 – 2024.

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[4] Plots were generated in Time Trends and includes outlying values (Minimum, Maximum, 5th and 95th Percentiles)
[5] Note that sampling at HS1A has been conducted from April 2020, and not 2012 as for HS1 and HS3.

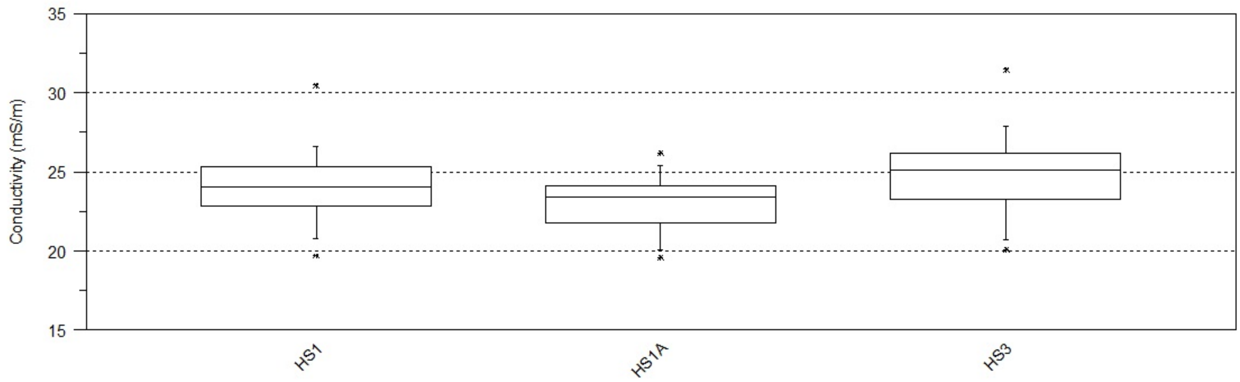

Figure 5-7 Box plot of Conductivity water quality results for Hōkio Stream sites HS1A[5], HS1 and HS3, 2012 – 2024.

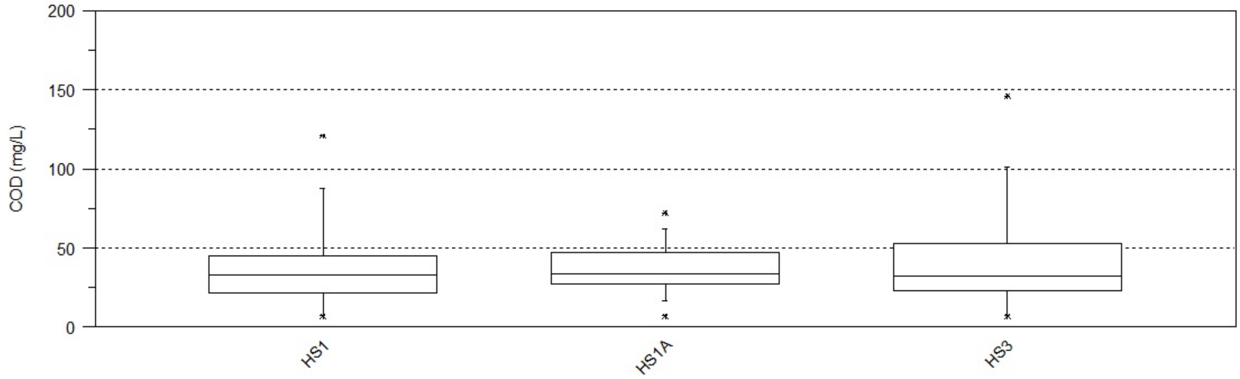

Figure 5-8 Box plot of COD water quality results for Hōkio Stream sites HS1A[5], HS1 and HS3, 2012 – 2024.

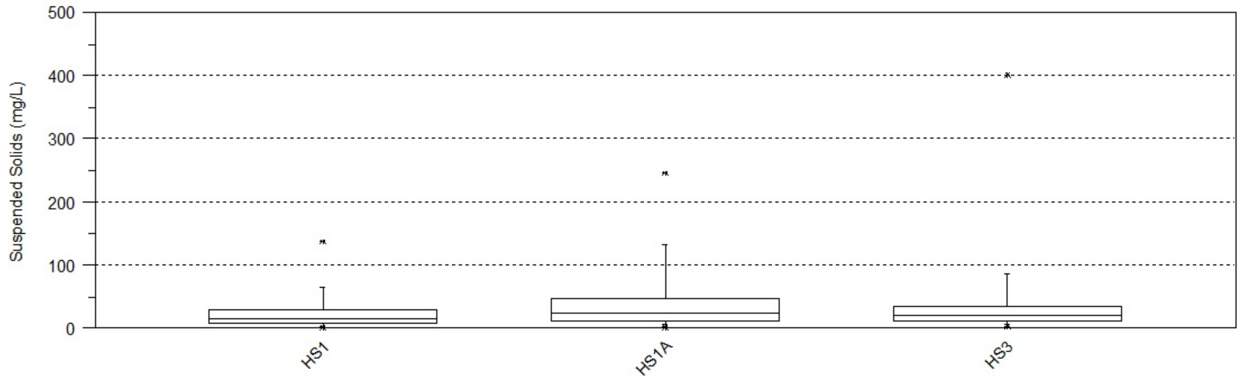

Figure 5-9 Box plot of Suspended Solids water quality results for Hōkio Stream sites HS1A[5], HS1 and HS3, 2012 – 2024.

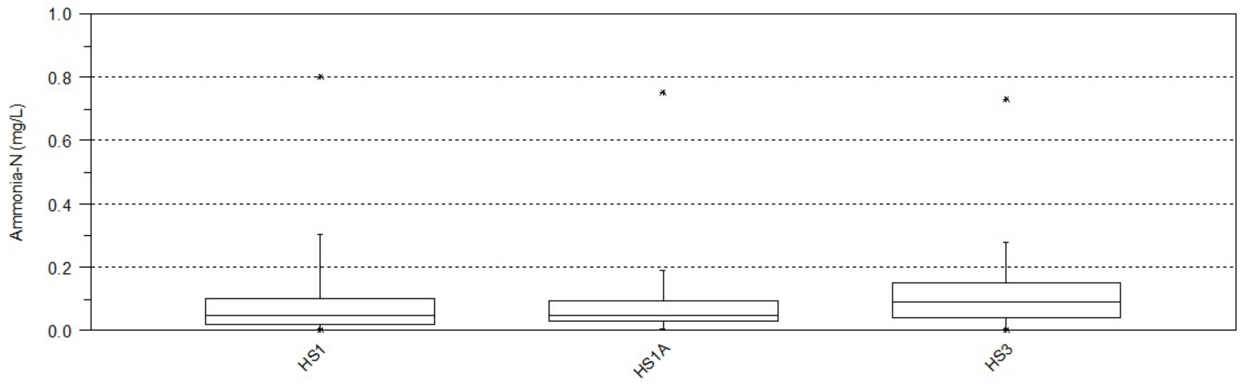

Figure 5-10 Box plot of Ammoniacal-N water quality results for Hōkio Stream sites HS1A[5], HS1 and HS3, 2012 – 2024.

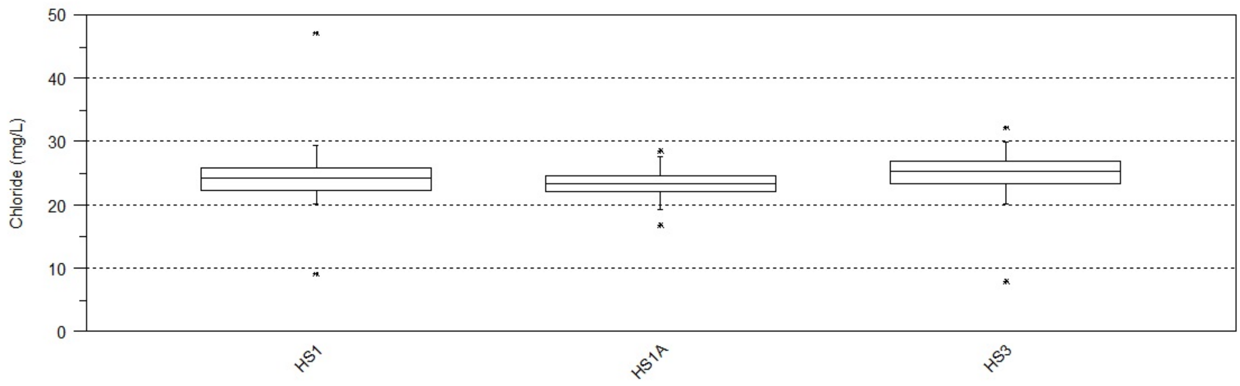

Figure 5-11 Box plot of Chloride water quality results for Hōkio Stream sites HS1A[5], HS1 and HS3, 2012 – 2024.

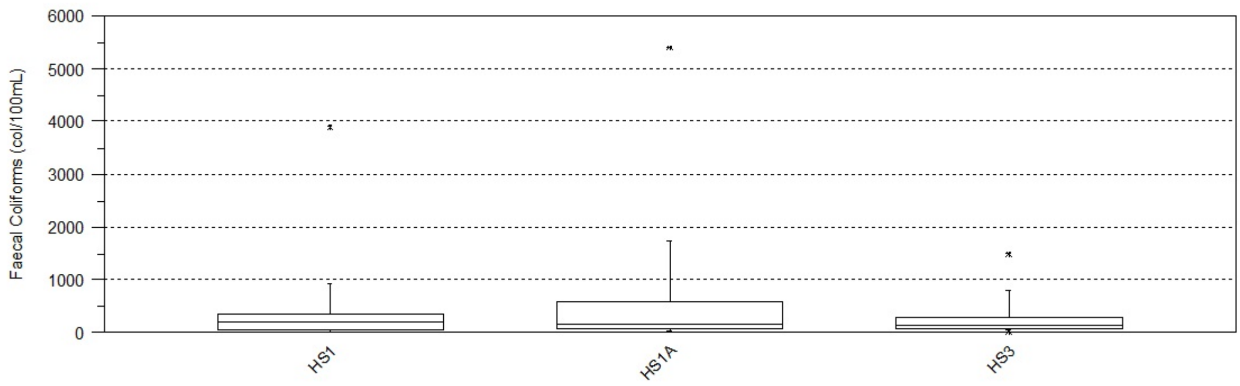

Figure 5-12 Box plot of Faecal Coliform water quality results for Hōkio Stream sites HS1A[5], HS1 and HS3, 2012 – 2024.

5.4 Northern Farm Drain

Stantec was commissioned by HDC in March 2015 to undertake a review of the water quality within a private drain located to the north of the Levin Landfill and to provide recommendations as to whether further monitoring and/or remediation was required. The report noted that water in the shallow drain was being impacted by landfill leachate within the vicinity of the unlined closed section of the landfill. The drain also interacts with the shallow groundwater aquifer, with groundwater emerging (daylighting) as surface water to the north of the landfill.

HRC subsequently requested that surface water in this drain along the Northern Farm property's boundary be monitored quarterly. Four sampling points were selected to represent upstream (SW1), midstream (SW2 & SW3) and downstream (SW4) flows at the Northern Farm property (see Figure 5-1).

The 2015 resource consent review (finalised in December 2019) changed the requirements for sampling the Northern Farm Drain. Subsequently, sampling at SW1, SW2 and SW4 was discontinued after January 2020, and only SW3 has continued to be sampled from April 2020. SW3 is now called "TD1".

5.4.1 Sampling Results

During the reporting period, samples were collected from TD1 (previously called SW3) in all months, however during July 2022 not all parameters were sampled (VFA, TOC and Faecal Coliforms). The median water quality results for all parameters met the consented trigger values (as per Table 5-3 below), except for total ammoniacal-N– indicated in **bold, red** lettering in Table 5-3.

Results for the full suite of analytes are summarised in Table 5-4. A full dataset for Northern Farm Drain over the last seven years is presented in Appendix E.

Annual median values exceeded the ANZECC AE 95% protection level trigger values for the following (see Table 5-4):

- Ammoniacal-N level exceeded the ANZECC (95%) DGV of 2.1 mg/L.
- Nitrate-N level exceeded the ANZECC (95%) DGV of 0.16 mg/L.

Table 5-3 Comparison of monitoring results for Northern Farm Property Drain with consent trigger values (Table C1, ATH-2002003983.02), 2023-2024 reporting period

Determinand	Units [a]	Consent trigger value (Table C1); g/m^3	TD1 (SW3)
Total ammoniacal-N	g/m^3	Maximum ≤ 2.1	**24.9**
	g/m^3	Average ≤ 0.4	**12.95**
ScBOD$_5$ [b]	g/m^3	Monthly average ≤ 2	ND
Aluminium	g/m^3	0.055	0.009
Arsenic	g/m^3	0.024	ND
Cadmium	g/m^3	0.0002	ND
Copper	g/m^3	0.0014	0.0006
Lead	g/m^3	0.0034	ND
Nickel	g/m^3	0.011	0.00175
Zinc	g/m^3	0.008	0.004
Mercury	g/m^3	0.0006	ND

Notes:
Red bold *indicates exceedance of consent trigger values.*
Only annual maximum and average values are reported for total ammoniacal-N; and annual medians are reported for all other parameters.

[a] reported in Appendix E with units as mg/L which is equivalent to g/m^3; this applies to all parameters in this table
[b] reported in Appendix E as "BOD"
[c] The laboratory detection limit stated in Eurofins laboratory reports for $ScBOD_5$ is 1 g/m^3. However, the lab has been reporting 'non detected' results as "< 6 g/m^3". This is incorrect and makes it difficult to assess against the consent trigger values. The laboratory detection limit has varied between 1, 3, 4 and 6 g/m^2throughout the reporting period, for consistency, 6 g/m^2 has been used as the detection limit within this table.
ND indicates the value was below the laboratory detection limit.

Table 5-4: Northern Farm Property Drain median water quality results

Determinand	Units	No. of samples per site	ANZECC DGV (95%ile species protection)	TD1 (SW3)
Leachate Indicators				
Ammoniacal-N	mg/L	12	2.1	**12.6**
Boron	mg/L	12	0.370	0.33
Chloride	mg/L	12		84.15
Conductivity	mS/m	12		93.25
Other Determinants				
E.coli (Faecal coliforms)	CFU/100mL	12		75
pH	-	12		7.4
Suspended Solids	mg/L	11		137
Phenol	mg/L	10		0.015
VFA	mg/L	10		ND
TOC	mg/L	11		22.8
Alkalinity	mg $CaCO_3$/L	11		337
COD	mg/L	12		113
$ScBOD_5$	mg/L	12	2	ND
Nitrate-N	mg/L	12	0.16	**1.365**
Sulphate	mg/L	11		1.29
Hardness	mg $CaCO_3$/L	11		248
Calcium	mg/L	11		57.3
Magnesium	mg/L	11		25.2
Potassium	mg/L	11		22.5
Sodium	mg/L	11		60
DRP	mg/L	11		0.025
Aluminium	mg/L	12	0.055	0.009
Arsenic	mg/L	11	0.024	ND
Cadmium	mg/L	11	0.0002	ND
Chromium	mg/L	11	0.001	ND
Copper	mg/L	11	0.0014	0.0006
Iron	mg/L	11		0.3

Determinand	Units	No. of samples per site	ANZECC DGV (95%ile species protection)	TD1 (SW3)
Lead	mg/L	12	0.0034	ND
Manganese	mg/L	12	1.9	0.5565
Mercury	mg/L	12	0.0006	ND
Nickel	mg/L	12	0.011	0.00175
Zinc	mg/L	11	0.008	0.004

Notes:
Red bold *denotes an exceedance of the ANZECC AE 95% protection level trigger values.*
Where the number of samples collected was 3 or more, a median of all samples for the monitoring period is reported. ND indicates the value was below the laboratory detection limit.

The Northern Farm Property drain appears to be intercepting an unknown volume of leachate-contaminated shallow groundwater, and then discharging this to the Hōkio Stream. Concentrations of the key leachate parameters (ammoniacal nitrogen, conductivity, and chloride) are generally higher within the Northern Farm Property drain than in groundwater hydraulically up-gradient of the old landfill, but considerably lower than groundwater down-gradient of the old landfill.

Remediation of the groundwater entering the Northern Farm Drain is subject to specific resource consent conditions which are being addressed through the Leachate BPO project. The drain is located outside of the landfill property on farmland where, quite frequently, stock graze the land. Nitrate-N is not elevated in the shallow groundwater bores considered to the source of the groundwater contamination (i.e., C1, C2 and B3), and so the high nitrate-N concentrations measured in the Northern Farm Drain are most likely to be on account of the farming activities, and not the landfill activities.

However, in some of the shallow groundwater bores high levels of ammoniacal-N have been detected, and it is quite possible that this is causing the elevated ammoniacal-N measurements in the Northern Farm Drain. As noted above, remediation of the groundwater entering the drain is subject to specific resource consent conditions which are being addressed through the Leachate BPO project.

5.4.2 Leachate Remediation Options of Northern Farm Drain

Condition 2 of Discharge Permit ATH-2002003983.02 requires the Permit Holder to complete an assessment of leachate remediation options for the Northern Farm Drain (formerly Tatana Drain) and determine a Best Practicable Option (BPO).

As was reported last year, in late 2022 and the first part of 2023, HDC has worked with consultants Morrison & Low and Earthtech Consultants Ltd to further identify the most suitable options. As part of that work, the capping of the old landfill was identified as a suitable remediation measure for reducing infiltration into the top of the landfill, so reducing in the medium to long term, the extent of infiltration of leachate through to groundwater. This work was completed in April 2023.

Earthtech Consulting Ltd has continued to assess different options for improving the quality of groundwater that flows northwards from the Old Landfill towards the Hōkio Stream.

Whilst condition 2A of Discharge Permit ATH-2002003983.02 required the selected leachate remediation option to be fully implemented by June 2023, the costs to implement such a solution are likely to be considerably more than originally anticipated, and HDC has already spent over $300,000 on the capping of the old landfill. In addition, HDC has committed to further expenditure to provide information that will inform additional remediation work that may involve treatment of the groundwater.

Based on concept work completed to date, HDC has assigned a budget of ~ $1.8 million to implementing a remediation option.

6 Mass Loading Evaluation for the Hōkio Stream

This section summarises the consent requirements and assessment of effects of landfill leachate in respect of mass loading projections for the Hōkio Stream.

Consent conditions 11(d) and 11(e) of Discharge Permit ATH-2002003982.03 require, respectively, that an evaluation of contaminant mass load projections for the discharge of parameters from the landfill to the Hōkio Stream is undertaken annually and that the significance of the findings be determined. The relevant consent text is provided in Appendix A.

6.1 Background

A Mass Contaminant Loading Assessment was originally completed for Levin Landfill in April 2011. The modelling incorporated many simplifying assumptions and the conservative estimation of parameters, including:

- That all aquifer through-flow discharges to the Hōkio Stream. This is considered unlikely but has been incorporated into the model to provide a worst-case assessment.
- A further assumed worst-case scenario, that no attenuation of contaminants occurs between the monitoring wells and the discharge point into the Hōkio Stream.
- Estimation of input parameters, including hydraulic conductivity 'K', has been conservative.
- Full vertical mixing of contaminants in the aquifer has been assumed to the relevant depth of plume considered.
- A low flow is assumed for the Hōkio Stream, which is significantly lower than the mean flow, and therefore will generally provide a worst-case assessment.

In combination these assumptions mean that the predicted downstream concentrations are likely to be significantly higher than occurs.

The assumptions underpinning the mass loading calculations have been reviewed to identify any other factors which may be influencing the observed changes in spatial patterns in the plume that are referred to in Section 4.4.2.

Since April 2020, sampling location HS1A has been monitored with the purpose of replacing sampling location HS1 after 24 months. Sampling location HS1A is located further upstream than HS1 and has been sampled to provide greater certainty in comparisons between upstream and downstream sites of the landfill. Whilst there is limited information from sampling location HS1A, the results for sampling location HS1A have been included by combining them with the results from sampling location HS1 to get average upstream concentrations of the relevant parameters.

6.2 Update of assumptions

Based on recent work undertaken by Earthtech Consultants Ltd [6,7], the assumptions applied to calculate mass loads for contaminants from the landfill have been reviewed and, where appropriate, have been amended. They are summarised below.

Flow volume of Hōkio Stream

A minimum flow of 176 L/s (15,206 m^3/day) is assumed in the Hōkio Stream. This is based on information provided by NIWA and is very slightly more than the 174 L/s previously applied. NZ River Maps put this figure at 163 L/s, with a mean flow of 1,020 L/s and a median flow of 572 L/s. So, the adopted flow represents a conservative approach as it is significantly lower than the mean flow.

Extent of the groundwater aquifer

Various combinations of aquifer width and depth are applied in the calculations as part of the sensitivity analysis; results are therefore reported as ranges.

Previously, the aquifer front area was assumed to be between 300m and 500m, and this has now been increased to be between 350m and 550m, in line with Earthtech Consulting's assessment.

Similarly, the aquifer thickness has been revised. It was previously assumed to be between 5m and 15m thick and has now been set at between 13m and 17m. This is based on additional drilling work conducted on site.

The assumptions applied in each combination are depicted in Figure 6-1.

Aquifer Front Area = Thickness x Depth (m^2)		Thickness (m)		
		13	15	17
Width (m)	350	4,550	5,250	5,950
	450	5,850	6,750	7,650
	550	7,150	8,250	9,350

Figure 6-1 Assumptions for aquifer extent applied in mass load calculations (screenshot from model spreadsheet, 2024)

Hydraulic conductivity / Permeability (*k*)

Previously, the mass load calculations assumed hydraulic conductivity (i.e., permeability) values of between 0.5 and 2.0 m/day, which were based on field data collected in July 2012.

Earthtech Consulting has adopted a horizontal permeability of 2.39 m/day, which "…*is equivalent to 2.77e-5m/s, representing moderate permeability mid-range values for clean sand (Freeze and Cherry, 1979)*…"

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[6] "*Conceptual Groundwater Model Report, Levin Landfill, Hōkio Beach Road, Levin*", Report R10009-2, Rev B, prepared for Horowhenua District Council by Earthtech Consulting Ltd, 16 February 2023.
[7] "*Hōkio Stream Water Quality Predictions for Proposed Best Practical Option 3- Groundwater Intercept Drain Remedial Works, Levin Landfill*", Letter report PIK/L10009-5/mw, prepared for Horowhenua District Council by Earthtech Consulting Ltd, 11 July 2024.

Accordingly, a range between 2.0 m/day and 3.0 m/day has been assumed for the mass contaminant assessment.

Hydraulic gradient (*i*)

A value of 0.0059 has been assumed since 2011. This was developed based on groundwater level monitoring undertaken between 2004 and 2010.

Earthtech Consulting has assumed a horizontal hydraulic gradient for the northern flats area of 0.01, and this has now been adopted.

Background groundwater quality

Calculations have been run to account for background groundwater quality by removing loads from bores D5, F2 and F3 (as representative of 'background) from the calculations for 5-year averaged maximum and median values. A second series of calculations has been done including background groundwater quality which shows that there is minimal difference between including or excluding the background water quality concentrations of monitored parameters. This assumption has not been changed from last year's assessment.

6.3 Mass Loading Analysis Update

The input data to the model spreadsheet include groundwater quality within the leachate plume and upstream and downstream water quality within the Hōkio Stream (HS1A and HS1 represent the water quality upstream of the landfill, and HS3 represents the water quality downstream). The data for the last five years were used to recalculate the input information which is summarised in Table 6-1. Medians over five years are considered appropriate to use, given that some parameters in the indicator list (e.g., sodium) are only tested once per year.

Bores B2, B3, C1, C2, C2DS, G2S and Xs1 have been used to represent the leachate plume in undertaking the mass loading analysis. Bore Xs1 was included in the mass loading analysis in 2022 to meet condition 11(d) of discharge permit 6010 which requires that the mass contaminant load projections be based, but not exclusively so, '…*on the monitoring data obtained for the "B", "C" and "X" series bores*…'. It is noted that bore G2S is likely to be at the edge of, or outside, the leachate plume and therefore may no longer be representative of the main body of the leachate plume.

As in previous years, the shallow groundwater 'background' concentration of contaminants was included in the calculation to determine if any changes in the Hōkio Stream water quality are influenced by background concentrations of contaminants in shallow groundwater. As was done for the last three years, bores, D5, F2, and F3 have been included as being representative of background water quality.

The median results for ammoniacal-N, boron, chloride, sodium, nitrate-N and DRP have been averaged for HS1 and HS1A for the past five years to represent the upstream results, with the median results for the same parameters over five years for HS3 representing the downstream results.

The results are shown in Table 6-1 with green and red shading of cells corresponding with a decrease and increase, respectively, of this year's results compared to last year's results.

For the upstream results (HS1A and HS1), three of the six parameters (chloride, sodium, and DRP) increased, with ammoniacal-N and nitrate-N decreasing, and boron remaining the same.

In the downstream results (HS3), four of the six parameters (ammoniacal-N, chloride, sodium and DRP) increased, with nitrate-N decreasing, and boron staying the same.

For bores representing the background concentrations (D5, F2 and F3), the average of the median concentration of chloride decreased, with the average of the median concentrations of boron, sodium, nitrate-N and DRP all decreasing, whilst that for ammoniacal-N remained the same.

For the bores representing the leachate plume (B2, B3, C1, C2, C2DS, G2S and Xs1), the maximum and median results from the last five years for the six selected parameters have been averaged and compared to the values used last year. Table 6-1 shows how the results have changed compared to last year. Mostly the results have decreased (shaded green), and the only increases have been for:

- Boron, for average of maximum values,
- Nitrate-N, for average of maximum and median values, both including and excluding background concentrations.

Table 6-1: Updated Model Input Data 2019-2024

Site	Ammoniacal-N g/m^3	Boron g/m^3	Chloride g/m^3	Sodium g/m^3	Nitrate-N g/m^3	DRP g/m^3
Ave. of HS1A and HS1 (upstream) **5-year median**	0.050	0.06	23.4	19.95	0.415	0.037
HS3 (downstream) **5-year median**	0.12	0.06	24.7	20.65	0.385	0.040
D5, F2, F3 (background groundwater) **5-year median**	0.005	0.03	23.467	26.733	0.963	0.128
Bores representing leachate plume (B2, B3, C1, C2, C2DS, G2S, Xs1) **average of maximum values** (over 5-years)	82.17	1.491	281.0	165.8	19.37	0.043
Bores representing leachate plume (B2, B3, C1, C2, C2DS, G2S, Xs1) **average of median values** (over 5-years)	54.02	1.038	137.3	121.1	4.817	0.019
Bores representing leachate plume - average of maximum values (*removing background*)	82.15	1.431	240.5	133.7	17.403	-0.097*
Bores representing leachate plume - average of median values (*removing background*)	54.01	1.008	113.8	94.4	3.854	-0.108*

Decrease in concentration since last year | Increase in concentration since last year

The median and maximum concentration of DRP when the background concentration is factored out gives a negative concentration (as indicated by results with an asterisk * in Table 6-1). Essentially this indicates that the background concentration of DRP, most likely from farming activities, is higher than that found in the leachate plume, which implies that leachate is not influencing the concentration of this parameter in groundwater down-gradient of the old landfill.

The plume width has been estimated as being between 350m and 550m as discussed in the previous section.

The predicted downstream concentrations of leachate indicators in the Hōkio stream were calculated based on the average of maximum and median values from the leachate plume bores (B2, B3, C1, C2, C2DS, G2S and Xs1). The ranges of results obtained are presented in Table 6-2. For comparison, the median results for the upstream and downstream sample locations (average of HS1A and HS1 combined, and HS3) are also included in Table 6-2. The detailed mass contaminant loading calculations are included in Appendix G.

The predicted downstream concentrations at HS3 are similar, both when background concentrations are included and when they are excluded.

The predicted range of concentrations from the 2023 - 2024 mass contaminant load assessment shows reasonably close agreement with actual monitoring results obtained from HS3 for all parameters except for ammoniacal-N, where the predicted range is some three to twelve times higher than the actual.

The concentrations obtained by sampling at both the upstream sites (combined HS1A and HS1), and downstream site (HS3) and the predicted concentrations for the downstream site (HS3, including and excluding background levels) meet the ANZECC LDW trigger values for all parameters.

The maximum predicted concentrations of ammoniacal-N for the downstream site (HS3, including and excluding background levels) exceeded the ANZECC Freshwater DGV for 95th percentile species protection value.

Actual concentrations at both the upstream and downstream sites (combined HS1A and HS1, and HS3) exceeded the ANZECC Lowland River DGVs for ammoniacal-N and DRP. Predicted concentrations for the downstream site (HS3, both including and excluding background levels), also exceeded the ANZECC Lowland River DGVs for ammoniacal-N and DRP, but also for maximum nitrate-N.

Similarly, actual concentrations at both the upstream and downstream sites (combined HS1A and HS1, and HS3) exceeded the Horizons One Plan Schedule E values for nitrate-N and DRP. Predicted concentrations for the downstream site (HS3, both including and excluding background levels), also exceeded the Horizons One Plan Schedule E values for nitrate-N and DRP, but also for maximum ammoniacal-N.

The inference from these results is that the leachate contamination within the groundwater plume from the old landfill area is affecting the quality of water in the Hōkio Stream at HS3 to a minor extent only. By far the greatest contributions to the concentrations of measured parameters in the Hōkio Stream are arising from sources unrelated to the old landfill and are in fact originating from upstream of the landfill site.

The water quality of the Hōkio Stream is influenced strongly by its urban and rural catchments. The actual and predicted results indicate that the impact from the Levin Landfill on the Hōkio Stream is likely to be minimal within the wider catchment context.

Table 6-2: Predicted Leachate Impact on Hōkio Stream 2023-2024

		Ammoniacal-N g/m³	Boron g/m³	Chloride g/m³	Sodium g/m³	Nitrate-N g/m³	DRP g/m³
Guideline values	**ANZECC 2000 DGVs for Freshwater (Table 3.3.10 Lowland River)**	**0.02**	**-**	**-**	**-**	**0.44**	**0.01**
	ANZECC 2000 DGVs for Freshwater (Table 3.4.1 95%ile protection)	*0.9*	*0.37*	-	-	-	-
	ANZECC LDW trigger values	NA	5	-	-	90.3	NA
	Horizons One Plan - Hōkio Stream (Schedule E)	0.4	-	-	-	0.17 (SIN)	0.01
Predicted range of downstream concentration including background concentrations		**0.37 - *1.54***	0.07 – 0.09	24.08-28.06	20.55 – 22.59	0.44 – **0.76**	**0.036 – 0.037**
Predicted range of downstream concentration excluding background concentrations		**0.37 – *1.54***	0.07 – 0.08	23.94 – 27.33	20.39 – 22.01	0.44 – **0.72**	**0.034 – 0.036**
Actual 2019-2024 average median upstream concentration (HS1A and HS1)		**0.05**	0.06	23.40	19.95	0.415	**0.037**
Actual 2019-2024 average median downstream concentration (HS3)		**0.12**	0.06	24.7	20.65	0.385	**0.040**

Note: **bold text** indicates predicted or actual exceedances of the ANZECC Lowland River DGVs, red text indicates predicted or actual exceedance of the Horizons One Plan for the Hōkio Stream. *Italics text* indicates predicted or actual exceedances of the ANZECC toxicity 95%ile protection trigger values. There were no predicted or actual exceedances of the ANZECC Livestock Drinking Water trigger values.

6.4 Additional Mass Contaminant Loading Assessment

Work undertaken by Earthtech Consultants Ltd during the 2023-2024 reporting period[8] model the effects of the contaminated groundwater plume from the old landfill to a greater level of sophistication than the mass contaminant loading methodology that has been approved to meet consent conditions 11(d) and 11(e) of Discharge Permit ATH-2002003982.03.

A copy of the Earthtech report is included in Appendix G.

The summary and conclusions from that report are quoted below.

> "*NIWA have carried out flow gaugings at the Hōkio Stream during low-flow conditions. This data has been used to carry out a surface water quality assessment to predict ammoniacal-N concentrations at the HS3 monitoring location, with and without the proposed groundwater intercept drain remedial works.*
>
> *The surface water assessment methodology has been verified and achieves good agreement between the current ammoniacal-N concentrations entering the Hōkio Stream and recent low-flow chemistry data from HS3.*
>
> *With the groundwater intercept drain, ammoniacal-N concentrations at HS3 are expected to reduce below current values, and remain below the consented average and maximum limits.*
>
> *Without the groundwater intercept drain, future ammoniacal-N concentrations at HS3 are predicted to be a 12mth average of 0.38mg/l and a maximum of 2.6mg/l. This exceeds the Environment Court consented limit for maximum concentrations, and almost exceeds the consented limit for average concentrations. Given the high variability in ammoniacal-N concentrations dependant on Northern Farm Drain flow and other external factors, it is possible that the consented limit for average concentrations could also be exceeded.*
>
> *Although the consented limits apply to HS3, ammoniacal-N concentrations greater than the consented limits are already being experienced at HS2. Above HS2 ammoniacal-N concentrations entering the Hōkio Stream from groundwater are predicted to be 9.2mg/l over the 300m plume width, and up to 18mg/l through the peak of the plume.*
>
> *On the basis of the currently measured ammoniacal-N concentrations at HS2, and the future predicted consent limit exceedance at HS3, we recommend that the groundwater intercept drain is installed to meet the conditions of Discharge Permit 6010 to "cease, or if cessation is not feasible, materially reduce the discharge of leachate to the Tatana Drain and Hōkio Stream"".*

Based on Earthtech's work a decision has been made to develop a solution that will deal with the contaminated groundwater, either by abstraction, treatment or both. At the time of preparing this report, different options were still being considered.

Given where Earthtech's work has led, it is recommended that the purpose of doing the mass contaminant loading assessment by the current conservative methodology has been somewhat superseded, especially since HS2 is not covered by the mass contaminant assessment, and it is recommended that the need to do so be discussed with HRC.

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[8] Note that the report is dated 11 July 2024, which is outside of the reporting period.

7 Stormwater Discharges

Condition 14 of Discharge Permit ATH-2002009801.02 requires that annual monitoring to determine the effects of stormwater soakage on groundwater quality be carried out on site. This can be done in conjunction with the sampling of groundwater under Condition 15 of Discharge Permit ATH-2002009801.02.

As shown in the Site Plan in Appendix C, stormwater is discharged to a central inter-dune depression located to the west of the access road leading to the lined landfill area. From here it soaks to groundwater. When groundwater levels are high in winter, water tends to pond in the inter-dune depression.

Based on the current understanding of groundwater flow directions, bores D3rs and F3 are hydraulically up-gradient of the stormwater soakage area, and bores E1D, E1S, D4 and D2 are hydraulically down-gradient. Therefore, an examination of whether the water quality in down-gradient bores is comparable to that of the up-gradient bores can provide an indication of any potential effects from stormwater discharges to the soakage area on groundwater. This comparison is provided in Table 7-1, which shows that:

- Overall, annual median concentrations for sodium, chloride and conductivity were typically higher in groundwater bores down-gradient of the stormwater soakage area than they were at the up-gradient bores.
- Annual median concentrations for the remaining determinants were either similar (i.e., for ammoniacal-N, nitrate-N, boron) or higher (i.e., for iron) at the up-gradient bores compared with down-gradient bores.
- Comparing down-gradient bores with G1S, the shallow background bore, some parameters are generally more elevated in the background bore (e.g., conductivity, sodium, nitrate-N, and chloride), whereas other parameters are generally lower in the background bore (e.g., ammoniacal-N, boron, and iron). Section 4.3 discussed the use of G1S as a background bore.
- Overall, there does not appear to be a significant decrease in water quality down-gradient of the stormwater soakage area which indicates that discharges of stormwater from the landfill are ***not*** having an impact on the quality of groundwater down-gradient.

Table 7-1 Comparison of annual median groundwater quality up-gradient of the stormwater soakage area, to down-gradient

Determinant	Units	Back-ground Bore Quality	Bores up-gradient of stormwater soakage area		Bores down-gradient of stormwater soakage area			
		G1S	**D3rs**	**F3**	**E1D**	**E1S**	**D4**	**D2**
pH	pH units	6.6	6.45	7.15	7.5	7.1	7.05	6.4
Conductivity	mS/m	55.1	21.8	18.95	44.75	24.55	27.4	57.55
Ammoniacal-N	mg/L	0.04	0.755	ND	0.195	0.17	0.235	0.745
Nitrate-N	mg/L	0.11	0.0275	1.65	ND	ND	ND	ND
Sodium	mg/L	62.95	22.25	24.85	36.3	25.3	28.95	45.4
Boron	mg/L	0.04	0.035	0.035	0.06	0.0275	0.03	0.05
Chloride	mg/L	111	15.9	16.55	39.35	27.15	30.3	63.1
Iron	mg/L	1.805	14.45	ND	0.03	4.13	1.745	12.25

The environmental monitoring results for the last 10 years are presented in Appendix E. Table 7-2 below summarises compliance for the 2022-2023 sampling period with the ANZECC 2000 LDW trigger values (consent limits) in accordance with Condition 18 of Discharge Permit ATH-2002009801.02. Compliance is assessed using median values across the reporting period. There was a single exceedance (for *E.coli*, within bore E1D) and this was notified to HRC in the applicable quarterly report.

A more detailed summary of these groundwater quality results can be found in section 4.

Table 7-2: Summary of Selected 2022-2023 Bore Results for Stormwater Consent

Borehole	ANZECC 2000 LDW	Comments
D3rs (background)	Complies	Nil
F3 (background)	Complies	Nil
E1D	Complies	E1D is a deep aquifer bore and is normally assessed against the NZ DWS. Condition 18 requires assessment against ANZECC LDW, for which it complies.
E1S	Complies	Nil
D4	Complies	Nil
D2	Complies	Nil

8 Landfill Gas and Odour Monitoring

The resource consent review that was concluded in December 2019 introduced new reporting requirements for landfill gas and odour monitoring under Discharge Permit ATH-2002003984.02.

Condition 8F of Discharge Permit ATH-2002003984.02 requires the Permit Holder to maintain a log of all other inspections, investigations and actions taken in accordance with all monitoring and odour inspection conditions of the consent. A summary is to be included in the Annual Report which follows under this section.

8.1 Odour Monitoring at Landfill Boundary

Condition 3 of Discharge Permit ATH-2002003984.02 requires the Permit Holder to undertake monitoring at the landfill boundary for offensive odour or dust. This is to be in accordance with the methodology set out in the Odour Management Plan, as required under condition 5(m)(iii) of Discharge Permit ATH-2002003984.02.

Condition 8D of Discharge Permit ATH-2002003984.02 requires the Permit Holder to undertake monthly field investigations of ambient odour at locations beyond the site boundary that are downwind of the landfill and located between the landfill and residential houses. Such investigations are to continue until such time as discharges of refuse to the landfill cease, and the frequency thereafter is to be determined in consultation with the Regional Council.

Disposal of refuse at the landfill ceased in October 2021, however, throughout the monitoring period Council has undertaken odour monitoring on thirteen occasions, and at ten locations around the landfill property. A record of the odour monitoring that has been carried out is attached in Appendix H.

The following is a summary of the locations where odour gas monitoring has been conducted, and the number of tests done:

- Biofilter: 7 times
- Landfill gas flare: 13 times
- Landfill gate: 7 times
- Leachate pond: 7 times
- Landfill office: 7 times
- Landfill boundary (various locations, depending on wind direction): 7 times
- On top of the landfill: 7 times

On fifty of the fifty-five monitoring events the assessor concluded that "*I did not detect any odour*". For the other five monitoring events the assessor concluded: "*I did detect odour and consider it would not be objectionable at any location for any duration or frequency*". Accordingly, no further action was deemed necessary for all events.

As stated in the consent conditions, it is recommended that Council discuss the need for undertaking odour monitoring with the Regional Council to determine what frequency of inspections, if any, should be undertaken now that refuse disposal operations have ceased.

8.2 Gas Detection in Groundwater Monitoring Wells

Condition 4(a) of Discharge Permit ATH-2002003984.02 requires landfill gas sampling to be undertaken at each bore on every occasion that groundwater sampling is carried out. Refer to Appendix H for the gas monitoring results.

Gas detection results have been provided through the data portal, as soon as they are available, rather than waiting for the Annual Report. Whilst this is useful and provides an opportunity to assess gas results on a quarterly basis, it has been noted that gas monitoring has been occurring on days other than when sampling of the groundwater bores occurred. In part, this negates the purpose of the gas monitoring which is to provide a safeguard when sampling the groundwater and it is recommended that the gas sampling be done in conjunction with the groundwater sampling, not separate from it.

No methane (CH_4) was detected during the July 2023 monitoring round, and low concentrations of CH_4 were detected during the October 2023, January 2024, and April 2024 monitoring rounds. Low concentrations of hydrogen sulphide (H_2S) were reported in October 2023 (2ppm at bore G2s), January 2024 (1ppm at bores D2, D3rs and F2), and April 2024 (1ppm at bore Xs1). Levels of carbon dioxide (CO_2) were detected at moderately low levels in all bores in all sampling rounds, with bore B2 tending to have slightly higher readings. A summary of these results from the quarterly reports is as follows:

- In July 2023 no CH_4 or H_2S was detected in any of the groundwater bores, which is somewhat anomalous, but is possible. Minor concentrations of CO_2 were recorded at all bores, with the highest being 0.67% at bore B2. Historically, fluctuations have been seen across the bores, and July concentrations are within historical ranges. In January 2023, B2 presented a significantly high concentration of 7.01% - the July quarter showing substantial decrease.
- In October 2023 CH_4 was detected in three of the bores, with the greatest reading at Xd1 (0.04%), which is well below the explosive limit of 5%, and therefore represents a 'safe' level. Minor concentrations of CO_2 were recorded at all bores, with the highest being 1% at bore B2. H_2S was detected at one bore – G1s (2 ppm), which is around the threshold at which a 'rotten egg' smell (commonly associated with H_2S) can be detected.
- In January 2024 CH_4 was detected in five of the bores, with the greatest readings at B3 and D1 (0.07%), which are, again, well below the explosive limit of 5%. Minor concentrations of CO_2 were recorded at all bores, with the highest being 0.43% at bore B2. H_2S was detected at three bores, F2, D2 and D3rs, all at 1 ppm.
- In April 2024 CH_4 was detected in seven of the bores, with the highest reading being at D6 (0.06%) being well below the explosive limit. Minor concentrations of CO_2 were recorded at all bores, with the highest being 0.2% at bore C2. H_2S was detected at bore Xs1 at 1 ppm.

As has been noted previously, despite CH_4 and H_2S being detected only at low levels in the groundwater bores in the 2023 – 2024 reporting period, there is always a possibility of encountering these gases when sampling which endorses the need for appropriate health and safety measures to be adopted. No smoking should be permitted when personnel undertake groundwater sampling and when in the vicinity of the groundwater monitoring wells, or in fact anywhere else on the Levin Landfill site. For sake of safety a personal gas detector should be worn by all staff when working in the vicinity of the landfill.

8.3 Monitoring of Surface Emissions and Bio-filter

Condition 5(e) of Discharge Permit ATH-2002003984.02 requires the Permit Holder to undertake monthly methane surface monitoring of the temporary and permanent capped areas of the landfill and the bio-filter.

The pipe feeding landfill gas from the leachate sump to the bio-filter bed was disconnected in September 2021. Since then, the gas from the leachate sump has been directed to the pipe network that feeds the landfill gas flare. This change has been agreed between HRC and HDC. Therefore, monitoring of the biofilter is not required and has not been done during this reporting period.

Condition 5(f) of Discharge Permit ATH-2002003984.02 states that the levels which the surface concentrations of methane should not exceed. Any exceedance requires remedial action to be undertaken within 24 hours and retesting to be done within 24 hours of the remediation having been done.

Through the 2023 – 2024 reporting period HDC has engaged Whanganui Environmental Monitoring to undertake the surface emissions monitoring. During the monitoring period fifteen surface monitoring assessments were undertaken, one per month with an additional three in June 2024 when weekly testing was undertaken. As such, HDC has fully complied with the resource consent conditions to monitor surface emissions monthly.

Table 8-2 summarises the surface emissions testing undertaken in the reporting year. The reports provided by the service provider for the testing are included in full in Appendix I.

Table 8-1: Summary of Surface Emissions Testing Carried Out at Levin Landfill

Date of Assessment	Service Provider	Temporary Capping Area: Methane results >200ppm	Compliance	Actions taken	Methane results on re-test	Compliance	Permanent Capped Area: Methane results >100ppm	Compliance	Actions taken	Methane results on re-test	Compliance
22 July 2023	Whanganui Environmental Ltd	None noted.	Yes	Not applicable.	Not applicable.	Not applicable.	2 locations > 100ppm; CH_4 concentrations varied from 315 ppm to 800 ppm.	No	Remediated areas using bentonite granules and water.	Both sites re-tested and returned 0ppm	Yes
12 August 2023	Whanganui Environmental Ltd	1 location > 200ppm; CH_4 concentration was 380 ppm.	No	Remediated area using bentonite granules and water.	Site re-tested and returned 20ppm.	Yes	3 locations > 100ppm; CH_4 concentrations varied from 700 ppm to 1,000 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 0ppm and 30ppm.	Yes
23 September 2023	Whanganui Environmental Ltd	1 location > 200ppm; CH_4 concentration was 600 ppm.	No	Remediated area using bentonite granules and water.	Site re-tested and returned 0ppm.	Yes	2 locations > 100ppm; CH_4 concentrations varied from 260 ppm to 500 ppm.	No	Remediated areas using bentonite granules and water.	Both sites re-tested and returned between 0ppm and 30ppm.	Yes
22 October 2023	Whanganui Environmental Ltd	1 location > 200ppm; CH_4 concentration was 290 ppm.	No	Remediated area using bentonite granules and water.	Site re-tested and returned 0ppm.	Yes	2 locations > 100ppm; CH_4 concentrations varied from 160 ppm to 375 ppm.	No	Remediated areas using bentonite granules and water.	Both sites re-tested and returned between 5ppm and 47ppm.	Yes
19 November 2023	Whanganui Environmental Ltd	None noted.	Yes	Not applicable.	Not applicable.	Not applicable.	3 locations > 100ppm; CH_4 concentrations varied from 173 ppm to 330 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 0ppm and 15ppm.	Yes
31 December 2023	Whanganui Environmental Ltd	1 location > 200ppm; CH_4 concentration was 380 ppm.	No	Remediated areas using bentonite granules and water.	Site re-tested and returned 20ppm.	Yes	1 location > 100ppm; CH_4 concentrations measured at 210 ppm.	No	Remediated area using bentonite granules and water.	Site re-tested and returned 15ppm.	Yes
13 January 2024	Whanganui Environmental Ltd	2 locations > 200ppm; CH_4 concentrations varied from 130ppm to 325ppm.	No	Remediated areas using bentonite granules and water.	Sites re-tested and returned between 7ppm and 13ppm.	Yes	4 locations > 100ppm; CH_4 concentrations varied from 249 ppm to 400 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 12ppm and 34ppm.	Yes
10 February 2024	Whanganui Environmental Ltd	None noted.	Yes	Not applicable.	Not applicable.	Not applicable.	3 locations > 100ppm; CH_4 concentrations varied from 240 ppm to 380 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 19ppm and 30ppm.	Yes
23 March 2024	Whanganui Environmental Ltd	ALL AREAS OF THE LANDFILL HAVE NOW BEEN CAPPED WITH PERMANENT CAPPING					2 locations > 100ppm; CH_4 concentrations varied from 189 ppm to 227 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 18ppm and 22ppm.	Yes
21 April 2024	Whanganui Environmental Ltd	ALL AREAS OF THE LANDFILL HAVE NOW BEEN CAPPED WITH PERMANENT CAPPING					3 locations > 100ppm; CH_4 concentrations varied from 189 ppm to 348 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 13ppm and 22ppm.	Yes.
19 May 2024	Whanganui Environmental Ltd	ALL AREAS OF THE LANDFILL HAVE NOW BEEN CAPPED WITH PERMANENT CAPPING					1 location > 100ppm; CH_4 concentrations measured at 398 ppm.	No	Remediated area using bentonite granules and water.	Site re-tested and returned 53ppm.	Yes
02 June 2024	Whanganui Environmental Ltd	ALL AREAS OF THE LANDFILL HAVE NOW BEEN CAPPED WITH PERMANENT CAPPING					2 locations > 100ppm; CH_4 concentrations varied from 240 ppm to 380 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 20ppm and 30ppm.	Yes
16 June 2024	Whanganui Environmental Ltd	ALL AREAS OF THE LANDFILL HAVE NOW BEEN CAPPED WITH PERMANENT CAPPING					2 locations > 100ppm; CH_4 concentrations varied from 218 ppm to 384 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 25ppm and 35ppm.	Yes
23 June 2024	Whanganui Environmental Ltd	ALL AREAS OF THE LANDFILL HAVE NOW BEEN CAPPED WITH PERMANENT CAPPING					4 locations > 100ppm; CH_4 concentrations varied from 179 ppm to 662 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 24ppm and 78ppm.	Yes.
29 June 2024	Whanganui Environmental Ltd	ALL AREAS OF THE LANDFILL HAVE NOW BEEN CAPPED WITH PERMANENT CAPPING					2 locations > 100ppm; CH_4 concentrations varied from 210 ppm to 664 ppm.	No	Remediated areas using bentonite granules and water.	All sites re-tested and returned between 26ppm and 35ppm.	Yes

On each of the fifteen occasions that surface monitoring was conducted across both the temporary and/or permanent capped areas, compliance was not initially achieved. However, following remediation using bentonite granules and water of the areas where emissions had exceeded the resource consent trigger levels, all the remediated sites achieved compliance.

Note that permanent capping had been constructed across the whole of the new landfill by the end of February 2024.

It is further noted that the landfill gas infrastructure had been reconnected by May 2024 and the results show a corresponding reduction in the number of locations where emissions exceed the resource consent trigger levels.

Now that the landfill has been fully capped it is recommended that HDC discusses with HRC about the frequency of surface emissions testing which could be reduced to, say, a quarterly frequency.

8.4 Meteorological Data

Condition 5(p) of Discharge Permit ATH-2002003984.02 requires the Permit Holder to collect meteorological data from an on-site weather station. Condition 5(q) requires the Permit Holder to provide that information to the Regional Council.

During the reporting period, weather data was collected from an on-site weather station. Data has been recorded at intervals of one minute, as required by consent. It is noted that the dataset is missing information for the following periods:

- September 2023: last 12 hours of the month is missing.
- November 2023: Data missing between 01/11/23 and 19/11/23.
- February 2024: data missing between 02/02/24 and 13/02/24.

The following data are required to be collected:

- wind direction and speed
- air temperature
- barometric pressure
- relative humidity
- rainfall.

Wind direction and speed, and air temperatures appear to have been recorded consistently throughout the reporting period, although there were a handful of spurious (i.e., large negative values) temperature measurements in February 2024 and March 2024.

An examination of the monthly data files found the following errors with respect to recording rainfall and relative humidity:

- The recording of rainfall appears to have been problematic through half of the year, with rainfall appearing to be recorded correctly in the months of September 2023, October 2023, November 2023, December 2023, April 2024, and May 2024.
- The recording of relative humidity appears to have been problematic, with non-sensical readings being recorded from 08 October 2023 for the rest of the reporting period.

The dataset is available for the Regional Council should it be required.

9 Monitoring Results Compliance

This section contains a summary of compliance (or otherwise) with the resource consent conditions for the landfill site. This summary should be considered in the context provided throughout this report, especially around the existing consent requirements for monitoring (i.e., where a single sample is required per year) and where non-compliance has been reported because of a low/marginal detection as opposed to a significantly elevated result.

Exceedances have been identified with the number of samples taken for bores D3rs, D4, D6, E1s, and E2s which should have been tested for arsenic in the full comprehensive suite, but this did not occur. Additionally, surface water sites (HS1, HS1A, HS2, HS3, TD1 and Leachate Pond) missed at least I monthly comprehensive sampling round.

9.1 Groundwater - Sand Aquifer

Consent conditions for the site (Discharge Permit ATH-2002003983.02, Condition 11) require shallow groundwater quality to be compared with ANZECC 2000 LDW trigger values. During the reporting period, all bores were compliant within this requirement.

The detection limit for *E.coli* (Faecal coliforms) was 100 CFU/100mL, allowing for comparison with the ANZECC trigger values, however does not provide information on which bores were close to exceeding the trigger value.

9.2 Groundwater - Gravel Aquifer

Condition 12 of Discharge Permit ATH-2002003983.02 requires groundwater quality within the deeper gravel aquifer to be compared with DWSNZ MAVs.

Exceedances were recorded for five parameters in samples from bores monitoring the gravel aquifer during the reporting period, based on annual median values:

- Faecal coliforms (as measured by *E. coli*) at all bores.
- Iron in G1D
- Hardness in D3rd
- Arsenic concentration in D3rd
- Manganese in Xd1, D3rd, E2D and C2DD

Historically, both iron and manganese concentrations have exceeded the DWSNZ MAVs and so those exceedances are not considered to be significant.

D3rd is a relatively new bore thus additional monitoring to determine whether these exceedances are significant is advised.

Faecal coliforms have rarely been elevated in the deep aquifer, however due to the high laboratory detection limit used during the reporting year, the results cannot be compared to the DWSNZ MAV and as such are regarded as being non-compliant.

It is noted that all exceedances also occurred during the previous 2022-2023 reporting period, except for manganese in bore E2D.

Additionally, the deep aquifer is separated from the shallow aquifer by an aquiclude, in other words, a layer of low permeability material that acts as a barrier between the two aquifers. There is also a flow gradient from the deep aquifer to the shallow aquifer, which will prevent contamination of the deep aquifer from overlying groundwater. So, the exceedances for the deep aquifer are not unusual historically and are extremely unlikely to be related to landfill activities, particularly because of the environmental setting.

9.3 Surface Water – Hōkio Stream and Northern Farm Drain

Consent conditions for the site (Discharge Permit ATH-2002003983.02, Condition 11) require that surface water quality in the Hōkio Stream and the Northern Farm Drain be compared with trigger values from Table C1.

Water quality within Hōkio Stream and Northern Farm Drain was generally compliant at all sampling locations, except for the following exceedances.

- Ammoniacal-N within HS2 exceeded the maximum trigger level
- Maximum and monthly average ammoniacal-N exceeded the trigger levels in TD1

This is like the prior reporting period where exceedances in ammoniacal-N were observed at the same sites.

It is recognised that there is contamination of the groundwater arising from leachate from the old, closed landfill. However as determined from site observations, flows within the Northern Farm Property Drain are very minimal, particularly during the summer periods and whilst the drain is hydraulically connected to the Hōkio Stream, the volume flow within the Northern Farm Drain is significantly less[9] than that of the Hōkio Stream and any contamination within water discharged from the Northern Farm Drain to the Hōkio Stream will be rapidly diluted.

The significance of the ecological values of Northern Farm Drain has not been established; however, the drain is known to have been developed by the owner of the property (i.e., it was not naturally existing) and is periodically cleaned out by the owner using an excavator. On that basis, the ecological values of the drain are likely to be very low to low.

9.4 Stormwater

Groundwater bores E1D, E1S, D4 and D2 are currently understood to be located hydraulically down-gradient of the stormwater soakage area on the site, and groundwater quality in these bores was compared with the ANZECC 2000 LDW trigger values, and against two upstream bores, D3rs and F3.

An assessment comparing up-gradient groundwater quality up-gradient to the stormwater soakage area to down-gradient groundwater quality found that annual median concentrations of sodium, chloride and conductivity were more elevated within the down-gradient bores than for the up-gradient bores.

Annual median concentrations for the remaining determinants were either similar (i.e., for ammoniacal-N, nitrate-N, boron) or higher (i.e., for iron) at the up-gradient bores compared with down-gradient bores.

In all bores the annual median concentrations for all determinants were below the ANZECC 2000 LDW trigger values. There is no indication that stormwater quality is being affected by leachate.

9.5 Leachate

Whilst the quality of the leachate is not subject to any trigger levels, the consent conditions require that it be tested for SVOCs and VOCs annually. This was not done in the reporting period which is a non-compliance.

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[9] Flow in the Northern Farm Drain has been estimated to be between 10L/s and 50L/s, whereas the average flow reported in the Hōkio Stream (September 1980 – June 1982) was 833L/s.

The leachate was not sampled for the full suite of parameters in January 2024, and phenol has not been sampled since December 2023.

Leachate is currently being sampled monthly and was required to be done for a period of 24 consecutive months since April 2021. Because some months were missed, the monthly sampling continues. HDC is to assess the purpose of continuing this sampling and discuss with HRC the need to continue with it.

9.6 Landfill Gas and Odour Monitoring

Over the 2023-204 reporting period, despite refuse disposal operations having ceased, odour monitoring was carried out on thirteen different days, spread over some 10 locations, and recording fifty-five separate monitoring events.

On fifty of the fifty-five monitoring events no odour was detected, and for other five monitoring events it was concluded that the odour would not be objectionable at any location for any duration or frequency. Accordingly, no further action was deemed necessary.

It is recommended, however, that HDC confirms with HRC what frequency of odour monitoring, if any, is acceptable.

Concentrations of CH_4, CO_2, H_2S and O_2 were monitored quarterly during the 2023- 2024 monitoring period. It is noted that gas monitoring has been conducted on days other than when sampling of the groundwater bores occurred. In part, this negates the purpose of the gas monitoring which is to provide a safeguard when sampling the groundwater and it is recommended that the gas sampling be done in conjunction with the groundwater sampling, not separate from it.

No to low concentrations of CH_4 being detected during the four monitoring rounds. Low concentrations (1 to 2 ppm) of H_2S were reported on five occasions. Moderately low levels of CO_2 were detected in all bores, and slightly higher levels in bore B2 in all sampling rounds. A copy of gas monitoring results is provided in Appendix H.

The existing consent does not require assessment of the concentrations of landfill gases detected against any limits. However, given the potential for landfill gas emissions on the site (particularly of CH_4 and H_2S), it is stressed that sampling personnel must take specific health and safety precautions to avoid inhaling, or igniting the gases from the bores when measurements are being taken. No smoking should be permitted when personnel undertake groundwater sampling and when in the vicinity of the groundwater monitoring wells, or in fact anywhere else on the Levin Landfill site. For sake of safety a personal gas detector should be worn by all staff when working in the vicinity of the landfill.

Monthly surface methane emissions monitoring is required over all temporary and capped areas of the landfill. The bio-filter was decommissioned in September 2021, and so no further monitoring of that facility is required.

During the 2023-2024 reporting period, HDC has engaged environmental consultants to undertake surface gas monitoring of the new landfill. Monthly surface emissions monitoring of areas that have been capped with temporary and permanent capping have been carried out on fifteen occasions (i.e., each month throughout the reporting period), with an additional 3 monitoring assessments being done in June 2024. Note that from March 2024 the landfill has been permanently capped.

Aside from July 2023, November 2023 and February 2024, there were locations of temporary capping noted that had CH_4 concentrations greater than 200 ppm. Additionally, on all occasions there were locations of permanent capping that had CH_4 concentrations greater than 100 ppm.

On all occasions where CH_4 concentrations exceeded the relevant trigger levels, the locations were remediated using bentonite granules and water. On re-testing, all locations CH_4 concentrations had reduced to below the relevant trigger levels. So, HDC is compliant with its resource consent requirements.

HDC is required to collect meteorological data from an on-site weather station. This has been undertaken throughout the reporting period by an on-site weather station. The weather station records data at 1-minute intervals, as required by the consent conditions.

However, the data derived from the weather station has some gaps, with the rainfall and relative humidity data records being faulty for lengthy periods of the reporting year.

10 Refuse Density

Condition 14 of Discharge Permit ATH-2002003983.02 requires that the in-situ density of the waste be checked each year through an annual survey of the landfill. The compaction density is required to be between 600 and 800 kg/m^3 (0.6 – 0.8 tonnes/m^3).

Since no waste disposal operations have occurred during the reporting period, no assessment of in-situ density can be done or is needed.

11 Old Landfill Remediation and Settlement

Condition 15 of Discharge Permit ATH-2002003983.02 required the old landfill (Area A) to be remediated by April 2011, which was completed. The remediation encompassed:

- Grading the landfill faces and cap to a final slope of between 1V: 3H and 1V: 4H.
- Sloping the final landfill surface to promote run-off to the outside of the footprint to prevent ponding on the landfill surface.
- Ensuring the landfill cap incorporated a layer of at least 700mm in thickness, with extra material to make up to this depth being of clayey soil origin.
- Establishing grass vegetation on the capped landfill.

Condition 15(f) of Discharge Permit ATH-2002003983.02 requires that the condition of the unlined landfill be reported annually, together with any maintenance carried out in the previous year.

Since 2011, and as the landfill has continued to settle, which is expected, minor ponding had started to occur on the top of the old landfill. It was recognised that the grade of the top surface had limitations for accommodating future settlement, and the ability to shed stormwater.

Additionally, as part of the assessment for dealing with leachate contaminating groundwater from the old landfill, it was recognised that re-shaping and remediating the top of the old landfill with clay capping would help with reducing stormwater infiltration in the future.

Accordingly, the landfill was recapped in March/April 2023, which involved stripping off the existing topsoil down to the clay/sand layer, and importing approximately 3,800 m^3 of clay material, which was compacted in place. Topsoil was reinstated and the surface sown with grass seed.

The recapping of the landfill required new monitoring points to be established across the newly capped surface, which was done in December 2023.

A drone aerial photograph is attached in Appendix J which shows the locations and co-ordinates of the re-established monitoring locations.

A survey of the monitoring pegs was undertaken on 22 August 2024. The results are also attached in Appendix J.

The results show that that there has been between 3mm and 19mm of settlement across the top of the closed landfill over a period of approximately eight months. This amount of settlement is nominal and is of no consequence.

A site inspection of the old landfill was conducted on 16 August 2024. Figure 11-1 shows the old landfill with good grass cover established.

Figure 11-1 Photograph taken on 16 August 2024 showing the vegetation cover achieved over the capping layer.

A minor shallow depression was identified close to monitoring location IS3, as shown in Figure 11-2 below. Its presence was picked up because of the prevalence of sedge vegetation locally in that area. At the final inspection of the capping construction in May 2023 it had been noted that there was a low spot at this location which was then filled with topsoil. It is likely that the topsoil has since settled resulting in the minor low point. It is recommended that this area be filled in again with topsoil and then re-seeded.

Figure 11-2 Photograph taken on 16 August showing a minor shallow depression near IS3.

12 Leachate Irrigation

In 2004, the old landfill site stopped receiving waste and the first stage of the new lined landfill began operating on site. Initially leachate from the lined landfill was collected in a leachate pond and irrigated on site. Leachate irrigation to the area of pine trees to the south-east of the lined landfill was curtailed at the end of 2008 and leachate was recirculated to Stage 1A.

At the beginning of June 2009, a pipeline was extended from the leachate pond to the Levin WWTP, allowing leachate to be pumped directly to that facility. From June 2009 until December 2012 most of the leachate was pumped to the Levin WWTP with some leachate being re-circulated through Stage 1A (about 5m^3 per day when operating). Since January 2012 all leachate has been pumped to the Levin WWTP. Figure 12-1 shows the daily quantities over the 2023-2024 reporting period. It is interesting to note a gradual reduction in daily quantities assumedly on account of the permanent capping that has been done.

Modifications made to the leachate pumping system allows leachate from the leachate pond to be pumped to a manhole located next to the leachate pond, from where it is pumped to the Levin WWTP. This allows leachate pumping to occur without having to fill up the leachate pond which was thought to be a possible source of odour.

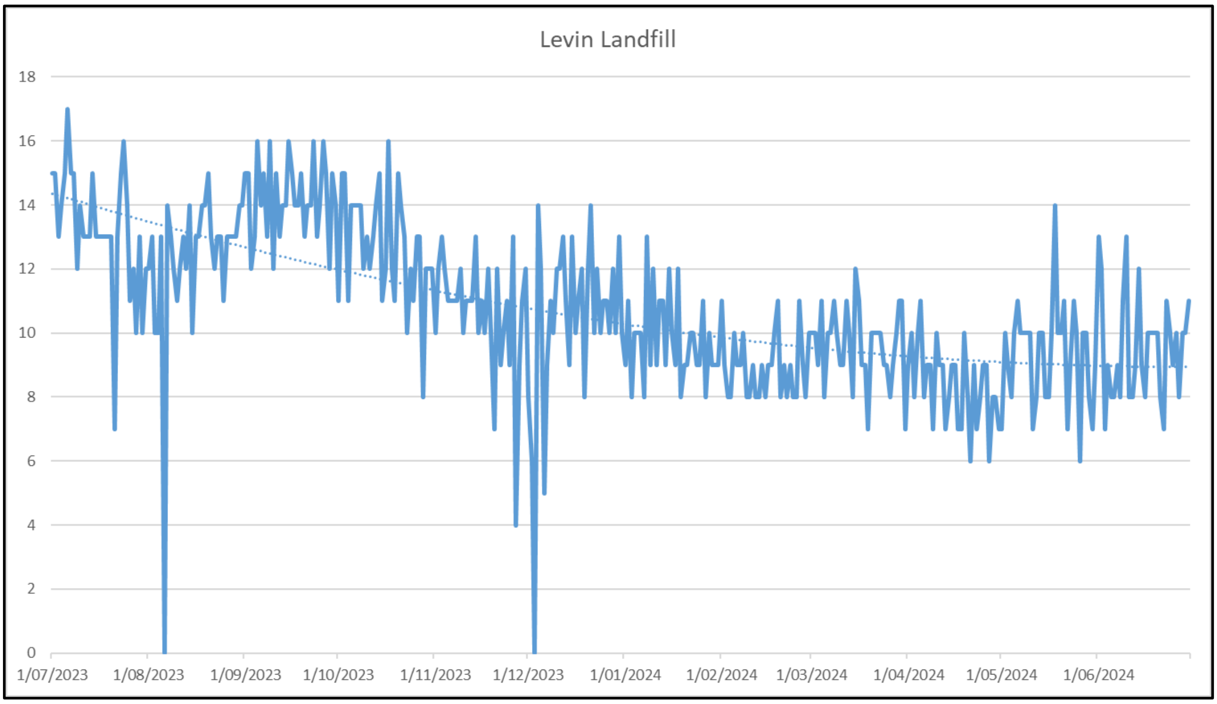


Figure 12-1: Daily quantities of leachate (m^3) that were pumped to the Levin WWTP during the 2023-2024 reporting period.

13 Site Walkover Records

Condition 28 of Discharge Permit ATH-2002003983.02 requires that the landfill be inspected for leachate breakout, settlement, and other adverse environmental effects at least once per month until such a time as discharge of refuse to the landfill ceases, thereafter the frequency of inspection is to be determined in consultation with the Regional Council.

The landfill has been inspected by HDC staff practically weekly from the end of August 2023 through to the end of June 2024 with observations being recorded on an Excel-based inspection log. A total of 47 site visits have been undertaken in that period. Notes of the site visits are attached in Appendix K.

With the landfill being closed for refuse disposal, many of the operational issues associated with landfills do not occur. Typical issues that have occurred include the following:

- Landfill gas flare disconnected due to capping operations, or non-operational due to failure of a methane detector.
- Dust present due to haulage of clay for capping purposes.
- Limited settlement on top of Cell 3 (which was remediated with final capping).
- Sea gulls present on-site.
- Fly tipping occurring occasionally outside the closed front gate.
- Gorse starting to grow again in places.
- Limited sludge noted in the leachate pond.

No leachate breakouts were reported through the monitoring period.

As was recommended last year, HDC should consider engaging a contractor who can undertake minor remediation at the landfill, from time to time.

Additionally, HDC should discuss and agree with HRC about the frequency of site walkover inspections now that the landfill has been closed for the disposal of municipal solid waste and capped.

14 Vermin and Pest Control

Condition 5 of Discharge Permit ATH-2002003982.03 requires that the landfill be regularly inspected for the presence of vermin, birds and other pests and that appropriate measures be taken to control them.

Capping of the landfill has limited the opportunities for feral cats and seagulls to scavenge in the waste for food scraps. This has significantly reduced the seagull population, though some seagulls have returned to nest on the remediated landfill. It is likely that the capping will reduce the presence of feral cats too, and there is no note of them in the site walkover log.

15 Weed Control

Spraying of gorse took place at the Levin Landfill around December 2023 / January 2024, as indicated in the site walkover records and confirmed in invoice details provided by Council.

The site walkover records indicate that gorse is still propagating, and so more frequent spraying may be needed to control the gorse, and it is recommended that this be undertaken.

16 Hazardous Waste Disposal

Since disposal operations ceased at the end of October 2021, no hazardous waste has been disposed of in the landfill in the reporting period.

17 Special Waste Disposal

Since disposal operations ceased at the end of October 2021, no special waste (e.g., biosolids and sludges, and liquid wastes) have been disposed of in the landfill in the reporting period.

18 Landfill Development

Reporting on the development that has occurred at the landfill over the previous year and noting what is proposed for the coming year is not a requirement of the conditions of consent. However, it has been included in this Annual Report for information purposes.

During the 2023-2024 reporting period final capping was constructed on the front face of the landfill and under the access road leading to the top of Cell 3, and the landfill was topsoiled and grassed. An inspection during the Defects Liability Period has shown that there are some minor matters to be dealt with, including getting a good strike of grass over some patchy areas on the front face. These will be addressed by the contractor before the end of the Defects Liability Period.

Figure 18-1 to Figure 18-3 show the completed front face and top of the landfill.

Figure 18-1: Front face of the landfill showing completed capping and vegetation.

Figure 18-2: Photo from the side of the front face.

Figure 18-3: Photo showing the crest of the landfill front face slope with access road leading to the top.

19 Conclusions

HDC is required to carry out compliance monitoring as part of Resource Consents ATH-2002003982.03, ATH-2002003983.02, ATH-2002003984.02 and ATH-2002009801.02. This report summarises the findings from the July 2023 to June 2024 monitoring period.

Background Groundwater

Historically, bores G1S and G1D, situated hydraulically up-gradient from the new and old landfills to the southeast of the site, have been used to represent background water quality from the shallow and deep aquifers, respectively. More recently, results from bores F2, F3 and D5 have also been used to characterise background shallow groundwater quality, since these bores are up-gradient of the landfills.

As has been reported in previous years, background groundwater quality in bore G1S continues to be characterised by low pH levels and elevated chloride, iron, and aluminium concentrations in the shallow aquifer. Bore G1D also had elevated iron concentrations.

Whilst bores F2, F3 and D5 are required to, and do meet the ANZECC LDW trigger values, the water quality at all these bores also meet the DWSNZ, with the exception of *E.coli* (faecal coliforms) which are unable to be assessed against the DWSNZ due to the detection limit of 100CFU/100mL which is applied to all samples from the shallow bores.

New landfill (now closed) Bores

In bores hydraulically up-gradient of the old landfill and down-gradient of the new landfill, concentrations of leachate indicators were below ANZECC LDW trigger values for the reporting period. The results indicate that there is no leachate from the new lined landfill impacting on groundwater down-gradient of the landfill.

Shallow Aquifer Down-gradient of Old Landfill

In bores situated hydraulically down-gradient of the old landfill, leachate indicators (such as chloride, ammoniacal-nitrogen, and boron) have been detected at elevated concentrations – particularly in bores B1, B2, B3, C2 and G2S. Boron is the only leachate indicator with an assigned LDW trigger value (5 mg/L), and this was not exceeded in any of the shallow aquifer down-gradient bores.

Bores B1, B2, B3, C1, C2, G2S and Xs1 all appear to be located and screened within the leachate plume, though C1, G2S and Xs1 appear much less affected. This leachate plume appears to have a confined radius northward and is not extending to the north-west and the north-east. The plume width is estimated at 350 - 550 m; a key model assumption which has been updated this year based on additional work by other consultants.

Results of leachate indicators have been graphed for the various groupings of groundwater bores. In assessing the graphs for the sand aquifer downstream of the old landfill, it is evident that concentrations of the leachate indicator parameters indicate a somewhat stable, slightly reducing trend in some contaminant concentrations over time (e.g., chloride, sodium and conductivity), whereas other parameters, such as ammoniacal-N in bores B2, B3 and C2, show clear increased levels, and B1 and C1, which show slight increases recently. Additionally, boron now appears to be increasing in all bores, even though it reduced quite considerably for many years in bores B1 and B2.

These trends are being further investigated by Earthtech Consultants Ltd through monitoring of additional groundwater bores to intercept the leachate plume within the northern vicinity of the old landfill. This work is part of the Leachate BPO project for which HDC has committed a significant financial budget.

Selected down-gradient bores were also analysed for VOCs and SVOCs throughout the reporting period. Of the five detected substances, none exceeded the guideline values. It is noted that the detection limit for some of the VOCs and SVOCs is higher than the 99th percentile limits.

Irrigation Area Bores

Groundwater quality observed down-gradient of the old irrigation area (F-series bores) was comparable to or better than the background shallow groundwater quality up-gradient of the old landfill during this reporting period. However, these monitoring results for these bores were variable which could be indicative of leaching within land hydraulically down-gradient of the old irrigation area. It should be noted that no irrigation of leachate has occurred on the site since 2008.

Deep Aquifer Bores

Groundwater quality in the deep gravel aquifer bores exceeded consent limits for some parameters. Faecal coliforms were above the DWSNZ MAV of nil for all sites, due to the variability between detection limits, and a detection limit considerably higher than the consent limit, the exact level of exceedance is unknown. Hardness, manganese, and arsenic levels were exceeded in bore D3rd; and manganese was exceeded in bores E2D, Xd1 and C2DD. Iron was exceeded at bore G1D.

Such results are not exceptional for those bores. Given this and given the environmental setting with the deep aquifer being separated from the shallow aquifer by an aquiclude, and there being an upward gradient of flow between the deep and shallow aquifers, the exceedances are extremely unlikely to be on account of landfill activities.

Deep bores were also analysed for VOCs and SVOCs throughout the reporting period with no contaminants being recorded above the laboratory detection limit.

Mass Loading Evaluation

As outlined in Section 6, mass load calculations were undertaken to predict a range of contaminant concentrations in the Hōkio Stream for specific indicator parameters (ammoniacal-nitrogen, boron, chloride, sodium, nitrate-nitrogen and dissolved reactive phosphorus). The mass load calculation compares these predicted concentrations with median and maximum concentrations (averaged over five years) in the bores which are most representative of the leachate plume, these being bores B2, B3, C1, C2, C2DS, G2S, and Xs1.

The predicted range of concentrations from the 2023 - 2024 mass contaminant load assessment shows reasonably close agreement with actual monitoring results obtained from HS3 for all parameters except for ammoniacal-N, where the predicted range is some three to twelve times higher than the actual.

Earthtech Consultants Ltd conducted a mass contaminant loading assessment using a more sophisticated model than the current methodology that has been approved to meet consent conditions. That work has modelled the effect of having a cut-off drain to capture contaminated groundwater and has also checked what the concentration of ammoniacal-N is likely to be in the future at both HS2 and HS3.

Based on Earthtech's work a decision has been made to develop a solution that will deal with the contaminated groundwater, either by abstraction, treatment or both.

Given the outcome of Earthtech's work, it is recommended that the purpose of doing the mass contaminant loading assessment by the current conservative methodology has been somewhat superseded and it is recommended that the need to do so in the future be discussed with HRC, which may require a change in the methodology.

Hōkio Stream

Samples collected at the upstream and downstream locations within Hōkio Stream generally met the consent trigger values for all parameters, except for total-ammoniacal nitrogen at HS2. Annual median values for nitrate-N levels at all sites exceeded the ANZECC (95%) trigger values.

Concentrations of nitrate-N increased downstream from HS1A/HS1 to HS2/HS3 which implies that some activity occurs between these monitoring locations to cause this. Whilst it is well documented that there is a plume of contaminated groundwater arising from the old, unlined landfill, (and this is being assessed through the Leachate BPO project), nitrate-N levels at the shallow groundwater bores, which are the assumed source of contamination, show low levels of nitrate-N compared to the Hōkio Stream. So, there is little to no evidence of the elevated nitrate-N levels in the Hōkio Stream originating from a landfill leachate source. Bores B1 and B2, however, do show elevated levels of nitrate-N, as do other bores on-site, such as D1 and D6, but these elevated levels do not appear to be related to the landfill activity.

Northern Farm Drain

The drain on the Tatana Property appears to be intercepting a low level of leachate-contaminated shallow groundwater prior to discharging to the Hōkio Stream. The key leachate parameters ammoniacal-N, conductivity and chloride were generally lesser in concentration within this drain than in the shallow groundwater bores which are screened in the leachate plume. Annual median values for ammoniacal-N and nitrate-N levels exceeded the ANZECC (95%) trigger values.

Remediation of the groundwater entering the drain is being addressed through the Leachate BPO project. However, nitrate-N is not elevated in the shallow groundwater bores considered to be the source of the groundwater contamination, and so the high nitrate-N concentrations measured in the Northern Farm Drain are most likely to be on account of the farming activities which occur in the paddock through which the drain runs.

However, in some of the shallow groundwater bores high levels of ammoniacal-N have been detected, and it is quite possible that this is causing the elevated ammoniacal-N measurements in the Northern Farm Drain. As noted above, remediation of the groundwater entering the drain is subject to specific resource consent conditions which are being addressed through the Leachate BPO project.

Stormwater Soakage

With respect to the stormwater soakage area on site, sodium, chloride, and conductivity were elevated in the down-gradient bores compared with up-gradient bores. However, ammoniacal-N, nitrate-N and boron were generally similar in the upstream and downstream bores, with iron being higher in the upstream bores. Comparing the down-gradient bores with G1S, the shallow background bore, some parameters are generally more elevated in the background bore (e.g., conductivity, sodium, nitrate-N, and chloride), whereas other parameters are generally lower in the background bore (e.g., ammoniacal-N, boron, and iron). Overall, there does not appear to be a significant decrease in water quality down-gradient of the stormwater soakage area which indicates that discharges of stormwater from the landfill are not having a significant impact on the quality of groundwater down-gradient.

Landfill Leachate

The quality of the leachate is not subject to any trigger levels, but it is noted that the concentrations observed for all parameters analysed are mostly within the range reported for Class 1 landfills, except for mercury, which was not detected, ammoniacal-N, TOC, alkalinity and arsenic, which were slightly higher than the maximum range value. Consent conditions require that leachate be tested for SVOCs and VOCs annually. This was not done in the reporting period which is a non-compliance.

Number of Samples

Non-compliances have been identified with the number of samples taken for bores D3rs, D4, D6, E1s, and E2s which should have been tested for arsenic in the full comprehensive suite, but this did not occur. Additionally, surface water sites (HS1, HS1A, HS2, HS3, TD1 and Leachate Pond) missed at least I monthly comprehensive sampling round.

Waste Compaction

Since no waste disposal operations have occurred during the reporting period, no assessment of in-situ density can be done or is needed.

Old Landfill Remediation and Settlement

New monitoring pegs have been established across the newly capped surface of the Old Landfill and the pegs were re-surveyed after approximately 8 months. The results showed that that there has been between 3mm and 19mm of settlement across the top of the Old Landfill in that period, which is a nominal amount and is of no consequence.

A site inspection in August 2024 showed that good grass cover has been established the old landfill, though a minor, very shallow depression was identified close to monitoring location IS3. It is likely settlement of topsoil that had been placed in this area to remediate a low spot that was identified previously. It is recommended that this area be filled in again with topsoil and then re-seeded.

Odour Monitoring at Boundary

Over the 2023-204 reporting period fifty-five separate odour monitoring events were conducted at various locations about the landfill property.

No odour was detected for fifty of the monitoring events. For the events where odour was noted, it was not considered to be objectionable for any duration or frequency, and no further action was deemed necessary. HDC should, however, confirm with HRC about the frequency of odour monitoring in the future.

Gas Monitoring in Bores

Concentrations of CH_4, CO_2, H_2S and O_2 were monitored quarterly during the 2023- 2024 monitoring period, with no to low concentrations of CH_4 being detected. Low concentrations (1 to 2 ppm) of H_2S were reported on five occasions, and moderately low levels of CO_2 were detected in all bores, with slightly higher levels in bore B2.

Given the potential for landfill gas emissions on the site (particularly of CH_4 and H_2S), sampling personnel must take specific health and safety precautions to avoid inhaling or igniting the gases from the bores when measurements are being taken. No smoking should be permitted when personnel undertake groundwater sampling and when in the vicinity of the groundwater monitoring wells, or in fact anywhere else on the Levin Landfill site. For sake of safety a personal gas detector should be worn by all staff when working in the vicinity of the landfill. Additionally, the gas monitoring should be conducted when the groundwater sampling is being done, which has not been the case recently. Doing so will provide a safeguard when sampling the groundwater.

Surface Monitoring of New landfill (now closed)

Monthly surface methane emissions monitoring is required over all temporary and capped areas of the landfill. The bio-filter was decommissioned in September 2021, and so no further monitoring of that facility is required.

During the 2023-2024 reporting period, monthly surface emissions monitoring has been carried out on fifteen occasions.

Aside from July 2023, November 2023 and February 2024, CH4 concentrations exceeded relevant trigger levels. On all occasions when this occurred, the locations were remediated using bentonite granules and water and, on re-testing, CH4 concentrations had reduced to below the relevant trigger levels at all locations. So, HDC is compliant with its resource consent requirements for surface monitoring.

Bio-filter

The bio-filter was decommissioned prior to the reporting period, and so no inspections and maintenance of the bio-filter were required.

Meteorological Data

HDC is required to collect meteorological data from an on-site weather station. This has been undertaken throughout the reporting period. The weather station records data at 1-minute intervals, as required by the consent conditions. However, the data derived from the weather station has some gaps, with the rainfall and relative humidity data records being faulty for lengthy periods of the reporting year.

20 Recommendations

A series of recommendations are made below, which will assist in improving the environmental monitoring that is done at and around the landfill site, as well as the general maintenance of the site.

1. As noted last year, it is recommended that all samples that require comparison against the DWSNZ be tested to a level of detection of 1 CFU/100mL for *E.coli*.
2. Surface water samples require the detection limits for testing of $scBOD_5$ to be 1 mg/L so that results can be compared to the appropriate trigger value.
3. The use of bore G1S as a background bore has been reviewed, and Bores F2, F3 and D5 should be used as the primary background reference bores. G1S should still be in conjunction with these bores.
4. Earthtech has undertaken a mass contaminant loading assessment using a more sophisticated model than that currently approved to meet resource consent conditions. It is recommended that the purpose of doing the mass contaminant loading assessment by the current conservative methodology be reviewed especially given that the assessment considers only HS3 and not HS2, and that the need for future mass contaminant assessments be discussed with HRC.
5. Now that the landfill is closed for disposal of municipal solid waste and has been capped permanently, Council should discuss the need for undertaking odour monitoring with HRC to determine what frequency of inspections, if any, should be undertaken.
6. Gas sampling of the groundwater monitoring bores should be done in conjunction with the groundwater sampling (i.e., at the same time), and not on a separate occasion.
7. With the capping of the landfill the frequency of surface emissions testing should be discussed with HRC.
8. The minor shallow area on the Old Landfill should be filled in with topsoil and then re-seeded.
9. Increase the frequency of spraying for gorse to at least twice-yearly.
10. Assess in the next reporting period, i.e., 2024 – 2025, the need for continuing with monthly monitoring of leachate and discuss this with HRC.

Appendices

Appendix A Relevant consent conditions

Relevant Consent Conditions

The Annual Report is required to meet the following consent conditions:

- Discharge Permit ATH-2002003982.03 (formerly DP 6009) – Discharge solid waste to land
  - ✓ Condition 8
    "The Permit Holder shall develop and implement a procedure for the landfill operator, such that potentially hazardous material, as listed in Annex 1 attached to and forming part of this permit, will not be accepted for disposal at the Levin landfill without specific authorization. The Operations Manager of the Horowhenua District Council, or some other designated person, is able at their discretion to accept quantities of such wastes. The waste shall be accompanied by a Hazardous Waste Manifest, as listed in Annex 1, which will form part of the permanent record and shall be reported by the Regional Council by 30 September each year for the term of this Permit.

  - ✓ Condition 14
    "The Permit holder shall submit an annual report to the Regional Council by 30 September each year for the duration of this Permit documenting the condition of the unlined landfill and any maintenance carried out during the previous year. The annual report shall address but not be limited to those aspects listed in Conditions 14(n) to 14(r) above. The annual report shall include a plan of the unlined landfill specifically documenting the shape of the closed landfill and any changes during the previous year related to Condition 14(q) [The annual report can be written in conjunction with the annual report required as part of Condition 15 (f) for Consent Number 6010]"

  - ✓ Condition 35 (b)
    "The Permit holder shall … Forward an annual report to members and to the Regional Council and the District Council"

- Discharge Permit ATH-2002003983.02 (formerly DP 6010) – Discharge landfill leachate onto and into ground
  - ✓ Condition 5
    "The results of monitoring under Conditions 3 and 4 of this Permit shall be reported to the Regional Council by 30 September each year for the duration of this Permit"

  - ✓ Condition 11(d)
    "The Permit Holder shall annually review the data derived from the groundwater monitoring program and evaluate contaminant mass load projections for discharges from the landfill to the Hokio Stream. The contaminant mass load projections shall be based primarily, but not exclusively, on the monitoring data obtained for the "B", "C" and "X" series bores indicated in Table D of this discharge permit. The annual report required under Condition 5 shall include the following information:
    - *i. A summary of the methodology used to calculate the mass load projections.*
    - *ii. The calculated mass loads transported in the groundwater and comparable mass loads in the Hokio Stream.*
    - *iii. An analysis of the implications of the mass load calculations with respect to ensuring discharges from the landfill would not result in a decline in the water quality in the Hokio Stream under Condition 3"*

- ✓ Condition 11 (e)

  “Should the groundwater parameters tested for under Condition 3 of this consent, and subsequent evaluation and indicative assessment of contaminant mass loads under Condition 11 (d) of this consent indicate that contaminants sourced from either the closed or active areas of the Levin Landfill are likely to result in a significant effect associated with the landfill leachate as identified through an investigation under Condition 3, then Condition 11(c) applies.

- ✓ Condition 14

  “In-situ refuse density shall be determined through annual calculation based on information derived from topographic surveys of the landfill and borrow areas, and from weighbridge records. The survey should be carried out within one month of the anniversary of the previous survey”

- ✓ Condition 15 (f)

  “The Permit holder shall submit an annual report to the Regional Council by 30 September each year for the duration of this Permit documenting the condition of the unlined landfill and any maintenance carried out during the previous year. The annual report shall address but not be limited to those aspects listed in Conditions 15(a) to (e) above. The annual report shall include a plan of the unlined landfill specifically documenting the shape of the closed landfill and any changes during the previous year. [The annual report can be written in conjunction with the annual report required as part of Condition 14 for Consent Number 6009]”

- ✓ Condition 27

  “The Permit holder shall keep a log of:

  a) The dates and times of leachate irrigation;

  b) The total volume of leachate irrigated daily;

  c) The volumes of leachate irrigated to specific areas;

  d) Weather and ground conditions during irrigation;

  e) Observations made during the weekly inspections of the pump, irrigation system;

  f) and irrigation areas; and

  g) Repairs and maintenance carried out on the irrigation system.

  Copies of this log shall be forwarded to the Regional Council’s Environmental Protection Manager on 28 February and 31 August of each year that the irrigation system is operated.

- Discharge Permit ATH-2002003984.02 (formerly DP 6011) – Discharge landfill gas, odour and dust to air

  - ✓ Condition 5 (g)

    “The Permit shall include records of surface emission monitoring for methane must be included in the Annual Report required by Condition 39 of Discharge Permit 6009 and must also be provided to Manawatu-Wanganui Regional Council on request.

- ✓ Condition 8F

  "The Permit Holder shall maintain a log of all other inspections, investigations and actions taken in accordance with all monitoring and odour inspection conditions of this consent. The inspection and investigation log shall be made available to the Manawatu-Wanganui Regional Council on request and submitted in summary form in the Annual Report".

- Discharge Permit ATH-2002009801.02 (formerly DP 102259) – Discharge stormwater to land and potentially to groundwater via ground soakage

  - ✓ Condition 16

    "The results of monitoring under Condition 14 of this permit shall be reported to Horizon Manawatu's Team Leader Compliance by 31 August each year for the duration of this Permit beginning 31 August 2003. The annual report shall be supplemented by the raw water quality analysis data being forwarded to the Regional Council as soon as practically possible following the receipt of laboratory analysis certificates".

Appendix B Environmental monitoring programs

LEVIN LANDFILL - SUMMARY OF SURFACE AND GROUNDWATER MONITORING REQUIREMENTS (July 2023 - April 2026).

(The testing regime is based on Consent Conditions following the completion of the 2015 Resource Consent Review process).

			Table A (Condition 3, ATH-2002003983.02, formerly DP 6010)						Table B (Condition 3, ATH-2002003983.02, formerly DP 6010)																
Reports Due		Sampling Month	Deep Aquifer Bores						Shallow Aquifer Bores																
Annual	Quarterly		C2dd	E1d	E2d	G1d	Xd1	D3rd[1]	C1	C2[6]	C2ds[6]	D4	B1	B2	B3s	E1s	E2s	D1[2]	D2[2]	D3rs[1,2]	D6[2]	G1s	G2s	Xs1[6]	Xs2[6]
Sep-23	Aug-23	Jul-23	I	I + SW	I	I	C	C	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	C + SW	I	I + SW	I	C	C
	Nov-23	Oct-23	I	I + SW	I	I	C	C	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	C + SW	I	I + SW	I	C	C
	Feb-24	Jan-24	I	I + SW	I	I	C	C	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	C + SW	I	I + SW	I	C	C
	May-24	Apr-24	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A
Sep-24	Aug-24	Jul-24	I	I + SW	I	I	I	C	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	C + SW	I	I + SW	I	I	I
	Nov-24	Oct-24	I	I + SW	I	I	I	C	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	C + SW	I	I + SW	I	I	I
	Feb-25	Jan-25	I	I + SW	I	I	I	C	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	C + SW	I	I + SW	I	I	I
	May-25	Apr-25	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A
Sep-25	Aug-25	Jul-25	I	I + SW	I	I	I	I	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	I + SW	I	I + SW	I	I	I
	Nov-25	Oct-25	I	I + SW	I	I	I	I	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	I + SW	I	I + SW	I	I	I
	Feb-26	Jan-26	I	I + SW	I	I	I	I	I	I	I	I + SW	I	I	I	I + SW	I + SW	I	I + SW	I + SW	I	I + SW	I	I	I
	May-26	Apr-26	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A	C + A

							Table C (Condition 3, ATH-2002003983.02, formerly DP 6010)					
Reports Due		Sampling Month	Irrigation Bores				Hokio Stream[4], [8]				Northern Farm Drain[9]	Leachate Pond[5]
Annual	Quarterly		D5[3]	F1[3]	F2[3]	F3[3]	HS1	HS1A	HS2	HS3	TD1[7]	
Sep-23	Aug-23	Jul-23	I	I	I	I + SW	Monthly Compre.	Monthly Compre.	Monthly Compre.	Monthly Compre.	Monthly Compre.	Monthly Compre.
	Nov-23	Oct-23	I	I	I	I + SW						
	Feb-24	Jan-24	I	I	I	I + SW	Sampling at HS1 to be discontinued when HRC advises.	I	I	I	I	I
	May-24	Apr-24	C + A	C + A	C + A	C + A		C	C	C	C	C + A
Sep-24	Aug-24	Jul-24	I	I	I	I + SW		I	I	I	I	I
	Nov-24	Oct-24	I	I	I	I + SW		C	C	C	C	C
	Feb-25	Jan-25	I	I	I	I + SW		I	I	I	I	I
	May-25	Apr-25	C + A	C + A	C + A	C + A		C	C	C	C	C + A
Sep-25	Aug-25	Jul-25	I	I	I	I + SW		I	I	I	I	I
	Nov-25	Oct-25	I	I	I	I + SW		C	C	C	C	C
	Feb-26	Jan-26	I	I	I	I + SW		I	I	I	I	I
	May-26	Apr-26	C + A	C + A	C + A	C + A		C	C	C	C	C + A

Measure groundwater level and sample all bores for CH_4, CO_2 and O_2 each time that groundwater is sampled (Condition 4a of DP 6011)

Notes:

(1) Replacement bore D3r consists of two nested piezometers that have been called D3rs and D3rd. Testing for comprehensive to continue to provide 2 year's of comprehensive monitoring.

(2) See table below

(3) If irrigation re-commences then the annual sampling is to change from comprehensive + 3 times indicator to bi-annual comprehensive + indicator (Clause D of Condition 3, DP 6010) .

(4) See table below

(5) See table below

(6) Measure water level at C2, C2ds, Xs1 and Xs2 when taking monthly samples at TD1 and within the Hokio Stream. Testing of X-series bores to continue at comprehensive to provide 2 year's of comprehensive data.

(7) Start taking comprehensive samples at TD1 every month when sampling the Hokio Stream sites. Also note the depth of water in the drain invert at TD1. Continue monthly comprehensive sampling to October 2023 to give 24 month's continuous data.

(8) Start measuring approximately the depth of flow in the Hokio Stream at each sampling site when sampling monthly. Monthly sampling at comprehensive level to continue to, and including, October 2023, to give a full continuous 24 months of data.

(9) Northern Farm Drain is a name change from the former 'Tatana Drain'

C Comprehensive list (see below)

I Indicator list (see below)

A Pesticide and SVOC analysis

SW Add sodium and iron analysis (for stormwater consent 102559)

A reduction in sampling frequency at any **groundwater monitoring point** is conditional on (Clauses A - D of Condition 3, DP 6010):

A. Completion of the initial monitoring program;
B. Good consistency of groundwater sample analysis results, or a clearly identified reason for inconsistent results that excludes the contaminant source being landfill operations, stored waste or leachate;
C. No decline in groundwater quality as determined from indicator parameter trends over a period of four consecutive sampling rounds;
D. If a well being monitored on a conditional frequency becomes non-compliant with condition C, the monitoring frequency for that well should return to the initial monitoring frequency until conditions B and C are again being fulfilled.

[2] If site management planning indicates any **early detection monitoring well** is likely to become buried or otherwise destroyed within the following year as a result of normal operations (Clauses E - H, Condition 3, DP 6010):

E. This must be communicated to the regional council;
F. A replacement well is to be constructed in a position agreed upon with Horizons Regional Council
G. The replacement well should be installed in a position suitable to act as a early detection well and be classed as an early detection well;
H. The replacement well should be constructed as a nested well (or two separate wells) with screens positioned in both shallow and deep aquifers.

[4] A reduction in sampling frequency at the **Hokio Stream monitoring locations (HS1A, HS2 and HS3)** is conditional on (Clauses I - L, Condition 3 of DP 6010):

I. No signficant increases in the concentrations between monitoring sites HS1A and HS3, for parameters exceeding the trigger values contained in Table C1 at Site HS3.
J. A statistical analysis approach is to be used to determine if there is a significant increase in contaminant levels between HS1A and HS3.
K. Following the 24 month monitoring period, there shall be no significant increases in concentrations between monitoring sites HS1A and HS3.
L. If the Hokio Stream monitoring locations are being sampled on a conditional frequency and do not meet condition K, the monitoring frequency for all three monitoring locations (HS1A, HS2 and HS3) shall return to the base case intensive monitoring until conditions J and K are again being fulfilled.

[5] A reduction in sampling frequency at the **leachate pond outlet** is conditional on (Clauses M - P, Condition 3, DP 6010):

M. Completion of the initial 2 year monitoring program;
N. Good consistency of water sample analysis results, or a clearly identified reason for inconsistent results;
O. No decline in water quality over a period of four consecutive sampling rounds;
P. If the leachate pond outlet is being sampled on a conditional frequency and becomes non-compliant with condition O, the monitoring frequency should return to the base case intensive monitoring until conditions N and O are again being fulfilled.

COMPREHENSIVE PARAMETER LIST (Table E of Condition 3, DP 6010)

Characterising parameters	pH
	electrical conductivity (EC)
	alkalinity
	total hardness
	suspended solids
Oxygen demand	COD and $scBOD_5$
Nutrients*	NO3-N, NH4-N, DRP and SO_4
Metals*	Al, As, Cd, Cr, Cu, Fe, Mg, Mn, Ni, Pb, Zn and Hg
Other elements	B, Ca, Cl, K and Na
Organics	Total organic carbon, total phenols, volatile acids
Biological	E. coli

* Analyses performed for nutrients and metals are for dissolved rather than total concentrations

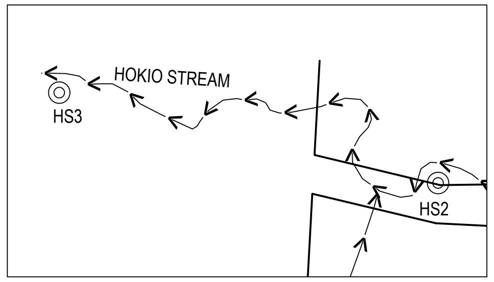
INDICATOR PARAMETER LIST (Table F, Condition 3, DP 6010)

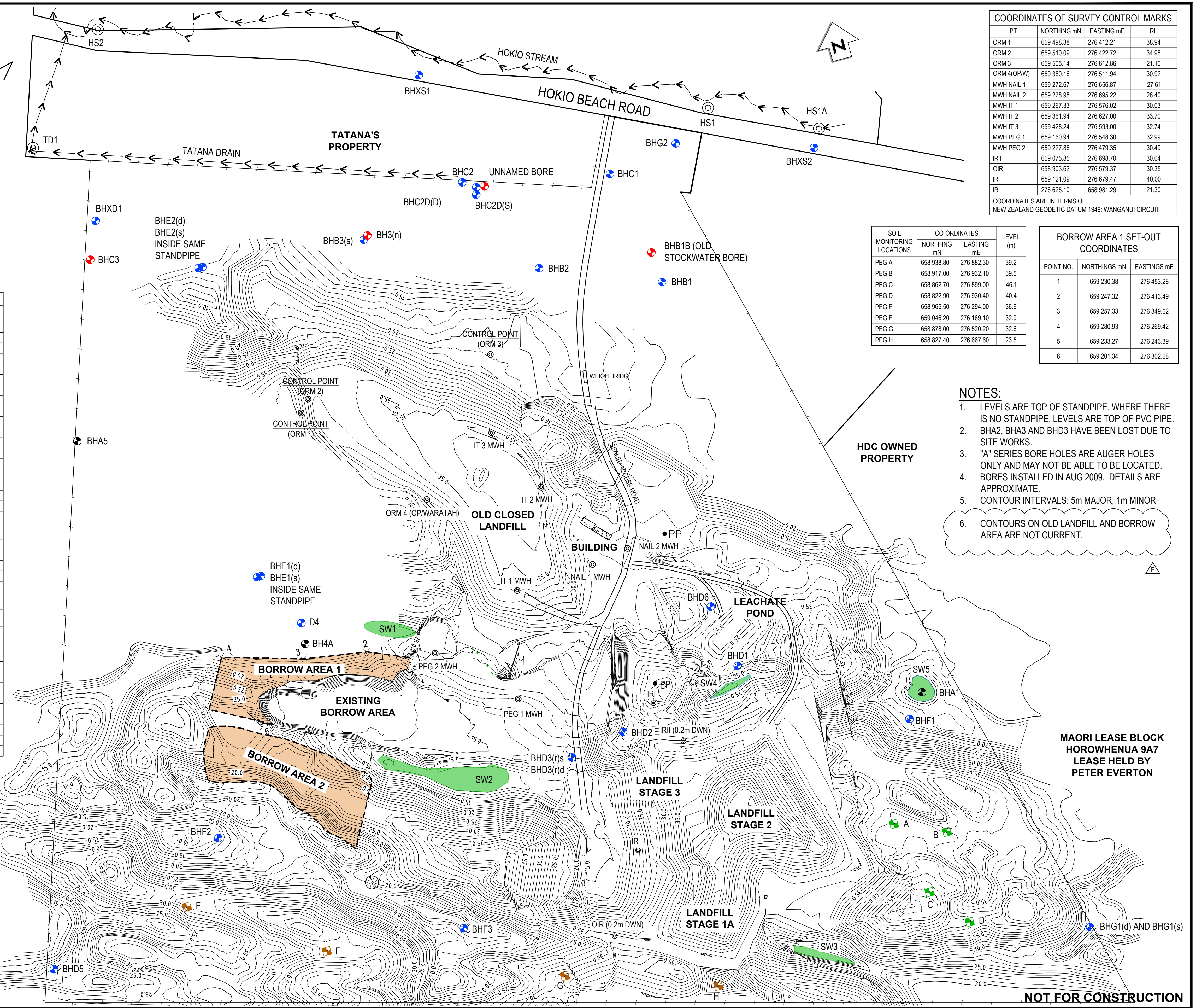
Characterising parameters	pH
	electrical conductivity (EC)
Oxygen demand	COD and $scBOD_5$
Nutrients*	NO3-N and NH4-N
Metals*	AL, Mn, Ni, Pb and Hg
Other elements	B and Cl
Biological[+]	E. coli

* Analyses performed for nutrients and metals are for dissolved rather than total concentrations

[+] E. coli added from April 2019 sampling onwards

Appendix C Site plan and Earthtech plan





COORDINATES OF SURVEY CONTROL MARKS			
PT	NORTHING mN	EASTING mE	RL
ORM 1	659 498.38	276 412.21	38.94
ORM 2	659 510.09	276 422.72	34.98
ORM 3	659 505.14	276 612.86	21.10
ORM 4(OP/W)	659 380.16	276 511.94	30.92
MWH NAIL 1	659 272.67	276 656.87	27.61
MWH NAIL 2	659 278.98	276 695.22	28.40
MWH IT 1	659 267.33	276 576.02	30.03
MWH IT 2	659 361.94	276 627.00	33.70
MWH IT 3	659 428.24	276 593.00	32.74
MWH PEG 1	659 160.94	276 548.30	32.99
MWH PEG 2	659 227.86	276 479.35	30.49
IRII	659 075.85	276 698.70	30.04
OIR	658 903.62	276 579.37	30.35
IRI	659 121.09	276 679.47	40.00
IR	276 625.10	658 981.29	21.30
COORDINATES ARE IN TERMS OF NEW ZEALAND GEODETIC DATUM 1949: WANGANUI CIRCUIT			

SOIL MONITORING LOCATIONS	CO-ORDINATES		LEVEL (m)
	NORTHING mN	EASTING mE	
PEG A	658 938.80	276 882.30	39.2
PEG B	658 917.00	276 932.10	39.5
PEG C	658 862.70	276 899.00	46.1
PEG D	658 822.90	276 930.40	40.4
PEG E	658 965.50	276 294.00	36.6
PEG F	659 046.20	276 169.10	32.9
PEG G	658 878.00	276 520.20	32.6
PEG H	658 827.40	276 667.60	23.5

BORROW AREA 1 SET-OUT COORDINATES		
POINT NO.	NORTHINGS mN	EASTINGS mE
1	659 230.38	276 453.28
2	659 247.32	276 413.49
3	659 257.33	276 349.62
4	659 280.93	276 269.42
5	659 233.27	276 243.39
6	659 201.34	276 302.68

NOTES:

1. LEVELS ARE TOP OF STANDPIPE. WHERE THERE IS NO STANDPIPE, LEVELS ARE TOP OF PVC PIPE.
2. BHA2, BHA3 AND BHD3 HAVE BEEN LOST DUE TO SITE WORKS.
3. "A" SERIES BORE HOLES ARE AUGER HOLES ONLY AND MAY NOT BE ABLE TO BE LOCATED.
4. BORES INSTALLED IN AUG 2009. DETAILS ARE APPROXIMATE.
5. CONTOUR INTERVALS: 5m MAJOR, 1m MINOR
6. CONTOURS ON OLD LANDFILL AND BORROW AREA ARE NOT CURRENT.

BORE LOCATIONS AND DETAILS						
BORE HOLE NO	NORTHING mN	EASTING mE	R.L. (m)	DEPTH OF WELL (m)	PIEZOMETER DIAMETER (mm)	FUNCTION
A1	659 060.15	276 944.89	12.95			SHALLOW AQUIFER
A2 (DESTROYED)						SHALLOW AQUIFER
A3 (DESTROYED)						SHALLOW AQUIFER
A4	659 271.67	276 354.72	10.10			SHALLOW AQUIFER
A5	659 530.47	276 185.91	9.62			SHALLOW AQUIFER
B1	659 561.81	276 797.35	9.04	4.3	40	SHALLOW AQUIFER
B1B (STOCK BORE)	659 530.08	276 799.91	9.28	10		
B2	659 576.32	276 683.50	9.42	3.5	50	SHALLOW AQUIFER
B3(s)	659 651.19	276 519.52	7.76	2.83	50	SHALLOW AQUIFER
B3(n)	659 654.26	276 524.38	7.49	2.33	32	DEEP AQUIFER
C1	659 649.64	276 777.83	7.47	3.60	50	SHALLOW AQUIFER
C2	659 680.80	276 631.22	7.50	2.81	32	SHALLOW AQUIFER
C2D(s)	659 671.19	276 641.63	10.13	12.88	32	SHALLOW AQUIFER
C2D(d)	659 671.19	276 641.63	10.11	18.85	32	DEEP AQUIFER
C3	659 704.29	276.246.89	7.22	2.8	32	SHALLOW AQUIFER
D1	659 134.97	276 771.65	27.46	23.69	50	EARLY DETECTION
D2	659 101.02	276 642.06	32.12	29.46	50	EARLY DETECTION
D4	659 293.20	276 356.60	17.97	17.0		SHALLOW AQUIFER
D5	659 020.80	276 022.40	20.65	18		SHALLOW AQUIFER BACKGROUND
D6	659 200.31	276 761.08	26.41	16.07	50	EARLY DETECTION
E1(d)	659 349.54	276 329.48	20.91	37.80	32	SHALLOW AQUIFER
E1(s)	659 349.54	276 329.48	20.91	20.05	32	DEEP AQUIFER
E2(s)	659 667.30	276 354.69	13.15	15.24	32	SHALLOW AQUIFER
E2(d)	659 667.30	276 354.69	13.15	28.66	32	DEEP AQUIFER
F1	659 037.10	276 925.50	18.90	15.0	50	SHALLOW AQUIFER LEACHATE IRRIGATION
F2	659 105.00	276 218.00	13.50	10.2	50	SHALLOW AQUIFER LEACHATE IRRIGATION
F3	658 951.70	276 434.00	16.70	10.5	50	SHALLOW AQUIFER LEACHATE IRRIGATION
G1(s) [4]	658 786.00	277 046.00	24	15	50	SHALLOW AQUIFER BACKGROUND
G1(d) [4]	658 786.00	277 046.00	24	31.5	50	DEEP AQUIFER BACKGROUND
G2 [4]	659 673.00	276 835.00	8	4	50	SHALLOW AQUIFER
COORDINATES FOR BORE HOLES BELOW ARE APPROXIMATE ONLY						
D3(r) s	659 089.60	276 585.30	18	10	50	EARLY DETECTION
D3(r) d	659 089.60	276 585.30	18	32	50	EARLY DETECTION
BHXS1	659 797.20	276 617.30	-	4	50	SHALLOW AQUIFER
BHXS2	659 620.80	276 984.30	-	4	50	SHALLOW AQUIFER
BHXD1	659 741.00	276 262.60	-	35	50	DEEP AQUIFER
COORDINATES ARE IN TERMS OF NEW ZEALAND GEODETIC DATUM 1949: WANGANUI CIRCUIT						

LEGEND

- MONITORING SAMPLING LOCATION
- MONITOR BORES CURRENTLY SAMPLED (FROM JAN 2010)
- BORES NOT SAMPLED
- SHALLOW HANDAUGER STANDPIPES NOT ABLE TO BE LOCATED
- SOIL SAMPLING LOCATION PEG - MONITORED PREVIOUSLY
- SOIL SAMPLING LOCATION PEG - NOT MONITORED
- EXISTING STORMWATER SOAKAGE AREA
- POSSILBE BORROW AREAS

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
F	FOR INFORMATION - FUTURE LANDFILL STAGES REMOVED AND LEGEND UPDATED	BCJ	PSL	PSL	23.09.24
E	FOR INFORMATION - BHD3(r)s AND BHD3(r)d ADDED, AND CONTOURS UPDATED FROM JULY 2021 SURVEY	BCJ	PSL	PSL	24.09.21
D	FOR INFORMATION - BORROW AREA 2 RELOCATED, DEFINED AREAS OF FUTURE STAGES 1B, 4 AND 5	BCJ	PSL	PSL	01.06.21
C	FOR INFORMATION - BORROW AREA AND LANDFILL AREA UPDATES AND BORE HOLES AND SAMPLING LOCATIONS ADDED FOR HOKIO STREAM AND TATANA DRAIN	BCJ	PSL	PSL	24.03.21
B	FOR INFORMATION - BORROW AREA AND LANDFILL AREA UPDATES	BCJ	PSL	PSL	22.09.20
A	FOR INFORMATION	BCJ	PSL	PSL	26.08.19

SURVEYED	MWH	
DESIGNED	N/A	-
DRAWN	Brent James	08.2019
CAD REVIEW	Brent James	22.09.24
APPROVED	Phil Landmark	23.09.24
PROF REGISTRATION:		

Stantec

Client:

HOROWHENUA DISTRICT COUNCIL
LEVIN LANDFILL

MONITORING BORES, SOIL SAMPLING LOCATIONS & BORROW AREAS
SITE PLAN, LOCATION AND DETAILS

Status Stamp: FOR INFORMATION ONLY

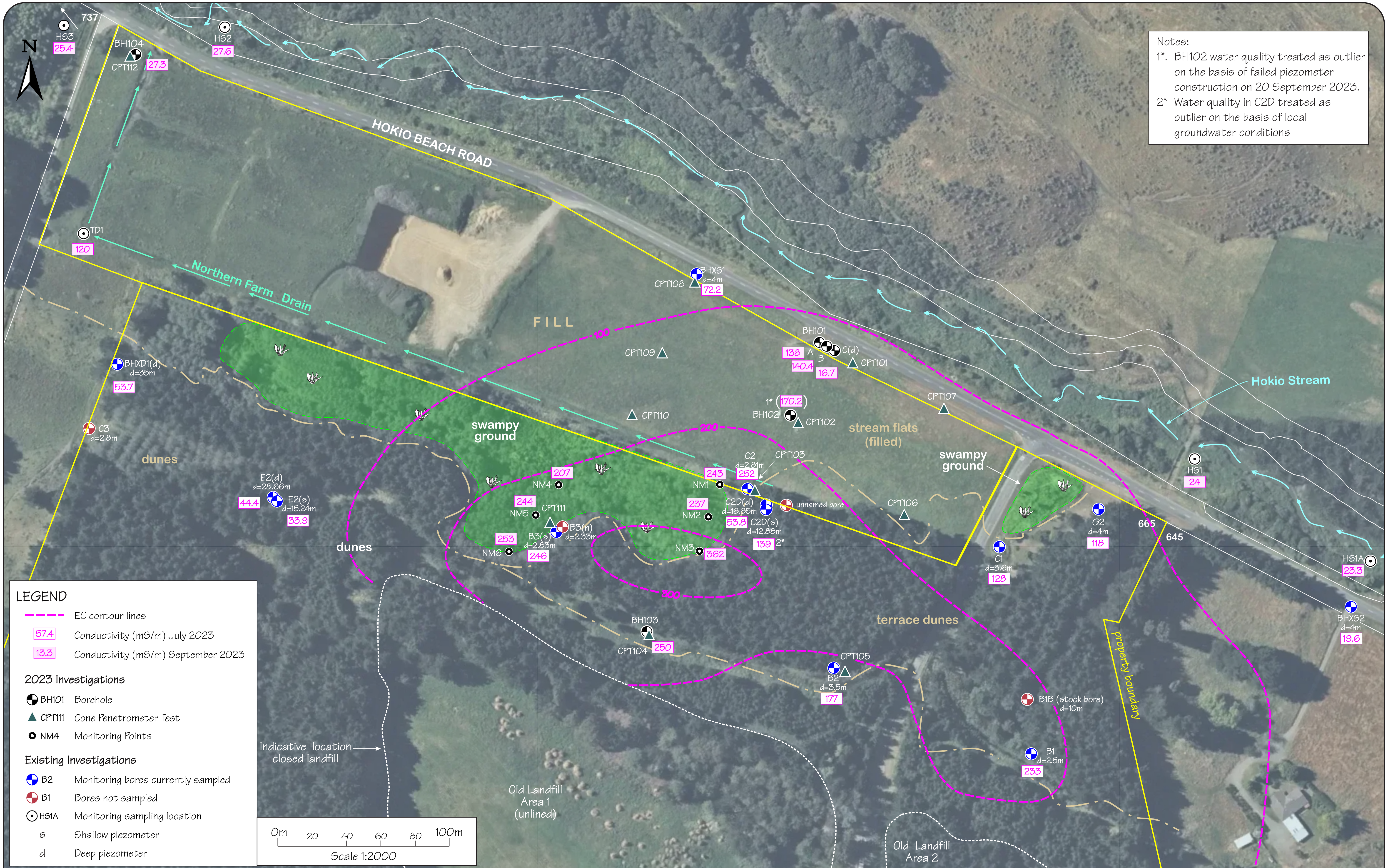
Date Stamp: 23.09.24

Scales: 1:2000 (A1) 1:4000 (A3)

Drawing No. 310101088-19-001-G001 Rev. F

26/08/2019 9:35 a.m.

pw:\\stantec-ap-pw.bentley.com:stantec-ap-pw-01\Documents\New Zealand Clients\Horowhenua District Council\80500724 (310101088) - Levin Landfill Volumes\2019\General\310101088-19-001-G001



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Note: All drawings are to be approved (initialled) before final issue.

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LEVIN LANDFILL, HOKIO BEACH ROAD, LEVIN

Horowhenua District Council

Electrical Conductivity Plume - September 2023

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	08-05-23	DRAFT FOR COMMENT	M.F	P.K	S.SW	
B	10-05-23	FOR FINAL REPORT R10009-1	M.F	P.K	S.SW	
C	31-10-23	FOR REPORT R10009-2	M.F	P.K	S.SW	

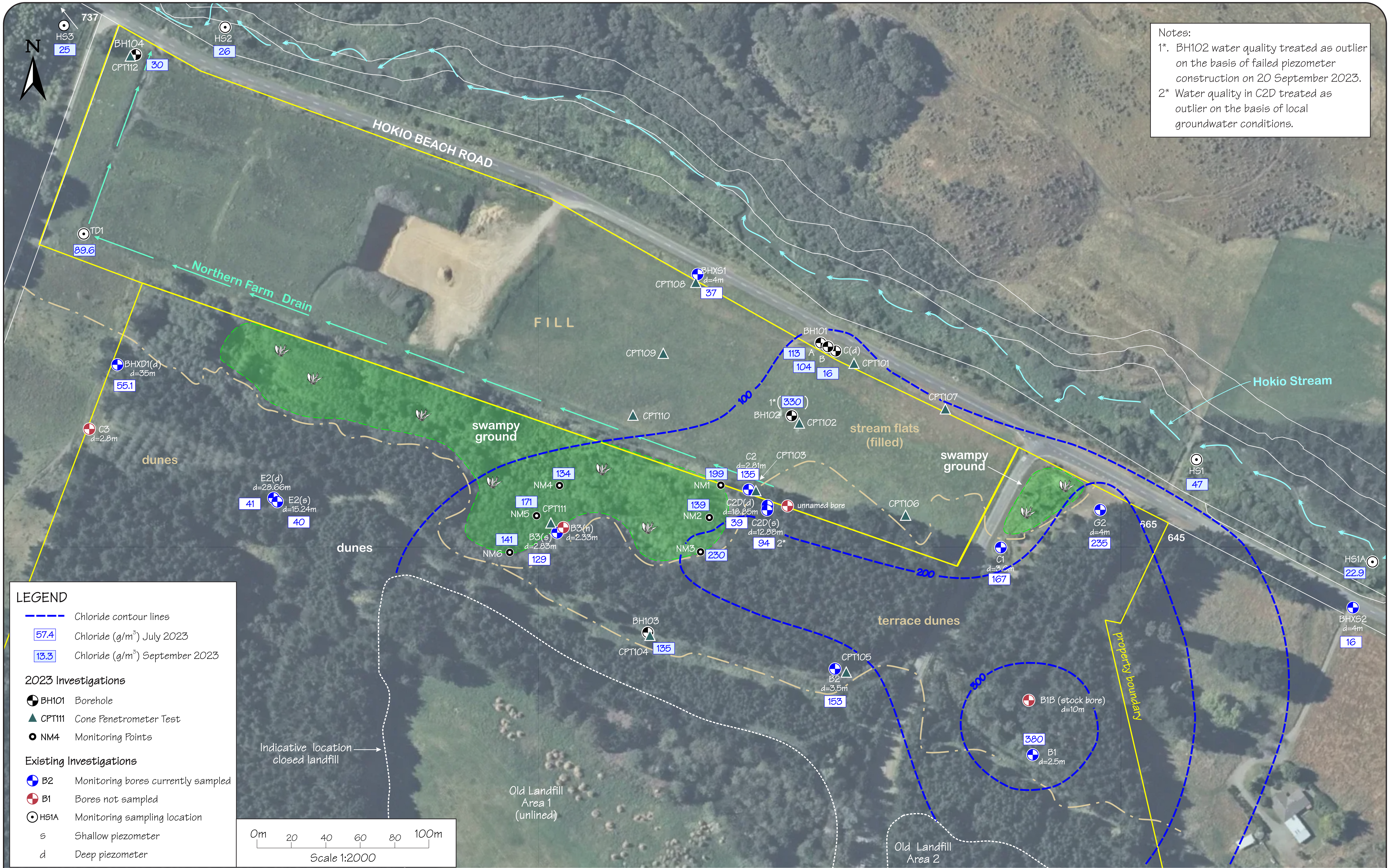
DRAWING NO.: FIG. 7

REF: 10009-R2

SCALE: 1:2000

CRS: NZTM

DATUM:



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LEVIN LANDFILL, HOKIO BEACH ROAD, LEVIN

Horowhenua District Council

Chloride Plume - September 2023

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	08-05-23	DRAFT FOR COMMENT	M.F	P.K	S.SW	
B	10-05-23	FOR FINAL REPORT R10009-1	M.F	P.K	S.SW	
C	31-10-23	FOR REPORT R10009-2	M.F	P.K	S.SW	

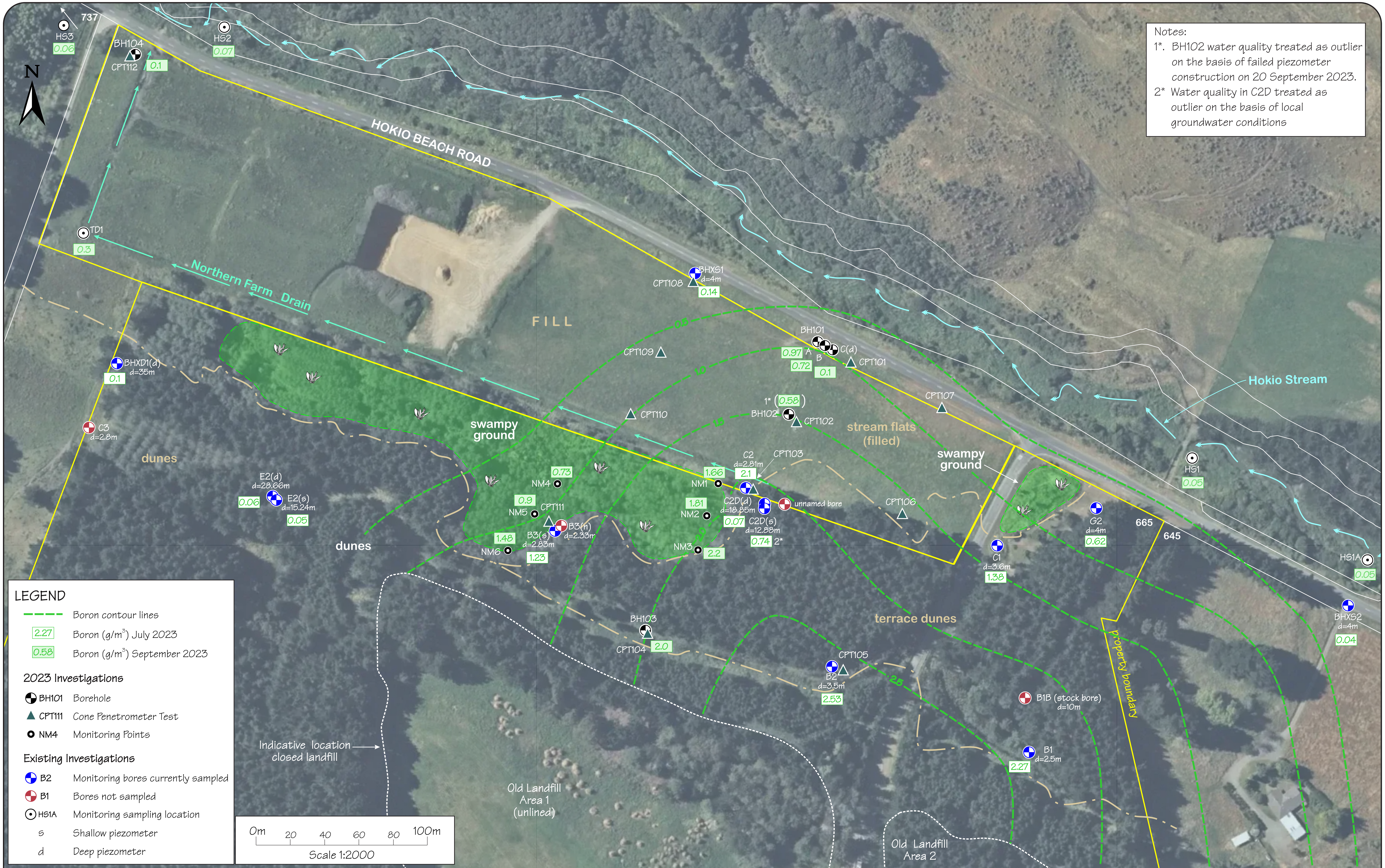
DRAWING NO.: FIG. 8

REF: 10009-R2

SCALE: 1:2000

CRS: NZTM

DATUM:



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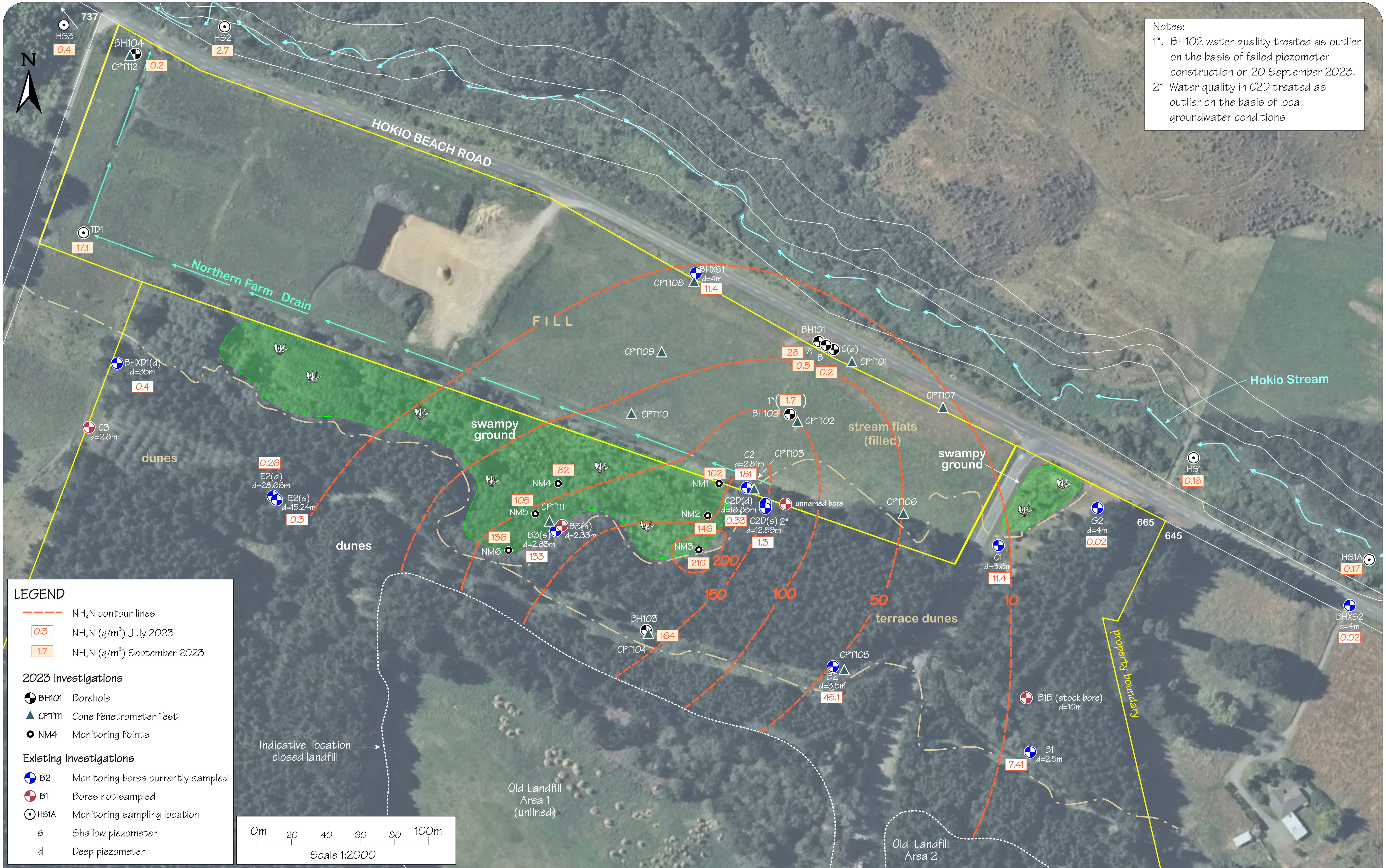
LEVIN LANDFILL, HOKIO BEACH ROAD, LEVIN

Horowhenua District Council

Boron Plume - September 2023

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	08-05-23	DRAFT FOR COMMENT	M.F	P.K	S.SW	
B	10-05-23	FOR FINAL REPORT R10009-1	M.F	P.K	S.SW	
C	26-10-23	FOR REPORT R10009-2	M.F	P.K	S.SW	

DRAWING NO.: FIG. 9
REF: 10009-R2
SCALE: 1:2000
CRS: NZTM
DATUM:



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Note: All drawings are to be approved (initialled) before final issue.

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LEVIN LANDFILL, HOKIO BEACH ROAD, LEVIN

Horowhenua District Council

Ammoniacal Nitrogen Plume - September 2023

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	08-05-23	DRAFT FOR COMMENT	M.F	P.K	S.SW	
B	10-05-23	FOR FINAL REPORT R10009-1	M.F	P.K	S.SW	
C	06-10-23	DRAFT FOR REPORT R10009-2	M.F	P.K	S.SW/C.M	
D	31-10-23	FOR REPORT R10009-2	M.F	P.K	S.SW/C.M	

DRAWING NO.: FIG. 10
REF: 10009-R2
SCALE: 1:2000
CRS: NZTM
DATUM:

Appendix D Number of samples per site

Determinants	B1	B2	B3	C1	C2	C2DD	C2DS	D1	D2	D3rs	D3rd	D4	D5	D6	E1S	E1D	E2S	E2D	F1	F2	F3	HS1A	HS1	HS2	HS3	Leachate Pond MH	G1S	G1D	G2S	TD1	XD1	XS1	XS2
Water level	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	12	12	12	12	0	3	3	3	12	3	3	3
pH	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	11	12	11	11	12	4	4	4	11	4	4	4
Suspended Solids	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	10	10	10	10	11	1	1	1	10	4	4	4
Phenol	1	1	1	1	1	1	1	1	1	3	3	1	1	1	1	1	1	1	1	1	1	10	11	10	10	5	1	1	1	10	3	3	3
VFA	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	10	1	1	1	11	4	4	4
TOC	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Alkalinity	1	3	3	1	3	3	3	1	1	4	4	1	1	1	1	1	1	1	1	1	1	12	12	12	12	11	1	1	1	12	4	4	4
Conductivity	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
COD	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
BOD (scBOD from Apr'20)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
Faecal C (*E.coli* from Apr'20)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
Chloride	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
Nitrate-N	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	11	12	11	11	12	4	4	4	11	4	4	4
Sulphate	1	3	3	1	3	3	3	1	1	4	4	1	1	1	1	1	1	1	1	1	1	12	12	12	12	11	1	1	1	12	4	4	4
Ammoniacal-N	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	11	12	11	11	12	4	4	4	11	4	4	4
Hardness	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Calcium	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Magnesium	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Potassium	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Sodium	1	1	1	1	1	1	1	1	4	4	4	4	1	1	4	4	4	1	1	1	4	11	12	11	11	11	4	1	1	11	4	4	4
D.R. Phosphorus	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	12	12	12	12	11	1	1	1	12	4	4	4
Aluminium	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	11	12	11	11	12	4	4	4	11	4	4	4
Arsenic	1	1	1	1	1	1	1	1	1	3	4	0	1	0	0	1	0	1	1	1	1	12	12	12	12	11	1	1	1	12	4	4	4
Boron	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	11	12	11	11	12	4	4	4	11	4	4	4
Cadmium	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Chromium	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Copper	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	11	12	11	11	11	1	1	1	11	4	4	4
Iron	1	1	1	1	1	1	1	1	4	4	4	4	1	1	4	4	4	1	1	1	4	12	12	12	12	11	4	1	1	12	4	4	4
Lead	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
Manganese	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
Mercury	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	12	12	12	12	12	4	4	4	12	4	4	4
Nickel	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	11	12	11	11	12	4	4	4	11	4	4	4
Zinc	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	12	12	12	12	11	1	1	1	12	4	4	4

Appendix E Tabulated analysis results

B1 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		1.1	1.96	1.06	1.325	1.06	0.8		0.05	0.94	0.8	0.79	0.7	0.96	1.08	0.77	1.19	1.205	1.21	0.863	1.96	1.00	1.39	1.14	0.875	1.01	1.33
pH		6 to 9	6.7	7.9	7	6.9	7	7.4	7	7.7		7.3	6.9	6.8	6.9	6.9	7	7.0		6.5	7.0	6.7	6.8	6.9	7.8	7.0	7.0	7.6
Suspended Solids	mg/l		9	250	178	178				5					18					*3*	*3*			*3*				*3*
Phenol	mg/L		0.025	0.18	0.005	*0.005*				*0.025*					*0.025*					*0.025*				*0.025*				*0.005*
VFA	mg/L		3.75	230	2.5	*2.5*				*2.5*					*2.5*					52.0				*2.5*				*2.5*
TOC	mg/L		27.6	185	27.6	27.6				24.3					31.2					30.1	13.0			22.8				17.2
Alkalinity	mg CaCO3/L		637.5	976	677	677				568	707				648					681	393			624				519
Conductivity	mS/m		240	484	233	217	233	238	233	238	247	224	203	187	214	194	161	185		241	174	168	203	276	167	123	119	190
COD	mg/L		92	694	109	145	271	73	59	45	90	131	43	87	114	85	77	92		118	63	90	87	60	69	87	58	102
BOD (scBOD frm Apr'20)	mg/L		3	88	0.5	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*3*	*3*	*3*	*3*	*3*	*3*	*1.5*	*3*		*3*	*0.5*	*0.5*	*0.5*	0.5				1.0
Faecal C (Ecoli frm Apr'20)	col/100ml	100	4	58000	50	*50*	*50*	*50*	*50*	*50*	*50*	26000	*2*	*50*	*2*	110	*2*	*2*		4	4	*2*	*2.0*	*2*	20	40	*2*	*2*
Chloride	mg/L		455	1200	318	286	350	126	380	386	399	397	330	297	323	292	216	263		4	291	264	354	506	283	139	118	297
Nitrate-N	mg/L	90.3	0.3	40.1	14.255	*0.005*	2.41	28.5	26.1	17.4		21.5	40.1	29.2	0.69	2.73	21.4	6.85		4.36	13.10	11.20	6.60	1.50	8.16	8.45	9.46	1.13
Sulphate	mg/L	1000	2.79	56	4.05	4.05				4.77					3.31					3.2	4.52			2.85				9.84
Ammonia-N	mg/L		37	126	11.5	29.1	15.3	7.7	7.41	6.39	9.08	4.33	5.43	4.27	8.41	8.72	6.29	10.1		14.3	8.580	7.6	12.4	16.80	9.79	7.10	7.79	18.1
Hardness	mg CaCO3/L		451	797	309	309				451					385					578	466.000			670				470
Calcium	mg/L	1000	87.5	160	54.7	54.7				82.1	82.3				74.1					112.0	85.000			122				90.8
Magnesium	mg/L		50.9	104	41.8	41.8				59.8					48.6					72.6	61.500			88.9				59.0
Potassium	mg/L		49	67	41.7	41.7				21.3					20.3					25.6	17.100			29.9				23.3
Sodium	mg/L		297.5	500	250	250				304					283					216	132.000			257	132	121	111	145
D.R. Phosphorus	mg/L		0.1045	1.53	0.112	0.112				0.095	0.117				0.109					0.115	0.099			0.105				0.104
Aluminium	mg/L	5	0.0165	14.7	0.016	0.021	0.139	0.011	0.008	0.007	0.011	0.02	0.009	0.017	0.012	0.007	0.005	0.007		0.005	0.004	0.005	0.004	0.005	0.004	0.004	0.007	0.004
Arsenic	mg/L	0.5	0.002	0.024	0.001	0.001				0.001	0.001				0.001					0.001	*0.0005*			0.001				*0.0005*
Boron	mg/L	5	1.3	2.91	1.94	2.38	1.61	1.61	2.27	1.84	2.08	1.55	1.16	1.15	1.72	1.34	0.93	1.38		1.47	0.830	0.69	1.07	1.20	0.53	0.56	0.64	0.89
Cadmium	mg/L	0.01	0.00018	0.01	0.0001	*0.0001*				*0.0001*	*0.0001*				*0.0001*					*0.0001*	*0.0001*			*0.0001*				0.0003
Chromium	mg/L	1	0.002	0.18	0.002	0.002				0.001	0.002				0.002					0.001	*0.0005*			*0.0005*				*0.0005*
Copper	mg/L	0.4	0.01525	0.091	0.0276	0.0276				0.0124	0.0176				0.0185					0.0116	0.0046			0.0094				0.0058
Iron	mg/L		0.6	45.8	0.08	0.08				0.055	0.075				0.102					0.047	0.056			0.032	0.02	0.01	0.02	0.047
Lead	mg/L	0.1	0.00075	0.639	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L		9.45	26	4.64	4.78	3.61	4.5	5.61	4.8		5.24	5.36	5.09	5.64	6.95	6.97	8.53		12.6	9.070	9.84	10.7	17.50	8.56	5.97	6.23	11.0
Mercury	mg/L		0.00025	0.0005	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		0.00050	*0.00025*	*0.00025*	*0.00025*	*0.00025*				
Nickel	mg/L	1	0.0057	0.07	0.0058	0.0077	0.0067	0.0042	0.0049	0.0048		0.0044	0.0026	0.0023	0.0062	0.0046	0.0021	0.0041		0.0056	0.0023	0.0019	0.0028	0.0045	0.0019	0.0010	0.0013	0.0033
Zinc	mg/L	20	0.017	0.181	0.02	0.02				0.006					0.046					0.006	0.007			0.005				0.007

B2	Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		1.37	1.96	1.23	1.61	1.23	1.06		0.7	1.17	0.95	1.07	0.92	1.14	1.25	0.98	1.49	1.38	1.38	1.07	1.32	1.13	1.65	1.45	1.21	1.44	1.61
pH		6 to 9	6.9	8	7	6.8	6.8	7.4	7	7.2		7.3	6.7	6.7	6.9	7	7.1	6.9		6.7	7.1	6.6	6.6	6.9	7.1	6.6	6.7	7.2
Suspended Solids	mg/l		20	297	201	201				7					20					29	*3*			9				*3*
Phenol	mg/L		0.025	0.04	0.005	*0.005*				*0.025*					*0.025*					*0.025*				*0.025*				*0.025*
VFA	mg/L		6	246	2.5	*2.5*				*2.5*					*2.5*					*2.5*				*2.5*				6
TOC	mg/L		40.9	254	45.3	45.3				29.5					32					36.4	28.4			31.7				25.6
Alkalinity	mg CaCO3/L		771	1350	900	1180	1020	780		553	653				683					783	516			723				688
Conductivity	mS/m		280	728	198	265	236	198	177	198	250	163	137	141	258	179	205	185		218	161	223	250	209	176	189	135	186
COD	mg/L		148	516	94	102	132	87	94	105	92	84	45	99	108	82	101	98		111	91	115	76	81	84	78	50	112
BOD (scBOD frm Apr'20)	mg/L		3	37	0.5	1	*0.5*	*0.5*	*0.5*	*0.5*	*3*	*3*	*3*	*3*	*3*	*3*	*1.5*	*3*		*3*	*0.5*	*0.5*	5.9	*0.5*				*1.5*
Faecal C (Ecoli frm Apr'20)	col/100ml	100	5	6000	50	*50*	*50*	*50*	*50*	*50*	100	6000	130	*50*	*2*	160	1700	*2*		*2*	44	8	*2.0*	*2*	4	28	48	*2*
Chloride	mg/L		264	1910	153	173	157	65.1	153	194	195	88.3	76	97.0	167	79.3	107	122		134	88.1	126	134	141	94.7	123	87.2	125
Nitrate-N	mg/L	90.3	10.08	213	8.21	0.25	1.23	8.79	8.21	32.1		36.2	20.9	62.8	108	33.7	54.8	27.3		17.00	37.60	94.40	133.00	21.8	44.2	34.7	30.4	4.03
Sulphate	mg/L	1000	8.68	182	12.78	19.8	8.56	17		17.6					8.99					3.22	13.0			8.85				19.6
Ammonia-N	mg/L		87.4	450	72.1	90.6	87.4	72.1	45.1	102	79.2	57.4	34.4	16.9	67.6	46.1	25.8	33.5		77.5	28.4	42.7	30.7	51.6	43.8	45.5	21.4	55.2
Hardness	mg CaCO3/L		514.5	1010	529	529				463					675					538	427			546				410
Calcium	mg/L	1000	117	239	128	128				117	134				146					122.0	93.6			117				90.6
Magnesium	mg/L		51	99.3	50.9	50.9				41.5					75.3					56.3	46.9			61.6				44.6
Potassium	mg/L		84.45	174	126	126				70.9					67.7					61.4	41.7			57.6				56.9
Sodium	mg/L		214	818	105	105				104					124					105	119			115.0	99.6	103	85.0	132
D.R. Phosphorus	mg/L		0.0355	0.41	0.018	0.018				0.013	0.012				0.016					0.025	0.041			0.021				0.029
Aluminium	mg/L	5	0.0455	8.86	0.008	0.010	0.007	0.008	0.018	0.007	0.007	0.065	0.027	0.013	0.008	0.012	0.033	0.011		0.004	0.020	0.014	0.011	0.009	0.011	0.011	0.017	0.012
Arsenic	mg/L	0.5	0.005	0.086	0.004	0.004				0.001	0.002				0.002					0.004	0.001			0.006				0.003
Boron	mg/L	5	2.37	4.63	2.18	2.26	1.97	2.18	2.53	2.05	2.36	2.16	1.25	0.98	2.33	2.18	1.87	1.67		2.37	1.77	1.69	1.65	1.69	1.02	1.37	0.92	1.20
Cadmium	mg/L	0.01	0.0001	0.01	0.0001	*0.0001*				*0.0001*	*0.0001*				*0.0001*					*0.0001*	*0.0001*			*0.0001*				*0.0001*
Chromium	mg/L	1	0.00435	0.23	0.001	0.001				0.001	0.001				*0.0005*					0.001	*0.0005*			0.001				0.001
Copper	mg/L	0.4	0.0052	0.0865	0.005	0.0050				0.0035	0.0028				0.0041					0.0025	0.0039			0.0031				0.0018
Iron	mg/L		0.722	18.1	0.11	0.11				0.306	0.248				0.187					0.315	0.083			0.722	1.34	0.14	0.04	0.264
Lead	mg/L	0.1	0.00025	0.025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		0.0012	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L		5.6	252	3.45	6.48	3.45	2.81	3.47	3.56		1.63	1.68	1.88	5.22	3.44	4.33	2.47		3.16	2.41	5.02	4.8	4.33	3.43	3.14	2.27	2.72
Mercury	mg/L		0.00025	0.00025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*				
Nickel	mg/L	1	0.0072	0.085	0.0029	0.0034	0.003	0.0022	0.0029	0.0024		0.0025	0.0019	0.0012	0.0027	0.0029	0.0026	0.0027		0.0031	0.0022	0.0026	0.0026	0.0030	0.0021	0.0018	0.0010	0.0018
Zinc	mg/L	20	0.012	0.095	0.012	0.012				0.003					0.017					0.003	0.008			0.004				0.003

B3 (B3s) Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		0.15	0.5	0.23	0.23	0.23	0		0.05	0.23	0.05	0.1	0	0	0	0	0.26	0.135	0.14	0.00	0.15	0.15	0.15	0.1	0.135	0.21	0.27
pH		6 to 9	6.9	8.1	7	7	7	7.3	7	7		7.8	7	7.1	7	7.1	7.3	7.5		7.1	7.2	7.0	7.0	7.1	7.0	6.9	7.1	7.0
Suspended Solids	mg/l		101	645	454	454				84					88					81	81			74				111
Phenol	mg/L		0.0225	0.07	0.005	*0.005*				*0.025*					*0.025*					*0.025*				*0.025*				*0.025*
VFA	mg/L		7.5	117	2.5	*2.5*				*2.5*					*2.5*					*2.5*				2.5				6
TOC	mg/L		55.1	113	69.1	69.1				54.1					55.1					61.6	53.0			70.6				72.7
Alkalinity	mg CaCO3/L		1055	1490	1250	1310	1250	1110		997	1040				1070					1070	919			1180				1290
Conductivity	mS/m		229	371	263	280	285	243	246	251	244	182	229	214	270	231	242	254		265	246	261	291	288	254	270	294	324
COD	mg/L		130	699	141	411	129	144	138	129	133	208	40	129	186	131	215	369		100	150	211	198	213	150	119	221	624
BOD (scBOD frm Apr'20)	mg/L		3	112	1	2	1	*0.5*	1	2	*3*	*3*	21	*3*	*3*	*3*	*3*	*3*		*3*	7.0	*0.5*	*3*	*3*				*3*
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	2800	50	*50*	*50*	*50*	*50*	*50*	*50*	100	*2*	*2*	*50*	96	*50*	*2*		68	*0.5*	*2*	*2.0*	*2*	*2*	*2*	*2*	*2*
Chloride	mg/L		179	450	124	119	138	65.1	129	139	135	105	132	109	174	122	114	154		166	159	159	162	194	172	177	179	213
Nitrate-N	mg/L	90.3	0.2	140	0.05	*0.05*	*0.05*	*0.005*	*0.05*	0.37		0.39	0.35	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*		*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	0.02	*0.05*	*0.05*	*0.050*
Sulphate	mg/L	1000	2.46	53	0.01	0.21	*0.01*	*0.01*		0.15					0.11					0.04	*0.01*			*0.01*				*0.01*
Ammonia-N	mg/L		109	235	146	184	159	121	133	116	127	72.7	104	145	183	166	173	174		177.0	159.0	169.0	177.0	143	140	141	170	170
Hardness	mg CaCO3/L		307	747	307	307				487					280					300	229			509				517
Calcium	mg/L	1000	62.3	158	54.7	54.7				82.7	69.1				52.8					58.5	45.0			89.7				105.0
Magnesium	mg/L		39.9	90.8	41.3	41.3				68.1					35.9					37.2	28.2			69.2				61.8
Potassium	mg/L		62.6	135	109	109				83					120					104.0	107.0			91.5				109
Sodium	mg/L		141	535	100	100				120					138					127	122			152	129	141	157	170
D.R. Phosphorus	mg/L		0.182	0.8	0.026	0.026				0.03	0.022				0.032					0.034	0.031			0.031				0.043
Aluminium	mg/L	5	0.0085	4.25	0.0055	0.006	0.005	0.007	0.005	0.004	0.006	0.003	0.005	0.004	0.005	0.005	0.004	0.005		0.005	0.006	0.006	0.006	0.007	0.005	0.003	0.003	0.007
Arsenic	mg/L	0.5	0.028	0.407	0.028	0.028				0.016	0.021				0.024					0.022	0.031			0.035				0.020
Boron	mg/L	5	1	2.11	1.41	1.59	1.63	1	1.23	1.01	0.98	0.74	1.11	0.9	1.17	0.97	1.24	1.23		1.00	1.11	1.18	1.35	1.40	0.80	1.17	1.40	1.38
Cadmium	mg/L	0.01	0.00013	0.01	0.0003	0.0003				*0.0001*	*0.0001*				*0.0001*					*0.0001*	*0.0001*			*0.0001*				*0.0001*
Chromium	mg/L	1	0.006	0.04	0.004	0.004				0.004	0.003				0.004					0.004	0.004			0.005				0.005
Copper	mg/L	0.4	0.0462	0.194	0.0491	0.0491				0.0021	0.0152				0.0025					0.0091	0.0009			0.0007				0.0027
Iron	mg/L		1.625	46.8	0.36	0.36				0.86	0.518				0.539					0.393	0.853			1.03	1.40	0.74	0.34	1.37
Lead	mg/L	0.1	0.00025	0.025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L		4.97	18	3.42	3.97	2.96	3.22	3.62	3.57		2.85	1.73	2.41	3.48	2.73	2.62	2.59		2.65	2.52	3.05	3.4	4.84	3.86	3.39	3.83	3.94
Mercury	mg/L		0.00025	0.00025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*				
Nickel	mg/L	1	0.0084	0.024	0.0085	0.009	0.0075	0.0081	0.0089	0.0086		0.0066	0.0108	0.0075	0.0093	0.0075	0.0085	0.0091		0.0098	0.0072	0.0090	0.0118	0.0136	0.0106	0.0085	0.0101	0.0117
Zinc	mg/L	20	0.01	0.192	0.006	0.006				*0.001*					0.006					*0.001*	0.002			*0.001*				0.003

C1 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		0.26	3.6	0.62	1.35	0.62	0.5		0.84	0.64	0.00	0.22	0.00	0.00	0.26	0.40	0.40	0.00	0.020	0.10	0.55	0.31	3.6	0.20	0.22
pH		6 to 9	6.5	7.9	6.95	6.8	7	7.2	6.9	7		6.6	6.8	6.8	7.5	7.0		6.7	6.8	6.600	6.7	6.7	7.0	6.6	6.6	6.8
Suspended Solids	mg/l		112	517	43	43				517			148					122	395			40				21
Phenol	mg/L		0.025	0.03	0.005	*0.005*				*0.03*			*0.025*					*0.025*				*0.025*				*0.025*
VFA	mg/L		5.5	127	2.5	*2.5*				*2.5*			*2.5*					*2.5*				*2.5*				*2.5*
TOC	mg/L		14.6	23.6	21.8	21.8				23.6			22.8					17.2	14.4			16.6				13.8
Alkalinity	mg CaCO3/L		269.5	415	380	380				352	353		258					281	287			249				262
Conductivity	mS/m		58	177	127	120	126	141	128	119	119	20.7	101	102	113	99.9		107	114	146.000	132	127	143	127	145	116
COD	mg/L		52.5	310	89.5	88	126	91	74	85	73	73	85	82	74	43		56	285	81.000	54	54	76	85	70	45
BOD (scBOD frm Apr'20)	mg/L		2.2	6.6	0.5	*0.5*	*0.5*	*0.5*	*1.5*	*3*	*3*	*3*	*3*	*3.0*	*3.0*	*3.0*		*3.0*	*3.0*	*0.500*	*0.5*	1				*1.5*
Faecal C (Ecoli frm Apr'20)	col/100ml	100	3.5	976	50	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*44*	*40*	2	2		*2*	*0.5*	*2.000*	*2.0*	2	2	*2.0*	*2*	*2*
Chloride	mg/L		99	380	145.5	137	154	85.5	167	147.00	155	25.4	146	108	152	128		129	181	283.000	237	217	252	244	283	193
Nitrate-N	mg/L	90.3	0.05	190	0.0275	0.07	*0.05*	*0.005*	*0.005*	*0.005*		0.02	0.06	*0.005*	0.04	*0.05*		*0.05*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.05*	*0.005*
Sulphate	mg/L	1000	13.6	37.2	26.4	26.4				22.10			37.2					31.1	30.9			32.6				18.7
Ammonia-N	mg/L		0.46	27.4	12.55	13.5	15	11.6	11.4	11.6	11.4	0.33	4.66	27.4	1.42	1.97		7.82	10.8	5.640	6.52	2.91	0.41	0.41	0.76	0.59
Hardness	mg CaCO3/L		218	335	180	180				233			209					231	232			306				261
Calcium	mg/L	1000	38.45	59.7	33.5	33.5				44.30	44.6		36.8					43.7	44.3			52.2				49.4
Magnesium	mg/L		28.8	46.3	23.4	23.4				29.70			28.4					29.5	29.5			42.6				33.4
Potassium	mg/L		23	140	26.5	26.5				25.8			17.7					20.6	23.5			16.70				9.88
Sodium	mg/L		53.4	305	129	129				120.00			94					95	112			122	157	151	137	119
D.R. Phosphorus	mg/L		0.0165	0.23	0.014	0.014				0.01	0.01		0.011					0.015	0.013			0.011				0.016
Aluminium	mg/L	5	0.0245	12.1	0.022	0.023	0.019	0.021	0.038	0.02	0.03	0.076	0.038	0.019	0.009	0.013		0.012	0.008	0.018	0.007	0.009	0.005	0.006	0.010	0.005
Arsenic	mg/L	0.5	0.0032	0.036	0.001	0.001				0.001	0.001		0.002					0.001	0.004			*0.0005*				*0.0005*
Boron	mg/L	5	0.175	1.38	0.88	0.87	0.89	0.87	1.38	1.02	0.99	0.07	0.95	1.17	0.89	0.84		0.64	0.74	0.720	0.69	0.57	0.47	0.62	0.69	0.45
Cadmium	mg/L	0.01	0.0001	0.091	0.0001	*0.0001*				*0.0001*	*0.0001*		*0.0001*					*0.00010*	*0.00010*			*0.0001*				*0.0001*
Chromium	mg/L	1	0.002	0.2	0.0005	*0.0005*				*0.0005*	*0.0005*		*0.0005*					*0.0005*	*0.0005*			*0.0005*				*0.0005*
Copper	mg/L	0.4	0.00555	0.0301	0.0011	0.0011				0.0028	0.0046		0.0055					0.0008	0.00025			0.0008				0.0012
Iron	mg/L		9.2	191	1.74	1.74				0.41	0.57		0.454					1.65	0.711			2.53	3.35	0.78	3.49	0.577
Lead	mg/L	0.1	0.0006	0.17	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		0.00060	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L		0.356	11.2	0.2655	0.257	0.274	0.24	0.377	0.307		0.0623	0.272	0.397	0.244	0.279		0.350	0.3540	0.471	0.4	0.410	0.323	0.197	0.419	0.328
Mercury	mg/L		0.00025	0.00025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*				
Nickel	mg/L	1	0.0012	0.085	0.0012	0.0011	0.0012	0.0014	0.0012	0.001		0.0007	0.0011	0.0018	0.0009	0.0009		0.0008	0.0008	0.0009	0.0009	0.0012	0.0009	0.0006	0.0007	0.0008
Zinc	mg/L	20	0.007	0.114	0.006	0.006				*0.001*			0.004					*0.001*	0.001			*0.001*				0.003

C2 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		0.44	2.84	0.32	0.49	0.32	0.15		0.3	0.2	0.4	0.355	0	0.23	0	0	0.32	0.32	0.32	0.00	0.220	0.20	0.47	0.42	0.245	0.36	0.44
pH		6 to 9	6.8	7.8	6.95	6.9	6.9	7.2	7	7.2		7.7	7	6.9		7.1	7.2	7.3		7.0	7.4	6.900	6.9	7.2	6.9	7.0	7.1	7.1
Suspended Solids	mg/l		385.5	2150	173	173				84										111	332			516				21
Phenol	mg/L		0.025	0.025	0.005	*0.005*				*0.025*										*0.025*				*0.025*				*0.025*
VFA	mg/L		9	315	2.5	*2.5*				*2.5*										*2.5*				*2.5*				*2.5*
TOC	mg/L		45.4	181	48.8	48.8				41.2										45.2	39.0			45.6				47.2
Alkalinity	mg CaCO3/L		899	1300	1200	1300	1030	1200		669	1140									871	899			818				968
Conductivity	mS/m		190	414	264	292	245	276	252	251	279	284	258	234		243	238	228		263	250	239.000	245	346	372	298.0	242	296
COD	mg/L		105	1335	152	43	195	429	109	107	133	63	55	116		196	135	132		175	135	129.000	105	127	157	113	141	472
BOD (scBOD frm Apr'20)	mg/L		3	30	1.25	1	*1.5*	*0.5*	*1.5*	2	*3*	*3*	*3*	*3*		5.9	*3*	*3*		*3*	22.0	*0.500*	5.9	*3*				*3*
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2.5	6000	50	*50*	*50*	*50*	*50*	*50*	6000	1400	*2*	100		260	300	*2*		4	*1*	*2.000*	*2.0*	*ND*	8	4	3900	1070
Chloride	mg/L		307	618	137	160	139	72.4	135	151	171	207	152	130		187	126	127		215	201	161.000	212	492	524	368	170	292
Nitrate-N	mg/L	90.3	0.05	190	0.05	*0.05*	0.39	*0.005*	*0.05*	*0.05*		*0.05*	*0.05*	*0.05*		0	*0.05*	*0.05*		0.19	*0.05*	*0.050*	*0.05*	0.08	*0.005*	*0.05*	*0.05*	*0.05*
Sulphate	mg/L	1000	3.395	51	0.19	0.19	1.3	*0.01*		0.39										6.58	4.42			42.3				11.4
Ammonia-N	mg/L		14.8	186	181.5	185	151	182	181	171	166	170	162	165		165	165	149		149.0	156.0	145.000	140.0	169	181	157	124	141
Hardness	mg CaCO3/L		320	553	282	282				240										227	223			277				236
Calcium	mg/L	1000	63.1	121	51.3	51.3				48.7	58.2									47.6	46.9			54.7				51.4
Magnesium	mg/L		38.5	60.5	37.3	37.3				28.7										26.3	25.6			34.0				26.0
Potassium	mg/L		25.7	115	82.2	82.2				70.8										84.8	83.4			91.5				78.3
Sodium	mg/L		258	430	136	136				128										189	166			291	256	206	183	262
D.R. Phosphorus	mg/L		0.0235	100	0.013	0.013				0.018	0.011									0.016	0.026			0.013				0.024
Aluminium	mg/L	5	0.018	23.7	0.0195	0.019	0.018	0.02	0.02	0.011	0.018	0.018	0.022	0.021		0.017	0.023	0.018		0.018	0.016	0.015	0.014	0.041	0.024	0.007	0.018	0.013
Arsenic	mg/L	0.5	0.002	0.015	0.002	0.002				0.001	0.002									0.002	0.002			0.002				0.002
Boron	mg/L	5	0.86	2.24	1.645	1.72	1.57	1.49	2.1	1.54	1.63	2.09	1.55	1.37		1.45	1.49	1.66		2.05	1.69	1.430	1.81	2.24	1.64	1.85	1.81	2.17
Cadmium	mg/L	0.01	0.0001	0.01	0.0001	*0.0001*				*0.0001*	*0.0001*									*0.0001*	*0.0001*			*0.0001*				*0.0001*
Chromium	mg/L	1	0.003	1.7	0.002	0.002				0.002	0.002									0.002	0.002			0.002				0.002
Copper	mg/L	0.4	0.0052	0.095	0.0023	0.0023				0.0019	0.0006									0.0006	0.0006			0.0017				0.0005
Iron	mg/L		12.5	45.4	0.48	0.48				0.636	0.901									0.719	1.95			0.158	0.48	0.63	2.48	0.994
Lead	mg/L	0.1	0.00025	0.046	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	0.0006		0.0004	0.0008	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L		0.426	4.94	0.1495	0.127	0.317	0.143	0.156	0.187		0.219	0.24	0.0934		0.0832	0.0554	0.0411		0.0531	0.0516	0.04280	0.0402	0.0650	0.0820	0.0512	0.0524	0.0558
Mercury	mg/L		0.00025	0.0004	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*		0.0004	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*				
Nickel	mg/L	1	0.005	0.62	0.0045	0.0063	0.0045	0.0045	0.004	0.0039		0.0054	0.0052	0.0039		0.0043	0.0049	0.0043		0.0053	0.0035	0.0039	0.0041	0.0017	0.0052	0.0033	0.0049	0.0060
Zinc	mg/L	20	0.014	0.154	0.022	0.022				0.009										0.003	0.010			0.009				0.002

C2DD	Monitoring Bore HDC Levin Landfill (Deep)

Determinand		NZDW MAV	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		2.68	3.73	2.75	2.975	2.75	2.58		2.3	2.58	2.6	2.63	2.45	2.65	2.37	2.42	2.56	2.79	2.79	2.455	2.3800	3.73	3.07	2.59	2.39	2.26	2.69
pH		7 to 8.5*	7.4	8.6	7.55	7.3	7.5	7.7	7.6	7.5		7.9	7.5	7.7	7.6	7.6	7.6	7.6		7.3	7.6	7.4000	7.6	7.7	8.0	7.4	7.4	7.4
Suspended Solids	mg/l		18.5	980	7	7				275					115					187	565			*3*				27
Phenol	mg/L		0.01	0.09	0.005	*0.005*				*0.025*					*0.025*					*0.025*				*0.025*				*0.025*
VFA	mg/L		25	25	2.5	*2.5*				*2.5*					*2.5*					*2.5*				*2.5*				*2.5*
TOC	mg/L		4.25	7.5	5.5	5.5				6.8					4.8					5.5	4.0			4.2				3.9
Alkalinity	mg CaCO3/L		214	272	241	241	224	272		214	217				226					200	221			194				186
Conductivity	mS/m		50.75	201	57.45	59.3	55.6	65.1	53.8	53.7	55.3	57.4	57.3	57.2	57	53	55.8	55.3		55.5	54.4	53.3000	52.9	52.5	55.2	51.6	52.3	50.6
COD	mg/L		10	83	23	20	26	37	*7.5*	20	*7.5*	33	*7.5*	33	*7.5*	16	28	18		26	*7.5*	34.0000	*7.5*	*7.5*	*7.5*	7.5	*7.5*	*7.5*
BOD (scBOD frm Apr'20)	mg/L		1.5	24	0.5	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*1.5*	*1.5*	*1.5*	*1.5*	*0.5*	*3*	2.9	*3*		*1.5*	*1.5*	0.5000	*0.5*	*0.5*				*0.5*
Faecal C (Ecoli frm Apr'20)	col/100ml	NIL	2	50	0.5	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*50*	*50*	*2*	*50*	2	46	3.9	*2*		*2*	*2*	*2*	*2*	*2*	*2*	2.0	*2*	*2*
Chloride	mg/L	250*	39	274	41.7	43.8	39.6	47.2	39.4	39.6	40.3	42.1	41.8	41.8	41.8	40.2	28.1	42.3		41.3	46	38.8000	40	40.5	41.0	38.2	38.2	37.7
Nitrate-N	mg/L	11.3	0.1	9.87	0.0075	*0.005*	0.1	0.01	*0.005*	*0.005*		*0.005*	0.01	*0.005*	*0.005*	0.35	0	*0.005*		*0.005*	*0.005*	*0.0050*	2.60	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Sulphate	mg/L	250*	0.07	1	0.01	0.08	*0.01*	*0.01*		0.11					0.02					0.04	*0.01*			0.03				0.02
Ammonia-N	mg/L	1.17	0.27	42	0.33	0.35	0.25	0.33	0.33	0.26	0.34	0.3	0.33	0.35	0.33	*0.005*	0.33	0.35		0.31	0.33	0.3200	0.3	0.33	0.33	0.32	0.33	0.37
Hardness	mg CaCO3/L	200*	167	213	197	197				181					186					166	166			168				161
Calcium	mg/L		43	58	46.6	46.6				45.3	46.6				47.8					42.6	42.1			43.8				41.5
Magnesium	mg/L		14.55	19.7	19.7	19.7				16.6					16.2					14.4	14.7			14.3				13.9
Potassium	mg/L		6.3	9.7	7.21	7.21				7.35					7.87					7.57	7.1			6.32				5.54
Sodium	mg/L	200*	40	182	51.5	51.5				41.1					40.5					39.1	39.4			39.4	39.4	15.3	26.5	37.5
D.R. Phosphorus	mg/L		0.61	0.8	0.663	0.663				0.629	0.667				0.662					0.617	0.641			0.667				0.660
Aluminium	mg/L	0.1*	0.006	1.2	0.0095	0.012	0.007	*0.001*	0.012	0.011	*0.001*	0.01	0.005	0.006	0.003	0.002	0.003	*0.001*		*0.001*	0.003	0.0230	*0.001*	*0.001*	*0.001*	*0.001*	0.006	0.002
Arsenic	mg/L	0.01	0.004	0.014	0.004	0.004				0.004	0.004				0.004					0.004	0.004			0.003				0.003
Boron	mg/L	1.4	0.065	0.71	0.08	0.1	0.07	0.09	0.07	0.09	0.08	0.05	0.05	0.06	0.06	0.07	0.07	0.07		0.06	0.07	0.0600	0.06	0.07	0.07	0.06	0.05	0.06
Cadmium	mg/L	0.004	0.0001	0.0005	0.0001	*0.0001*				*0.0001*	*0.0001*				*0.0001*					*0.0001*	*0.0001*			*0.0001*				*0.0001*
Chromium	mg/L	0.05	0.0005	0.014	0.002	0.002				*0.0005*	*0.0005*				*0.0005*					*0.0005*	*0.0005*			*0.0005*				*0.0005*
Copper	mg/L	2	0.0019	0.012	0.0014	0.0014				0.0013	*0.00025*				0.0006					*0.00025*	*0.00025*			*0.00025*				*0.00025*
Iron	mg/L	0.2*	0.13	5.8	0.13	0.13				0.046	0.013				0.022					0.016	0.031			0.02	0.04	0.02	0.01	0.016
Lead	mg/L	0.01	0.00025	0.017	0.00025	*0.00025*	0.0005	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	0.0005	0.0004	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L	0.4	0.551	2.77	0.689	0.65	0.553	0.741	0.728	0.685		0.642	0.592	0.628	0.735	0.0159	0.604	0.641		0.742	0.662	0.6270	0.6	0.583	0.701	0.624	0.488	0.533
Mercury	mg/L		0.00025	0.0004	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	0.0004	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*				
Nickel	mg/L	0.08	0.0005	0.021	0.00075	0.0008	0.0012	0.0007	*0.00025*	*0.00025*		0.0005	*0.00025*	0.0007	*0.00025*	*0.00025*	0.0004	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Zinc	mg/L	1.5*	0.016	0.116	0.009	0.009				0.005					0.004					0.004	*0.001*			*0.001*				*0.001*

C2DS Monitoring Bore HDC Levin Landfill (shallow)

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Aug-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		2.76	270	2.95	2.95	270	2.65		2.3	2.73	2.6	2.61	2.13	2.13	2.72	2.53	2.53	2.3	2.88	2.88	2.547	2.12	3.69	2.43	2.3	2.12	2.51	2.435
pH		6 to 9	6.8	8.3	6.85	6.7	6.6	7.3	7	7.2		8	6.7		6.7	6.8	6.9	7.4	7.2		6.8	7.1	6.8	6.8	7.0	6.7	6.7	6.7	7.0
Suspended Solids	mg/l		118	291	118	118				116						145					95	102			52				104
Phenol	mg/L		0.025	0.06	0.005	0.005				0.025						0.025					0.025				0.025				0.025
VFA	mg/L		7	250	2.5	2.5				2.5						2.5					2.5				2.5				2.5
TOC	mg/L		29.3	192	31	31				26.8						23.8					26.2	24.7			32.0				28.8
Alkalinity	mg CaCO3/L		738.5	1000	684	918	684	556		635	497					629					464	531			716				662
Conductivity	mS/m		168.5	246	149.5	193	160	127	139	158	115	103	124		147	138	153	104	105		117	137	150	163	170	182	170	178	157
COD	mg/L		80	150	68	73	122	63	62	78	65	42	55		72	74	60	65	89		82	105	106	94	89	97	82	100	73
BOD (scBOD frm Apr'20)	mg/L		2.8	7	0.75	1	0.5	0.5	1.5	6	3	3	3		3	3	<6	3	3		3.0	3.0	1.0	0.5	3				3
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	100	50	50	50	50	50	50	100	50	2		50	2	4	50	2		2	2	2	2.0	2	2	2	2	2
Chloride	mg/L		183.5	520	99.8	110	106	56.4	93.6	97.1	85.9	74.1	78.1		89.6	87.4	96.2	50.1	66.5		81.2	118	122	109	125	124	111	133	110
Nitrate-N	mg/L	90.3	0.04	1.2	0.0275	0.005	0.05	0.005	0.05	0.05		0.05	0.05		0.05	0.05	0.05	0.005	0.05		0.05	0.005	0.05	0.05	0.005	0.05	0.05	0.05	0.050
Sulphate	mg/L	1000	0.01	7	0.01	0.04	0.01	0.01		0.16						0.01					0.010	0.010			0.01				0.01
Ammonia-N	mg/L		1.35	76.6	1.6	1.85	31.2	1.35	1.29	76.6	1.37	1.27	1.18		1.51	1.48	1.69	1.29	1.28		1.33	1.27	1.3	1.6	1.79	1.71	1.54	1.45	1.77
Hardness	mg CaCO3/L		620	1720	678	678				251						553					406	465			589				568
Calcium	mg/L	1000	181.5	292	148	148				59.2	101					123					108.0	121.0			134				132
Magnesium	mg/L		54.1	74.8	74.8	74.8				24.9						59.5					33.2	39.3			61.7				58.0
Potassium	mg/L		16.5	33.1	15.8	15.8				33.1						14.9					12.3	13.1			16.7				14.6
Sodium	mg/L		129	235	101	101				92.5						95.5					99.6	105			115	108	105	132	104
D.R. Phosphorus	mg/L		0.043	0.26	0.041	0.041				0.017	0.015					0.02					0.025	0.029			0.122				0.070
Aluminium	mg/L	5	0.003	2	0.001	0.001	0.003	0.001	0.001	0.004	0.004	0.001	0.001		0.001	0.001	0.004	0.005	0.003		0.001	0.001	0.002	0.003	0.001	0.010	0.001	0.001	0.001
Arsenic	mg/L	0.5	0.004	0.0095	0.001	0.001				0.001	0.001					0.001					0.002	0.003			0.003				0.001
Boron	mg/L	5	0.55	1.48	0.815	0.89	0.92	0.62	0.74	0.89	0.76	0.65	0.55		0.85	0.74	0.59	0.74	0.87		0.85	0.86	0.94	1.39	0.87	0.52	0.89	1.01	0.82
Cadmium	mg/L	0.01	0.0001	0.0007	0.0001	0.0001				0.0001	0.0001					0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.001	0.03	0.0005	0.0005				0.001	0.0005					0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	0.4	0.002	0.02	0.00025	0.00025				0.0009	0.00025					0.0008					0.00025	0.00025			0.00025				0.00025
Iron	mg/L		14	69.6	2.54	2.54				0.415	2.14					2.45					2.61	16.30			22.5	20.2	4.55	9.45	3.75
Lead	mg/L	0.1	0.00025	0.1	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025		0.00025	0.00025	0.00025	0.0006	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		3.68	8.6	2.115	2.93	1.18	2.00	2.23	0.785		1.62	1.38		2.06	2.06	2.82	1.59	1.52		1.76	2.05	2.38	2.3	2.75	2.93	2.92	2.80	2.40
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.003	1	0.0024	0.0027	0.0025	0.0019	0.0023	0.0025		0.0019	0.0018		0.0020	0.002	0.0022	0.0018	0.0025		0.0022	0.0018	0.0023	0.0029	0.0029	0.0026	0.0015	0.0023	0.0021
Zinc	mg/L	20	0.0125	0.151	0.003	0.003				0.007						0.002					0.001	0.001			0.001				0.001

D1 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		16.915	17.47	16.6	16.82	16.57	16.6		1.64	16.60	16.34	16.60	16.64	16.75	16.71	16.83	17.1	17.04	17.04	16.895	16.920	17.00	17.23	16.72	16.65	16.32	16.915
pH		6 to 9	6.825	8.4	6.7	6.5	6.7	7.1	6.7	6.9		7	6.90	7.1	7.40	6.80	6.90	7.8		6.7	6.7	6.600	6.7		7.6	6.8	6.7	6.8
Suspended Solids	mg/l		12	103	2.5	2.5				2.5					1.50					2	3							3
Phenol	mg/L		0.0175	0.05	0.005	0.005				0.025					0.025					0.025								0.025
VFA	mg/L		25	37	2.5	2.5				2.5					2.50					2.5								2.5
TOC	mg/L		1.3	4.9	1.1	1.1				1					1.30					1.3	1.2							1.1
Alkalinity	mg CaCO3/L		92	200	200	200				129	89				109.00					133	143							114
Conductivity	mS/m		38.6	63.6	46.65	58	50.3	43	40.1	38.6	33.6	22.7	32.50	24.8	37.40	42.50	45.40	44.3		48.4	48.2	49.600	48.9		46.6	52.3	51.9	52.4
COD	mg/L		7.5	123	7.5	7.5	7.50	7.5	7.5	7.5	7.5	17	7.5	22	7.50	7.50	7.50	7.5		21	7.5	7.500	14.99		7.5	7.5	7.5	7.5
BOD (scBOD frm Apr'20)	mg/L		1.5	8.8	0.5	0.5	0.50	0.5	0.5	0.5	0.5	1.5	1.5	2	3.00	3	1.50	3		0.5	0.5	0.500	0.5					1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	1375	50	50	50.00	50	50	50	50	50	2	50	2.00	790.00	2.00	2		2.000	2.000	2.000	2.0		2	2	4	2
Chloride	mg/L		32.4	55.5	22.4	34.8	26.9	17.9	15.3	15.7	14.3	13.7	14.80	11.8	17.20	24.10	31.40	32.4		27.2	32.7	28.200	28.9		30.3	36.1	36.9	32.4
Nitrate-N	mg/L	90.3	8.89	33.2	6.325	6.17	6.48	5.61	8.94	8.01		2.89	5.86	4.38	9.80	8.84	7.95	9.68		9.44	9.98	10.900	11.40		10.6	11.5	13.0	14.7
Sulphate	mg/L	1000	3.82	41	17.9	17.9				8.69					9.85					5.07	5.03							6.27
Ammonia-N	mg/L		0.005	0.68	0.005	0.005	0.005	0.005	0.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.02	0.005	0.005		0.005	0.005	0.005	0.005
Hardness	mg CaCO3/L		103.5	166	166	166				109					90.00					139	131							135
Calcium	mg/L	1000	17.8	32.2	29.4	29.4				19.8	16.4				16.40					25.9	24.4							25.0
Magnesium	mg/L		13.7	22.5	22.5	22.5				14.5					11.90					18.0	17.0							17.5
Potassium	mg/L		6.905	12.4	12.4	12.4				9.03					9.42					10.7	9.34							9.3
Sodium	mg/L		33.85	54.2	46.3	46.3				33.9					33.50					43	43.1				39.4	14.2	23.5	41.1
D.R. Phosphorus	mg/L		0.098	0.3	0.089	0.089				0.099	0.095				0.10					0.100	0.098							0.092
Aluminium	mg/L	5	0.003	23.7	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.004	0.00	0.001	0.0010	0.001	0.001	0.001		0.001	0.001	0.001	0.001		0.009	0	0.006	0.001
Arsenic	mg/L	0.5	0.001	0.008	0.001	0.001				0.001	0.001				0.0010					0.001	0.001							0.001
Boron	mg/L	5	0.04	0.12	0.055	0.05	0.07	0.06	0.05	0.04	0.05	0.015	0.03	0.03	0.0400	0.0600	0.0600	0.05		0.05	0.06	0.050	0.05		0.05	0.05	0.015	0.015
Cadmium	mg/L	0.01	0.0001	0.001	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001							0.0001
Chromium	mg/L	1	0.001	0.014	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.0005							0.0005
Copper	mg/L	0.4	0.000475	0.031	0.00025	0.00025				0.00025	0.00025				0.0014					0.0011	0.00025							0.00025
Iron	mg/L		0.0265	21.5	0.005	0.005				0.0025	0.0025				0.0060					0.0025	0.0025				0.02	0.005	4.66	0.0025
Lead	mg/L	0.1	0.00025	0.065	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.00685	0.77	0.000475	0.0007	0.0036	0.00025	0.00025	0.00025		0.00025	0.0015	0.00025	0.0007	0.0007	0.0010	0.00025		0.00025	0.00025	0.00025	0.00025		0.0050	0.00025	0.218	0.00025
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025					
Nickel	mg/L	1	0.00025	0.009	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.005	1.55	0.011	0.011				0.001					0.0180					0.001	0.001							0.001

D2 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		21.56	25.5	21.2	21.36	21.1	21.2		21.5	21.12	20.90	21.07000	21.23	21.33	21.26	21.49	21.59	21.68	21.68	21.40	21.580	21.60	21.66	21.35	21.25	21.6	21.5
pH		6 to 9	6.5	7.8	6.4	6.3	6.3	6.7	6.5	6.4		6.6	6.40000	6.60	6.60	6.50	6.50	6.8		6.5	6.4	6.400	6.4	6.3	6.8	6.5	6.4	6.7
Suspended Solids	mg/l		14	483	53	53				7					6.00					10	3			17				10
Phenol	mg/L		0.02	0.025	0.005	0.005				0.025					0.025					0.025				0.025				0.025
VFA	mg/L		10	206	2.5	2.5				2.5					2.5					2.5				2.5				2.5
TOC	mg/L		13.65	24.9	16.3	16.3				12					16.10					11.7	11.9			13.2				11.9
Alkalinity	mg CaCO3/L		96	311	187	187				158	147				162.00					134	127			109				100
Conductivity	mS/m		30.6	164	57.55	67.8	61.1	54	53.5	51	48.2	47.4	46.70000	46.5	46.60	45.20	43.30	41.4		40.2	37.7	34.400	35.6	33.6	31.1	34.7	37.6	34.9
COD	mg/L		43.5	100	49	51	47	85	34	33	42	49	31.00000	55	38.00	45.00	7.50	16		38	30	40.000	48	31	36	35	32	21
BOD (scBOD frm Apr'20)	mg/L		1.6	17	1	1.5	0.5	0.5	2	0.5	0.5	1.5	1.50000	3	3.00	3.00	3.00	5.9		<6	3.0	0.500	0.5	1.5				1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	600	50	50	50	50	50	50	50	50	16.00000	50	2.00	180.00	50.00	3.9		8	0.5	2.000	32	2	2	2	20	2
Chloride	mg/L		36	122	63.1	94.4	73.2	17.1	53	51.4	50.7	50.2	48.60000	45.2	43.20	42.80	38.00	33.5		33	35.6	31.500	34.6	32.8	32.9	35.2	42.1	39.0
Nitrate-N	mg/L	90.3	0.02	31.5	0.005	0.005	0.05	0.005	0.005	0.005		0.005	0.00500	0.07	0.005	0.005	0.01	0		0.005	0.005	0.020	0.005	0.005	0.05	0.05	0.005	0.005
Sulphate	mg/L	1000	4.48	100	6.15	6.15				8.93					0.04					0.01	0.01			0.01				1.99
Ammonia-N	mg/L		0.35	0.76	0.745	0.76	0.75	0.74	0.7	0.69	0.65	0.63	0.65000	0.62	0.60	0.57	0.59	0.52		0.51	0.55	0.490	0.62	0.49	0.43	0.47	0.48	0.50
Hardness	mg CaCO3/L		77	288	160	160				137					123.00					100	91			87				87
Calcium	mg/L	1000	14.6	60.8	26.8	26.8				22.7	22.8				20.80					17.6	16.4			15.4				14.6
Magnesium	mg/L		10.09	33.5	22.6	22.6				19.4					17.20					13.7	12.1			11.8				12.3
Potassium	mg/L		5.755	26.5	11.7	11.7				9.61					10.90					9.73	7.98			7.10				7.32
Sodium	mg/L		28	108	45.4	42.4	48.4	50.6	31.4	42.4		32.7	40.60000	41.4	36.50	39.20	37.20	36.6		31.4	31.3	30.600	32.6	32.6	26.0	7.84	20.4	27.6
D.R. Phosphorus	mg/L		0.0695	0.44	0.033	0.033				0.042	0.027				0.06					0.036	0.055			0.038				0.039
Aluminium	mg/L	5	0.0255	17.8	0.003	0.001	0.003	0.003	0.007	0.003	0.009	0.003	0.00200	0.007	0.01	0.005	0.006	0.017		0.004	0.013	0.015	0.013	0.014	0.026	0.004	0.001	0.014
Arsenic	mg/L	0.5	0.002	0.0093	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.001			0.001				0.001
Boron	mg/L	5	0.0295	0.52	0.05	0.04	0.05	0.07	0.05	0.04	0.06	0.04	0.04000	0.05	0.06	0.05	0.07	0.05		0.05	0.07	0.060	0.04	0.04	0.05	0.05	0.03	0.015
Cadmium	mg/L	0.01	0.0001	0.002	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.00155	0.036	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.001			0.001				0.001
Copper	mg/L	0.4	0.002	0.082	0.00025	0.00025				0.00025	0.00025				0.0006					0.00025	0.00025			0.00025				0.00025
Iron	mg/L		11.2	20.5	12.25	11.4	12.1	12.4	12.7	9	5.01	2.07	5.32000	5.98	6.18	2.34	10.00	18		3.95	17.20	9.280	10.90	15.0	14.9	9.04	0.02	11.9
Lead	mg/L	0.1	0.00095	0.12	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.000250	0.000250	0.0008		0.00025	0.00025	0.0028	0.00025	0.00025	0.0014	0.00025	0.00025	0.00025
Manganese	mg/L		0.3	0.607	0.4955	0.607	0.521	0.47	0.39	0.499		0.406	0.41000	0.506	0.47	0.433	0.41	0.41		0.362	0.314	0.317	0.318	0.306	0.332	0.325	0.0153	0.338
Mercury	mg/L		0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.000250	0.000250	0.0004		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.00025	0.018	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.000250	0.000250	0.0004		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.012	0.151	0.005	0.005				0.003					0.01					0.005	0.001			0.005				0.006

D3r (replaced by D3rs)	Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19	Jan-19
Water level	mBGL		4.85	5.41		4.69	4.55	4.940	4.70	4.89	4.67	4.695	4.56	4.874	4.745
pH		6 to 9	6.8	7.3		6.8	6.7	6.700	6.8	7.0	7.2	6.8	6.8	6.9	6.8
Suspended Solids	mg/l		12.0	131.0		3	3.5			3				3	8
Phenol	mg/L		0.0	0.0		0.025				0.025				0.025	0.025
VFA	mg/L		25.0	184.0		2.5				2.5				2.5	6
TOC	mg/L		2.2	3.1		3.0	3.0			3.1				2.9	2.6
Alkalinity	mg CaCO3/L		56.5	186.0		55	55			56				56	57
Conductivity	mS/m		30.5	53.6		22.30	21.7	22.100	21.8	21.4	22.0	22.0	23.0	53.6	22.1
COD	mg/L		7.5	64.0		19	7.5	7.500	16	7.5	18	7.5	7.5	7.5	7.5
BOD (scBOD frm Apr'20)	mg/L		1.5	21.0		3	0.5	0.500	0.5	0.5				1.5	1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2.0	36.0		2.000	0.5	2.000	2.0	2	2	2	2	2	2
Chloride	mg/L		29.3	36.3		20.9	23.3	22.100	22.1	21.7	22.0	21.8	21.6	22.7	22.4
Nitrate-N	mg/L	90.3	0.1	0.7		0.17	0.16	0.190	0.18	0.18	0.29	0.19	0.17	0.21	0.20
Sulphate	mg/L	1000	4.4	9.9		9.86	7.54			6.96				8.48	7.68
Ammonia-N	mg/L		0.2	0.3		0.15	0.19	0.160	0.18	0.18	0.17	0.17	0.12	0.17	0.17
Hardness	mg CaCO3/L		36.0	110.0		36	36			34				35	36
Calcium	mg/L	1000	7.0	22.8		7.07	6.98			6.81				7.17	6.99
Magnesium	mg/L		4.4	13.6		4.44	4.44			4.19				4.24	4.49
Potassium	mg/L		5.5	10.1		5.54	5.57			4.90				4.53	5.30
Sodium	mg/L		30.9	45.7		24.8	25.5	25.300	25.7	27.3	25.10	8.79	21.3	26.1	25.9
D.R. Phosphorus	mg/L		0.0	0.2		0.017	0.020			0.015				0.016	0.013
Aluminium	mg/L	5	0.0	0.5		0.001	0.002	0.001	0.001	0.0010	0.002	0.001	0.003	0.001	0.001
Arsenic	mg/L	0.5	0.0	0.0		0.007	0.008			0.011				0.004	0.007
Boron	mg/L	5	0.0	0.1		0.03	0.03	0.040	0.03	0.015	0.03	0.03	0.03	0.015	0.03
Cadmium	mg/L	0.01	0.0	0.0		0.0001	0.0001			0.0001				0.0001	0.0001
Chromium	mg/L	1	0.0	0.0		0.0005	0.0005			0.0005				0.0005	0.0005
Copper	mg/L	0.4	0.0	0.0		0.00025	0.00025			0.00025				0.00025	0.00025
Iron	mg/L		2.9	15.2		2.89	2.35	1.050	2.60	2.86	2.95	4.00	2.20	0.83	2.47
Lead	mg/L	0.1	0.0	0.0		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.3	0.9		0.177	0.179	0.184	0.166	0.176	0.193	0.201	0.160	0.171	0.189
Mercury	mg/L		0.0	0.0		0.00025	0.00025	0.00025	0.00025	0.00025					
Nickel	mg/L	1	0.0	0.0		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.0	0.0		0.001	0.001			0.001				0.001	0.001

D3rs Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21
Water level	mBGL		5.455	6.14	5.6	6.14	5.6	5.34		5.2	5.13	5.11	5.60000	5.39	5.52	6	
pH		6 to 9	6.5	6.9	6.45	6.3	6.4	6.5	6.5	6.5		6.6	6.80000	6.5	6.9	6.6	6.3
Suspended Solids	mg/l		3	67	3	6	2.5	3	3	3		33	67.00000		3.0	3.0	12
Phenol	mg/L		0.025	0.025	0.025	0.005		0.025	0.025	0.025		0.02500	0.02500		0.025	0.025	0.025
VFA	mg/L		2.5	6.4	2.5	2.5	6.4	2.5	2.5	2.5		2.50000	2.50000		2.5	2.5	2.5
TOC	mg/L		23.55	26.4	22.85	21.9	21.5	24.4	23.8	23.3		26.4	21.50000		25.5	20.9	23.9
Alkalinity	mg CaCO3/L		68	90	79.5	80	90	79	63	65	64	69	58.00000		68	64	70
Conductivity	mS/m		20.1	23.6	21.8	22	23.6	21.6	19.8	19.7	20.1	20.5	17.30000	19.7	19.8	18.9	21.7
COD	mg/L		63	119	66.5	63	54	74	70	63	67	87	46.00000	77	119	55	62
BOD (scBOD frm Apr'20)	mg/L		1.75	5	1	2	0.5	0.5	1.5	0.5	0.5	5	1.50000	3	3	3	3
Faecal C (Ecoli frm Apr'20)	col/100ml	100	50	500	50	50	50	50	50	50	50	50	2.00000	50	2	500	2
Chloride	mg/L		16.4	32	15.9	15.8	15.7	17.3	16	16.3	16.5	16.4	14.10000	15.3	17	16.7	32
Nitrate-N	mg/L	90.3	0.005	0.05	0.0275	0.05	0.05	0.005	0.005	0.005		0.00500	0.00500	0.005	0.005	0.005	0.005
Sulphate	mg/L	1000	1.35	2.1	1.37	0.81	1.8	1.07	1.67	2.1		0.59	1.63000		1.07	2.01	0.03
Ammonia-N	mg/L		0.66	0.76	0.755	0.75	0.76	0.76	0.66	0.67	0.67	0.65	0.62000	0.63	0.63	0.53	0.54
Hardness	mg CaCO3/L		46.5	52	46	43	49	43	52	47		46	42.00000		46	48	51
Calcium	mg/L	1000	10.9	13.4	10.1	9	10.6	9.6	12.8	10.6	11.2	10.9	10.10000		10.9	12	13.4
Magnesium	mg/L		4.635	5.5	4.83	4.89	5.5	4.68	4.77	4.87		4.59	4.16000		4.58	4.42	4.2
Potassium	mg/L		4.25	5.8	4.4	4.61	4.36	4.44	4.13	3.69		4.5	3.63000		4.14	3.8	5.8
Sodium	mg/L		21.75	24.3	22.25	23	22.4	21.4	22.1	21.4		23.5	19.80000	20.0	20.4	20.8	24.3
D.R. Phosphorus	mg/L		0.076	0.198	0.0835	0.082	0.085	0.198	0.069	0.096	0.065	0.07	0.07700		0.071	0.076	0.058
Aluminium	mg/L	5	0.072	0.089	0.067	0.055	0.056	0.078	0.089	0.066	0.088	0.083	0.07200	0.077	0.065	0.073	0.06
Arsenic	mg/L	0.5	0.001	0.001	0.001		0.001	0.001	0.001	0.001	0.001	0.001	0.00100		0.001	0.001	0.001
Boron	mg/L	5	0.04	0.06	0.035	0.03	0.04	0.03	0.06	0.015	0.04	0.015	0.03000	0.03	0.04	0.05	0.05
Cadmium	mg/L	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.00010	0.00010		0.0001	0.0001	0.0001
Chromium	mg/L	1	0.004	0.004	0.003	0.003	0.003	0.004	0.003	0.004	0.004	0.004	0.00300		0.004	0.004	0.004
Copper	mg/L	0.4	0.00025	0.001	0.00025	0.00025	0.00025	0.00025	0.0008	0.0008	0.00025	0.00025	0.00100		0.0009	0.00025	0.00025
Iron	mg/L		15.7	17.4	14.45	14.8	14	15.7	14.1	11.4	17.2	16.4	13.30000	16.2	16.6	15.9	17.4
Lead	mg/L	0.1	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.349	0.512	0.3475	0.382	0.352	0.343	0.342	0.346		0.36	0.30900	0.388	0.331	0.363	0.512
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Nickel	mg/L	1	0.00065	0.001	0.00025	0.00025	0.00025	0.0006	0.00025	0.00025		0.0007	0.00100	0.0007	0.0007	0.0009	0.0009
Zinc	mg/L	20	0.003	0.007	0.0035	0.004	0.001	0.007	0.003	0.003		0.001	0.00300		0.006	0.005	0.002

D3rd Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21
Water level	mBGL		5.835	6.49	5.94	6.49	5.94	5.69		5.8	5.73	5.47	5.96	5.75	5.87	6.4	
pH		6 to 9	7.65	7.8	7.6	7.5	7.5	7.7	7.8	7.6		7.7	7.7	7.7	7.4	7.7	7.5
Suspended Solids	mg/l		75	551	16	2.5	6	26	86	64		105	28		551	122	206
Phenol	mg/L		0.025	0.025	0.025	0.005		0.025	0.025	0.025		0.025	0.025		0.025	0.025	0.025
VFA	mg/L		2.5	6.6	2.5	2.5	6.6	2.5	2.5	2.5		2.5	2.5		2.5	2.5	2.5
TOC	mg/L		5.9	7.2	5.9	5.8	6.4	5.9	5.9	6.2		5.5	5.7		7.2	5.6	5.9
Alkalinity	mg CaCO3/L		222	249	224	223	225	226	215	218	209	216	211		249	222	224
Conductivity	mS/m		52.9	53.5	53.05	53.2	52.9	53.2	52.5	51.9	51.8	51.9	52.3	52.3	53.5	53	53.1
COD	mg/L		15	28	11.25	7.5	7.5	15	23	7.5	23	25	7.5	30	18	7.5	28
BOD (scBOD frm Apr'20)	mg/L		1.5	3	0.5	0.5	0.5	0.5	1.5	0.5	0.5	3	1.5	1.5	3	3	1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	12	50	50	0.5	50	50	50	0.5	50	50	2	100	2	12	8
Chloride	mg/L		31.6	32.6	31.45	32.6	31.7	26.6	31.2	31.6	31	31.2	31.6	31.6	32.4	32	21.8
Nitrate-N	mg/L	90.3	0.005	0.3	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005	0.11	0.3
Sulphate	mg/L	1000	0.01	30.1	0.01	0.01	0.01	0.01	0.01	0.01		0.01	0.01		0.01	0.01	30.1
Ammonia-N	mg/L		0.39	0.42	0.39	0.37	0.39	0.4	0.39	0.4	0.38	0.38	0.42	0.41	0.4	0.28	0.04
Hardness	mg CaCO3/L		202.5	223	200.5	186	214	193	208	201		198	204		199	223	220
Calcium	mg/L	1000	59.1	64.7	56.7	53	61.3	56.1	57.3	58.1	64.5	59.1	59.8		57.8	64.7	64.3
Magnesium	mg/L		13.4	15.7	13.9	13	14.8	12.8	15.7	13.5		12.2	13.3		13.2	14.8	14.5
Potassium	mg/L		6.725	7.76	6.635	6.37	6.65	6.62	7.28	6.45		6.8	6.57		7.16	7.52	7.76
Sodium	mg/L		22.1	25.8	21.7	20.4	21.8	21.6	25.8	22.4		20.4	23		21.5	22.4	25.7
D.R. Phosphorus	mg/L		1.21	1.24	1.18	1.14	1.21	1.23	1.15	1.22	1.24	1.23	1.23		1.21	1.18	0.011
Aluminium	mg/L	5	0.003	0.026	0.003	0.003	0.003	0.026	0.003	0.003	0.004	0.005	0.001	0.001	0.015	0.002	0.005
Arsenic	mg/L	0.5	0.02	0.022	0.0195	0.019	0.022	0.02	0.019	0.021	0.02	0.018	0.02		0.018	0.02	0.017
Boron	mg/L	5	0.04	0.07	0.04	0.015	0.04	0.04	0.07	0.03	0.05	0.03	0.03	0.05	0.04	0.05	0.05
Cadmium	mg/L	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001
Chromium	mg/L	1	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005	0.0005	0.0005
Copper	mg/L	0.4	0.00025	0.0012	0.00025	0.00025	0.00025	0.00025	0.0009	0.00025	0.00025	0.00025	0.00025		0.0011	0.0012	0.00025
Iron	mg/L		0.028	0.035	0.025	0.03	0.03	0.02	0.02	0.022	0.035	0.029	0.033		0.009	0.017	0.028
Lead	mg/L	0.1	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.4765	0.537	0.4765	0.5	0.446	0.455	0.498	0.486		0.448	0.44	0.514	0.467	0.498	0.537
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Nickel	mg/L	1	0.00025	0.0024	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.0024	0.00025
Zinc	mg/L	20	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001		0.001	0.001		0.001	0.001	0.001

D4 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		8.25	11	7.55	8.12	7.55	7.53		7.41	7.55	7.4	7.96	7.67	7.73	8.35	7.79	8.4	7.98	7.98	7.83	8.28000	8.10	8.25	8.7	8.01	8.41	11
pH		6 to 9	7	7.8	7.05	7	7.1	7.4	7	7.1		7	6.9	6.9	7.1	7	7.5	7.0		7.0	7.2	6.80000	6.9	7.1	7.7	7.1	6.9	7.1
Suspended Solids	mg/l		3	27	2.5	2.5				2.5					2.5					2	3			5				3
Phenol	mg/L		0.025	0.06	0.005	0.005				0.025					0.025					0.025				0.025				0.025
VFA	mg/L		7.5	122	2.5	2.5				2.5					2.5					25.0				2.5				2.5
TOC	mg/L		2.5	27	4	4				3.7					3					3.5	3.3			2.4				2.1
Alkalinity	mg CaCO3/L		60.5	85	83	83				85	85				70					65	65			55				53
Conductivity	mS/m		29.4	35.1	27.4	27.4	27.5	27.1	27.4	27.5	28.3	28.5	29.2	29.7	29.4	29.8	29.6	29.6		30.6	30.3	31.10000	30.2	31.3	31.5	32.7	29.4	27.1
COD	mg/L		7.5	118	23.5	28	38	19	18	7.5	20	22	7.5	28	42	7.5	19	16		7.5	7.5	7.50000	7.5	7.5	7.5	7.5	7.5	7.5
BOD (scBOD frm Apr'20)	mg/L		1.5	6	0.5	0.5	0.5	0.5	1.5	0.5	3	1.5	3	3	3	3.0	1.5	3.0		3.0	0.5	0.50000	0.5	0.5				1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	260	50	50	50	50	50	50	50	50	2	50	96	260	2	2		2	0.5	2.00000	8	2	2	2	2	2
Chloride	mg/L		41.8	64.4	30.3	29.8	30.9	29.8	30.8	31.4	31.4	33.5	33.9	35.4	36.3	38.3	35.5	35.6		36.4	40.9	44.30000	43.9	44.6	49.2	53.5	45.3	38.5
Nitrate-N	mg/L	90.3	0.005	0.8	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.00500	0.005	0.005	0.005	0.005	0.005	0.005
Sulphate	mg/L	1000	8	22.5	5.61	5.61				5.01					12.9					11.8	13.7			12.5				11.2
Ammonia-N	mg/L		0.16	0.34	0.235	0.24	0.23	0.26	0.23	0.23	0.23	0.18	0.23	0.25	0.24	0.19	0.23	0.25		0.24	0.25	0.25000	0.22	0.21	0.21	0.23	0.22	0.23
Hardness	mg CaCO3/L		56	70	49	49				56					56					60	59			62				48
Calcium	mg/L	1000	9.925	12.5	9.2	9.2				10.4	11.4				10					11.6	11.2			11.0				9.26
Magnesium	mg/L		7.32	9.47	6.34	6.34				7.17					7.47					7.67	7.53			8.39				5.96
Potassium	mg/L		5.93	6.87	5.63	5.63				5.62					6.76					6.09	6.5			6.62				4.64
Sodium	mg/L		32.2	390	28.95	28.8	32.2	28.4	29.1	32.2		31.8	33.4	33.4	28.8	35.5	34.4	31.9		29.2	33.4	32.00000	33.4	31.7	31.4	33.7	32.2	29.1
D.R. Phosphorus	mg/L		0.0555	0.54	0.052	0.052				0.029	0.023				0.023					0.021	0.0250			0.016				0.021
Aluminium	mg/L	5	0.003	8.81	0.003	0.003	0.003	0.002	0.003	0.003	0.005	0.001	0.004	0.001	0.001	0.002	0.001	0.002		0.001	0.001	0.00100	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.5	0.002	0.005	0					0.003	0.003				0.002					0.003	0.003			0.004				0.002
Boron	mg/L	5	0.03	0.2	0.03	0.015	0.03	0.03	0.05	0.11	0.2	0.03	0.04	0.015	0.03	0.03	0.12	0.03		<0.03	0.04	0.04000	0.08	0.04	0.015	0.03	0.04	0.015
Cadmium	mg/L	0.01	0.0001	0.0005	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.0005	0.006	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	0.4	0.0005	0.024	0.00025	0.00025				0.00025	0.00025				0.0139					0.00025	0.00025			0.00025				0.00025
Iron	mg/L		1.225	7.6	1.745	1.9	1.61	1.88	0.84	1.26	0.866	0.74	4.27	0.32	0.283	0.95	0.4	0.71		1.54	1.59	0.43000	0.38	1.51	0.831	0.77	1.91	0.15
Lead	mg/L	0.1	0.00025	0.0089	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.175	0.324	0.2065	0.207	0.206	0.169	0.207	0.188		0.179	0.214	0.200	0.193	0.19	0.188	0.213		0.209	0.202	0.20100	0.18	0.189	0.175	0.175	0.181	0.151
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.00025	0.01	0.00025	0.00025	0.00025	0.00025	0.00025	0.0082		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.0025	0.038	0.001	0.001				0.003					0.006					0.001	0.001			0.001				0.001

D5 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		9.93	11.53	8.95	9.8	8.9	8.95		8.8	0.93	8.66	9.48	9.25	9.31	9.97	9.46	10.23	9.59	9.59	9.49	10.075	9.62	9.93	9.76	9.755	9.77	9.93
pH		6 to 9	7	7.9	7.1	6.9	7	7.2	7.2	7.1		7	7.1		7.6	7.2	7.4	7.0		7.0	7.4	7.000	7.1	7.4	7.9	7.2	7.0	7.1
Suspended Solids	mg/l		3	24.4	2.5	2.5				2.5					1.5					2	3			2.5				3
Phenol	mg/L		0.01	7.5	0.005	0.005				0.025					0.025					0.025				0.025				0.025
VFA	mg/L		2.5	25	2.5	2.5				2.5					2.5					2.5				2.5				2.5
TOC	mg/L		1.8	2.3	1.9	1.9				2.1					2.3					1.9	2.0			2.0				1.9
Alkalinity	mg CaCO3/L		61	84	73	73				78	84				75					62	68			63				66
Conductivity	mS/m		25.1	252	30.4	28.8	29.1	31.8	31.7	30.5	31.8	32	32.3		30.4	25.9	29.7	30.5		29.4	31.2	29.400	29.5	29.9	29.4	30.7	28.7	31.2
COD	mg/L		7.5	2820	12.25	7.5	7.5	17	36	7.5	7.5	7.5	15		30	7.5	7.5	2,820		7.5	21	50.000	7.5	7.5	7.5	7.5	22.0	7.5
BOD (scBOD frm Apr'20)	mg/L		0.5	6.2	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	0.5		0.5	0.5	1.5	3		1.5	0.5	0.500	0.5	0.5				0.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	50	50	50	50	50	50	50	50	50	2		2	48	4	2		2	0.5	2.000	2.0	2.0	2.0	2	4	2
Chloride	mg/L		29	62.2	29.45	27.3	28.9	31.8	30	28.4	30.8	31.9	31		29.7	21.6	28.2	29.4		26.7	29.9	54.800	29.8	29.1	30.0	29.5	29.3	29.9
Nitrate-N	mg/L	90.3	2.67	9.5	0.975	1.18	1.04	0.91	0.89	1.3		0.57	0.4		0.72	2.79	1.5	1.34		1.73	0.84	1.640	1.44	1.18	1.34	1.15	1.45	1.03
Sulphate	mg/L	1000	12.5	28.3	18	18				17.1					18.7					16.0	22.5			21.0				24.2
Ammonia-N	mg/L		0.005	0.57	0.0075	0.005	0.005	0.02	0.01	0.005	0.01	0.02	0.02		0.02	0.005	0.01	0.005		0.005	0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005
Hardness	mg CaCO3/L		60.5	73	73	73				68					70					61	69			64				67
Calcium	mg/L	1000	10.4	12.8	12.3	12.3				11.3	12.8				12.2					10.3	12.4			11.1				11.7
Magnesium	mg/L		8.305	10.3	10.3	10.3				9.61					9.49					8.61	9.34			8.86				9.03
Potassium	mg/L		6.34	10.4	6.85	6.85				8.28					8.15					7.0	7.83			7.83				6.55
Sodium	mg/L		26.65	101	23.5	23.5				28.9					30.1					28.3	32.4			32.5	29.4	33.0	36.8	32.1
D.R. Phosphorus	mg/L		0.136	0.33	0.107	0.107				0.097	0.072				0.094					0.104	0.093			0.096				0.100
Aluminium	mg/L	5	0.002	35	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.001	0.002		0.001	0.004	0.002	0.004		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.5	0.001	0.006	0.0005	0.0005				0.0005	0.0005				0.001					0.0005	0.001			0.001				0.001
Boron	mg/L	5	0.025	0.06	0.05	0.05	0.05	0.06	0.04	0.05	0.04	0.015	0.03		0.03	0.06	0.04	0.04		0.03	0.03	0.030	0.03	0.04	0.03	0.015	0.015	0.030
Cadmium	mg/L	0.01	0.0001	0.0005	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.0005	0.039	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	0.4	0.0012	0.037	0.0007	0.0007				0.0009	0.00025				0.0012					0.0006	0.0014			0.0009				0.0005
Iron	mg/L		0.07	35	0.01	0.01				0.082	0.117				0.178					0.033	0.086			0.070	0.06	0.05	0.005	0.043
Lead	mg/L	0.1	0.00025	0.0363	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025		0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.0089	0.52	0.01665	0.0051	0.0088	0.0245	0.0267	0.0189		0.0658	0.15		0.0671	0.005	0.0161	0.0071		0.0095	0.0185	0.0149	0.006	0.0193	0.0148	0.0162	0.0035	0.0109
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025		0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.00025	0.0421	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025		0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.0007	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.00325	0.191	0.001	0.001				0.001					0.001					0.001	0.001			0.001				0.001

D6 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		16.49	17.3	16.3	16.42	16.3	16.16		1.61	16.21	15.94	15.98	16.24	16.32	16.43	16.42	16.59	16.59	16.59	16.49	16.500	15.30	16.62	16.23	16.22	16.38	16.523
pH		6 to 9	6.9	7.8	6.8	6.6	6.7	7	6.9	6.8		6.9	7	7.1	7.4	6.9	7	6.9		6.9	6.8	6.700	6.8	7.1	7.1	7.0	6.8	7.0
Suspended Solids	mg/l		12	134	2.5	2.5				2.5					1.5					2	3			2.5				3
Phenol	mg/L		0.01	0.025	0.005	0.005				0.025					0.025					0.025				0.025				0.025
VFA	mg/L		25	25	2.5	2.5				2.5					2.5					2.5				2.5				2.5
TOC	mg/L		1	3.7	1.1	1.1				1					1					1.2	0.9			1.0				0.9
Alkalinity	mg CaCO3/L		74.5	123	68	68				123	113				90					69	81			73				75
Conductivity	mS/m		29.8	73.8	46.4	73.8	49.7	43.1	41.4	42.8	37.7	32.7	21.5	39.4	36.9	28.4	43.5	40.4		37.5	36.6	44.700	42.6	37.2	29.1	31.9	41.9	43.4
COD	mg/L		7.5	218	7.5	7.5	7.5	7.5	7.5	7.5	7.5	18	7.5	7.5	38	7.5	7.5	7.5		7.5	7.5	7.500	7.5	7.5	7.5	7.5	7.5	7.5
BOD (scBOD frm Apr'20)	mg/L		1.25	8.6	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	1.5	3	3	3	1.5	3		0.5	0.5	0.500	0.5	0.5				1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	3	830	50	50	50	50	50	50	50	50	> 240	50	16	830	2	2		2.000	24	2.000	2.0	240	2	2	2	2
Chloride	mg/L		26.8	59	29.6	56.6	34.1	25.1	21.4	22	16.9	13.6	8.81	18.4	17.7	13.8	20.5	22.6		17.4	17.7	20.900	22.1	19.8	14.2	16.3	27.7	26.4
Nitrate-N	mg/L	90.3	9.395	50.3	18.15	50.3	23.9	11.6	12.4	12.4		9.81	6.31	13.9	14.2	10.3	16.2	17.5		16.60	16.70	21.200	23.90	16.9	11.1	11.7	17.7	21.7
Sulphate	mg/L	1000	3.13	60	7.85	7.85				6.5					5.48					28.1	5.54			4.34				4.82
Ammonia-N	mg/L		0.005	0.75	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.01	0.005		0.005	0.050	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Hardness	mg CaCO3/L		82	186	186	186				123					96					97	92			95				104
Calcium	mg/L	1000	16.55	32.2	32.2	32.2				21.8	19				17.3					17.8	17.5			18.0				18.5
Magnesium	mg/L		10.5	25.7	25.7	25.7				16.6					12.8					12.8	11.7			12.3				13.1
Potassium	mg/L		6.615	10.6	10.6	10.6				7.95					8.35					8.89	8.0			8.16				7.31
Sodium	mg/L		29.4	340	39.2	39.2				34.4					26.3					30.8	31.8			33.9	26.7	9.72	24.8	37.9
D.R. Phosphorus	mg/L		0.106	3.2	0.078	0.078				0.101	0.106				0.1					0.098	0.099			0.101				0.093
Aluminium	mg/L	5	0.0065	5.5	0.001	0.001	0.001	0.001	0.008	0.001	0.003	0.003	0.002	0.002	0.001	0.004	0.003	0.001		0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.016	0.001
Arsenic	mg/L	0.5	0.002	0.0047	0					0.001	0.001				0.001					0.001	0.001			0.001				0.001
Boron	mg/L	5	0.03	0.083	0.06	0.06	0.06	0.06	0.07	0.04	0.06	0.03	0.04	0.05	0.05	0.05	0.06	0.04		0.05	0.06	0.060	0.05	0.05	0.05	0.05	0.03	0.03
Cadmium	mg/L	0.01	0.0001	1.6	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.001	0.015	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	0.4	0.00175	0.028	0.00025	0.00025				0.0006	0.002				0.0008					0.0006	0.00025			0.0057				0.00025
Iron	mg/L		0.2	56	0.005	0.005				0.0025	0.0025				0.011					0.02	0.007			0.0025	0.005	0.005	14.2	0.0025
Lead	mg/L	0.1	0.00025	0.083	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.00755	1.1	0.00185	0.0015	0.0011	0.0022	0.0039	0.001		0.001	0.0036	0.0006	0.0011	0.0064	0.0015	0.00025		0.0018	0.00025	0.00025	0.0006	0.0009	0.00025	0.00025	0.372	0.00025
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.00025	0.024	0.00025	0.00025	0.00025	0.00025	0.0023	0.00025		0.00025	0.00025	0.00025	0.00025	0.0096	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.008	0.15	0.004	0.004				0.001					0.023					0.002	0.001			0.004				0.001

E1S Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		11.51	13.59	11.1	11.37	11.1	11.08		10.9	11.09	10.86	11.23	11.21	11.28	11.33	11.32	11.6	11.51	11.51	11.35	11.510	11.60	11.51	11.327	11.385	11.25	11.495
pH		6 to 9	7	7.9	7.1	7	7	7.2	7.2	7.1		7.1	6.9	7.2	7.4	7.1	7.1	7.1		6.9	6.9	6.800	7.0	7.2	7.1	7.0	6.9	7.6
Suspended Solids	mg/l		7	75	2.5	2.5				6					3					5	58			7				3
Phenol	mg/L		0.01	0.03	0.005	0.005				0.025					0.025					0.025				0.025				0.025
VFA	mg/L		8.5	25	2.5	2.5				2.5					2.5					2.5				2.5				2.5
TOC	mg/L		3.1	7	3.5	3.5				4.9					7					6.4	6.6			5.2				3.7
Alkalinity	mg CaCO3/L		60	87	69	69				83	87				82					70	77			68				61
Conductivity	mS/m		26.2	45	24.55	24.3	24.3	24.8	25.5	26	25.9	25.4	26.8	26.7	26.5	25.3	26.4	25.8		26.7	25.7	27.400	26.4	27.1	26.6	26.9	26.7	26.7
COD	mg/L		16	126	19.5	44	17	7.5	22	7.5	16	7.5	7.5	7.5	24	40	7.5	19		25	18	19.000	19	7.5	19	7.5	7.5	25.0
BOD (scBOD frm Apr'20)	mg/L		1.5	38	0.5	0.5	0.5	0.5	1.5	2	3	1.5	3	3	3	3	1.5	3		3.0	1.5	0.500	5.9	0.5				1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	100	50	50	50	50	100	50	50	50	2	50	2	50	2	2		2.000	2.000	2.000	2.0	2	2	2	2	2
Chloride	mg/L		35.4	54.1	27.15	27.1	29.4	26.1	27.2	27	26.4	27.6	26.9	27.1	26.7	26.9	26.7	26.6		26.1	28.5	27.800	28.7	28.7	29.7	30.0	30.7	33.5
Nitrate-N	mg/L	90.3	0.005	1.9	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005	0.005	0.02	0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Sulphate	mg/L	1000	7.83	26	6.87	6.87				3.66					3.58					5.37	5.26			9.1				11.2
Ammonia-N	mg/L		0.13	0.64	0.17	0.18	0.11	0.17	0.17	0.17	0.21	0.16	0.19	0.20	0.18	0.17	0.2	0.19		0.18	0.2	0.230	0.18	0.17	0.16	0.18	0.18	0.18
Hardness	mg CaCO3/L		51	61	46	46				59					61					59	55			59				52
Calcium	mg/L	1000	8.685	12.2	7.4	7.4				10.9	11.6				12.2					11.6	10.6			11.0				9.56
Magnesium	mg/L		6.76	7.9	6.62	6.62				7.72					7.48					7.19	7.04			7.62				6.76
Potassium	mg/L		5.4	6.84	5.63	5.63				5.92					6.6					5.95	6.05			6.22				5.02
Sodium	mg/L		28.3	89.8	25.3	24.9	27.2	24.4	25.7	29.8		27.5	26.8	28.5	26.9	30	28.4	27.5		26	27.6	26.800	29.2	28.9	25.80	9.45	22.9	28.1
D.R. Phosphorus	mg/L		0.074	0.46	0.087	0.087				0.069	0.048				0.074					0.059	0.068			0.053				0.054
Aluminium	mg/L	5	0.0065	3.1	0.007	0.005	0.008	0.006	0.008	0.006	0.012	0.006	0.006	0.007	0.007	0.007	0.007	0.007		0.004	0.016	0.007	0.009	0.006	0.006	0.001	0.002	0.002
Arsenic	mg/L	0.5	0.002	0.0046	0					0.002	0.002				0.002					0.001	0.003			0.002				0.002
Boron	mg/L	5	0.015	0.4	0.0275	0.015	0.04	0.015	0.05	0.12	0.1	0.015	0.015	0.03	0.015	0.04	0.03	0.015		0.015	0.03	0.015	0.02	0.03	0.015	0.015	0.04	0.015
Cadmium	mg/L	0.01	0.0001	0.0005	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.00085	0.008	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	0.4	0.002	0.037	0.00025	0.00025				0.0025	0.00025				0.0009					0.00025	0.0011			0.0006				0.0005
Iron	mg/L		3.91	7.5	4.13	3.54	3.91	4.35	4.55	4.73	5.14	4.3	5.67	5.79	5.44	4.59	5.36	4.93		1.96	4.77	4.830	4.83	4.65	4.22	4.63	0.02	3.97
Lead	mg/L	0.1	0.00205	0.068	0.00075	0.0009	0.0014	0.00025	0.0006	0.0015		0.0018	0.00025	0.0012	0.0005	0.0025	0.0007	0.0008		0.00025	0.00700	0.0018	0.00220	0.0005	0.00025	0.0023	0.00025	0.0009
Manganese	mg/L		0.18	0.32	0.2085	0.183	0.207	0.21	0.225	0.243		0.214	0.281	0.269	0.264	0.229	0.258	0.242		0.239	0.236	0.241	0.229	0.243	0.219	0.242	0.0353	0.209
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.00025	0.0071	0.00025	0.00025	0.00025	0.00025	0.00025	0.0014		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0007		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.00725	0.041	0.001	0.001				0.023					0.004					0.001	0.002			0.001				0.001

E1D Monitoring Bore HDC Levin Landfill

Determinand		NZDW MAV	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		11.43	13.54	11.01	11.31	11.01	11		2.88	10.97	10.75	11.1	11.07	11.17		11.19	11.46	11.41	11.41		11.3900	11.32	11.38	11.25	11.165	11.33	11.43
pH		7 to 8.5*	7.4	8.1	7.5	7.5	7.5	7.7	6.9	7.8		7.8	7.6	7.5	7.7	7.7	7.8	7.7		7.5	7.6	7.5000	7.7	7.7	7.9	7.5	7.5	8.1
Suspended Solids	mg/l		18	86	72	72				13					7					9	50			2.5				3
Phenol	mg/L		0.01	0.025	0.005	0.005				0.025					0.025					0.025				0.025				0.025
VFA	mg/L		8	57	2.5	2.5				2.5					2.5					2.5				2.5				2.5
TOC	mg/L		3.1	5.1	2.9	2.9				3					3.7					3.0	2.9			3.1				2.8
Alkalinity	mg CaCO3/L		164.5	185	164	164				172	170				164					151	153			155				160
Conductivity	mS/m		44.8	437	44.75	44.1	45.2	45	44.5	44.7	45	44.6	44.8	45.1	45.1	45.9	44.9	43.6		44.7	44.7	44.9000	44.3	45.5	45.8	45.9	45.2	45.7
COD	mg/L		10	191	7.5	7.5	7.5	7.5	28	7.5	18	16	7.5	19	7.5	17	7.5	75		26	7.5	18.0000	23	7.5	7.5	7.5	45	7.5
BOD (scBOD frm Apr'20)	mg/L		1	4.3	0.5	0.5	1	0.5	0.5	0.5	3	1.5	1.5	1.5	0.5	0.5	1.5	3		1.5	0.5	0.5000	0.5	0.5				2
Faecal C (Ecoli frm Apr'20)	col/100ml	NIL	2	200	0.5	0.5	0.5	0.5	0.5	0.5	50	50	2	50	2	20	2	200		2.0000	2.0000	2.0000	2.0	2.0	2.0	2	2	1.5
Chloride	mg/L	250*	38.7	372	39.35	39.4	40.1	39.3	38	39.1	38.2	38.7	39.1	39.1	38.5	39.3	38.2	40.4		38.5	38.9	39.2000	40.1	38.7	38.2	39.0	39.4	39.3
Nitrate-N	mg/L	11.3	0.005	1	0.005	0.005	0.005	0.005	0.005	0.005		0.01	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.0050	0.005	0.005	0.005	0.005	0.005	0.005
Sulphate	mg/L	250*	0.01	2	0.01	0.01				0.01					0.01					0.01	0.01			0.01				0.01
Ammonia-N	mg/L	1.17	0.2	7.88	0.195	0.2	0.17	0.2	0.19	0.18	0.2	0.18	0.2	0.20	0.19	0.2	0.19	0.28		0.2	0.19	0.2200	0.22	0.20	0.19	0.21	0.21	0.23
Hardness	mg CaCO3/L	200*	138	148	146	146				134					137					138	128			131				124
Calcium	mg/L		33.45	36.3	34.9	34.9				30.9	33.6				32.8					32.6	31.1			31.8				28.7
Magnesium	mg/L		13.2	14.7	14.3	14.3				13.9					13.2					13.8	12.3			12.4				12.6
Potassium	mg/L		5.15	5.99	5.08	5.08				5.05					5.75					5.14	5.06			5.03				5.03
Sodium	mg/L	200*	37.2	340	36.3	43.1	36.5	36.1	35.2	36.5		35.3	36	39.6	36.3	38.7	40.1	36.6		37.2	35.5	36.0000	37.1	36.5	37.2	14.7	43.9	35.9
D.R. Phosphorus	mg/L		0.394	0.71	0.421	0.421				0.38	0.39				0.421					0.390	0.419			0.411				0.391
Aluminium	mg/L	0.1*	0.002	3.42	0.001	0.001	0.003	0.001	0.001	0.002	0.004	0.001	0.001	0.001	0.001	0.005	0.0010	0.006		0.0010	0.002	0.0010	0.003	0.001	0.003	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.008	0.047	0.007	0.007				0.006	0.006				0.006					0.007	0.007			0.007				0.007
Boron	mg/L	1.4	0.05	0.74	0.06	0.07	0.05	0.05	0.07	0.05	0.15	0.04	0.04	0.05	0.05	0.06	0.06	0.05		0.06	0.06	0.0500	0.05	0.06	0.06	0.06	0.04	0.015
Cadmium	mg/L	0.004	0.0001	0.001	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	0.05	0.0005	0.0081	0.002	0.002				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	2	0.00069	0.009	0.00025	0.00025				0.0007	0.00025				0.0009					0.00025	0.00025			0.00025				0.00025
Iron	mg/L	0.2*	0.11	12.7	0.03	0.03	0.06	0.03	0.03	0.024	0.034	0.09	0.05	0.02	0.038	0.04	0.03	0.19		0.023	0.026	0.0300	0.02	0.03	0.05	0.04	0.05	0.037
Lead	mg/L	0.01	0.00025	0.0244	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.0005	0.00025	0.0151		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	0.4	0.25	0.726	0.2215	0.209	0.211	0.232	0.304	0.221		0.239	0.215	0.226	0.236	0.232	0.236	0.280		0.24	0.226	0.2400	0.226	0.248	0.274	0.258	0.235	0.241
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	0.08	0.00025	0.0064	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0007		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	1.5*	0.002	0.109	0.003	0.003				0.006					0.0005					0.001	0.001			0.001				0.001

E2S Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		5.475	6.12	5.3	4.73	5.46	5.3		5.103	5.37	4.3	4.55	5.3	5.43	5.56	5.34	5.8	5.57	5.57	4.515	5.670	5.55	4.97	4.79	4.635	4.75	4.965
pH		6 to 9	7.5	8	7.7	7.7	7.7	7.8	7.7	7.7		7.4	7.3	7.7	7.6	7.8	7.9	7.8		7.7	7.8	7.500	7.4	7.6	7.9	7.7	7.4	7.5
Suspended Solids	mg/l		13	85	16	16				13					9					*2*	*3*			*2.5*				*3*
Phenol	mg/L		0.025	0.08	0.005	*0.005*				*0.025*					*0.025*					*0.025*				*0.025*				*0.025*
VFA	mg/L		6.5	255	2.5	*2.5*				*2.5*					*2.5*					*2.5*				*2.5*				*2.5*
TOC	mg/L		2.7	3.5	2.1	2.1				2.2					2.4					3.3	2.9			2.9				2.7
Alkalinity	mg CaCO3/L		92	151	92	92				97	90				82					85	145			146				149
Conductivity	mS/m		30.2	46.9	34.25	33.6	34.6	34.7	33.9	33.8	33.8	43.8	44.5	33.3	32.4	33.7	33.2	33.1		35.5	43.8	36.500	43.8	44.9	44.5	44.8	44.2	44.5
COD	mg/L		7.5	54	11.25	*7.5*	44	15	*7.5*	20	30	44	*7.5*	35	18	*7.5*	54	*7.5*		16	18	7.500	*7.5*	*7.5*	27	*7.5*	*7.5*	*7.5*
BOD (scBOD frm Apr'20)	mg/L		1.5	9	0.5	*0.5*	*0.5*	*0.5*	*1.5*	*0.5*	*3*	*1.5*	*3*	*3*	*3*	*3*	*1.5*	*3*		*1.5*	*0.5*	*0.500*	*0.5*	*0.5*				*1.5*
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	3200	50	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*2*	*50*	4	3200	4	*2*		*2.000*	*0.5*	*2.000*	*2.0*	*2*	*ND*	*2*	*2*	*2*
Chloride	mg/L		36	56.1	40.25	40.2	42.4	12.9	40.3	40.7	38.9	41.2	41	39.0	38.1	38.1	35.6	39.8		39.4	44	45.700	40.7	40.7	41.8	41.0	41.4	41.8
Nitrate-N	mg/L	90.3	0.025	0.88	0.005	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*		0.07	*0.005*	*0.005*	*0.005*	0.01	*0.005*	*0.005*		*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Sulphate	mg/L	1000	6.54	21	13.4	13.4				10.1					11					14.1	*0.01*			*0.01*				*0.01*
Ammonia-N	mg/L		0.27	0.54	0.29	0.3	0.26	0.29	0.29	0.3	0.08	0.2	0.24	0.31	0.3	0.29	0.36	0.32		0.33	0.28	0.330	0.26	0.25	0.25	0.26	0.25	0.27
Hardness	mg CaCO3/L		87	123	76	76				84					77					101	123			119				112
Calcium	mg/L	1000	25.55	33.2	20.5	20.5				23.6	24.7				21.3					29.6	27.9			26.0				25.4
Magnesium	mg/L		6.09	13	6.13	6.13				6.15					5.84					6.68	13.0			13.0				11.9
Potassium	mg/L		5.095	6.46	5.71	5.71				5.09					6.28					5.62	6.17			6.46				5.45
Sodium	mg/L		26	112	27.5	27	28.1	27.8	27.2	30.1		41.3	44	30.2	26.7	30.2	27.4	30.9		26.8	44.2	31.400	43.4	41.2	42.7	41.7	44.5	40.6
D.R. Phosphorus	mg/L		0.38	0.66	0.233	0.233				0.245	0.29				0.201					0.238	0.610			0.621				0.567
Aluminium	mg/L	5	0.0045	5.3	0.0035	0.003	0.005	0.003	0.004	0.007	0.021	0.004	0.002	0.002	0.002	0.003	0.002	*0.001*		*0.001*	*0.001*	*0.001*	*0.001*	0.004	*0.001*	*0.001*	*0.001*	*0.001*
Arsenic	mg/L	0.5	0.001	0.004	0					*0.0005*	0.003				0.001					*0.0005*	0.001			0.001				0.001
Boron	mg/L	5	0.028	0.16	0.0275	*0.015*	0.04	*0.015*	0.05	*0.015*	0.16	0.06	0.05	0.03	0.03	0.04	*0.015*	*0.015*		*0.015*	0.06	*0.015*	0.05	0.05	0.04	0.05	0.05	*0.015*
Cadmium	mg/L	0.01	0.0001	0.0005	0.0001	*0.0001*				*0.0001*	*0.0001*				*0.0001*					*0.0001*	*0.0001*			*0.0001*				*0.0001*
Chromium	mg/L	1	0.0005	0.011	0.0005	*0.0005*				*0.0005*	*0.0005*				*0.0005*					*0.0005*	*0.0005*			*0.0005*				*0.0005*
Copper	mg/L	0.4	0.002	0.036	0.00025	*0.00025*				*0.00025*	0.0174				*0.00025*					*0.00025*	*0.00025*			*0.00025*				*0.00025*
Iron	mg/L		0.37	5.27	0.085	0.07	0.1	0.09	0.08	0.082	0.504	0.06	0.09	0.08	0.081	0.06	0.11	0.04		0.064	0.019	0.030	0.06	0.047	0.03	0.02	0.05	0.055
Lead	mg/L	0.1	0.0006	0.03	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		0.0051	0.002	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L		0.251	0.473	0.2555	0.251	0.26	0.234	0.269	0.241		0.358	0.419	0.227	0.225	0.219	0.22	0.239		0.237	0.376	0.246	0.377	0.386	0.389	0.283	0.404	0.376
Mercury	mg/L		0.00025	0.00025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*				
Nickel	mg/L	1	0.0005	0.02	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		0.0006	0.0006	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Zinc	mg/L	20	0.011	0.15	0.002	0.002				*0.001*					*0.001*					0.002	*0.001*			0.003				*0.001*

E2D	Monitoring Bore HDC Levin Landfill

Determinand		NZDW MAV	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Feb-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Feb-21	Jan-21	Nov-20	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		5.03	6.17	4.58	4.87	4.58	4.4		2.302	4.49	5.22	5.56	4.39	4.56		4.62	4.44	4.9	4.78	4.78		5.40		4.7650	6.17	5.79	5.7	5.58	5.66	5.81
pH		7 to 8.5*	7.4	8.1	7.5	7.4	7.4	7.7	7.6	7.5		7.7	7.6	7.6	7.6		7.5	7.6	7.7		7.5		7.7		7.3000	7.8	7.7	8.0	7.7	7.6	7.6
Suspended Solids	mg/l		12	4600	2.5	2.5				21					2.5						7		8				14				3
Phenol	mg/L		0.01	0.03	0.005	0.005				0.025					0.025						0.025						0.025				0.025
VFA	mg/L		8	398	2.5	2.5				2.5					2.5						2.5						2.5				2.5
TOC	mg/L		2.8	3.5	2.7	2.7				3.2					3.1						2.8		2.0				2.1				1.9
Alkalinity	mg CaCO3/L		158	165	161	161				163	158				157						138		81				76				76
Conductivity	mS/m		43	47.8	44.35	44.2	44.7	44.3	44.4	44.9	44.5	34.8	33.9	44.4	44.4		44.5	44.5	44.2		44.4		34.7		44.8000	36.4	35.4	34.6	34.4	34.8	34.9
COD	mg/L		7.5	51	7.5	7.5	7.5	7.5	16	23	7.5	26	7.5	7.5	7.5		7.5	7.5	7.5		7.5		7.5		7.5000	7.5	7.5	20	7.5	7.5	7.5
BOD (scBOD frm Apr'20)	mg/L		0.5	22	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	1.5	3	0.5		0.5	1.5	3		0.5		0.5		0.5000	0.5	0.5				1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	NIL	2	560	0.5	0.5	0.5	0.5	1	38	50	50	2	50	2		12	2	2		4		0.5		2.0000	2.0	2	2	2	2	2
Chloride	mg/L	250*	41.3	66.7	41.6	41.8	42.2	41.1	41.4	41.7	40.7	42.4	40.4	41.6	40.8		41.3	40.6	40.7		40.6		47.3		40.6000	48.1	47.8	45.0	45.9	48.2	48.4
Nitrate-N	mg/L	11.3	0.01	1.2	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005		0.005	0.01	0.005		0.005		0.005		0.0050	0.005	0.005	0.005	0.005	0.005	0.005
Sulphate	mg/L	250*	0.1	16.3	0.01	0.01				0.01					0.01						0.01		16.3				12.4				10.0
Ammonia-N	mg/L	1.17	0.24	3.3	0.24	0.23	0.23	0.25	0.26	0.28	0.27	0.31	0.32	0.25	0.28		0.22	0.25	0.26		0.25		0.29		0.2600	0.3	0.30	0.29	0.29	0.30	0.34
Hardness	mg CaCO3/L	200*	119	129	116	116				129					128						121		81				83				75
Calcium	mg/L		26.7	29.7	24.8	24.8				27.4	26.1				28.1						26.8		22.7				23.1				20.0
Magnesium	mg/L		12.8	14.6	13.1	13.1				14.6					13.9						13.2		5.85				6.14				5.97
Potassium	mg/L		6.1	7.5	6.45	6.45				5.96					7.31						6.67		5.34				5.67				5.40
Sodium	mg/L	200*	40.4	182	39.5	39.5				41.7					43						40.9		28.4				30.2	30.0	10.9	27.2	28.1
D.R. Phosphorus	mg/L		0.541	0.74	0.612	0.612				0.623	0.612				0.632						0.624		0.202				0.198				0.148
Aluminium	mg/L	0.1*	0.004	0.4	0.001	0.001	0.002	0.001	0.001	0.006	0.002	0.001	0.001	0.002	0.002		0.003	0.001	0.001		0.001		0.001		0.0010	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.002	0.0034	0.001	0.001				0.002	0.001				0.001						0.001		0.001				0.001				0.002
Boron	mg/L	1.4	0.05	0.12	0.05	0.04	0.05	0.05	0.06	0.04	0.07	0.015	0.015	0.06	0.006		0.06	0.06	0.06		0.07		0.03		0.0600	0.015	0.015	0.015	0.015	0.015	0.015
Cadmium	mg/L	0.004	0.0001	0.0005	0.0001	0.0001				0.0001	0.0001				0.0001						0.0001		0.0001				0.0001				0.0001
Chromium	mg/L	0.05	0.0005	0.01	0.0005	0.0005				0.0005	0.0005				0.0005						0.0005		0.0005				0.0005				0.0005
Copper	mg/L	2	0.0017	0.0108	0.00025	0.00025				0.002	0.00025				0.00025						0.00025		0.00025				0.00025				0.00025
Iron	mg/L	0.2*	0.5	10.5	0.03	0.03				0.121	0.065				0.071						0.046		0.066				0.046	0.07	0.05	0.05	0.052
Lead	mg/L	0.01	0.0011	0.0733	0.00025	0.00025	0.0009	0.00025	0.00025	0.0014		0.00025	0.00025	0.00025	0.0011		0.0013	0.00025	0.00025		0.00025		0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	0.4	0.4	0.78	0.432	0.458	0.406	0.382	0.505	0.45		0.261	0.229	0.391	0.438		0.393	0.398	0.405		0.409		0.212		0.4020	0.226	0.234	0.232	0.229	0.219	0.230
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025		0.00025		0.00025		0.00025	0.00025	0.00025				
Nickel	mg/L	0.08	0.0008	0.0048	0.00025	0.00025	0.00025	0.00025	0.00025	0.0005		0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025		0.00025		0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	1.5*	0.011	0.058	0.003	0.003					0.014					0.004						0.001		0.001					0.001		

F1 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		7.965	8.62	7.56	8.15	7.56	7.4		7.1	7.46	7.07	7.76	7.46	7.57	7.96	7.65	8.25	7.905	7.91	7.70	8.130	7.80	8.38	7.97	7.92	7.89	8.21
pH		6 to 9	6.9	7.9	7.05	6.7	6.9	7.2	7.2	7.7		7	6.9	7.0	7.5	7	7	6.8		6.9	7.2	6.900	6.9	7.6	7.8	6.8	7.9	7.6
Suspended Solids	mg/l		3	51	2.5	*2.5*				*2.5*					*1.5*					*2*	*3*			*2.5*				*2.5*
Phenol	mg/L		0.02	0.04	0.005	*0.005*				*0.025*										*0.025*				*0.025*				*0.025*
VFA	mg/L		2.5	25	2.5	*2.5*				*2.5*					*2.5*					*2.5*				*2.5*				*2.5*
TOC	mg/L		4.6	9.6	4.4	4.4				6.4					6					5.1	4.8			5.5				6.2
Alkalinity	mg CaCO3/L		115	157	134	134				149	146				141					113	115			131				144
Conductivity	mS/m		44.8	62	45.5	49.3	48.5	42.2	42.5	42	41.2	40.1	43.2	41.6	42.4	41.1	45.2	47.8		48.5	47.8	47.500	47.4	46.6	43.4	42.4	46.8	47.2
COD	mg/L		7.5	266	11.75	*7.5*	16	*7.5*	34	25	28	24	*7.5*	33	47	*7.5*	21	28		26	28.0	*7.500*	26	16	*7.5*	*7.5*	30	18
BOD (scBOD frm Apr'20)	mg/L		0.5	7.6	0.5	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*1.5*	*1.5*	*0.5*	*1.5*	*0.5*	*0.5*	*1.5*	*3*		*1.5*	*0.5*	*0.500*	*0.5*	*0.5*				*0.5*
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	290	50	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*2*	*50*	*2*	*2*	*2*	*2*		*27*	*0.5*	*2.000*	*2.0*	*2*	*2*	*2*	*2*	*2*
Chloride	mg/L		55.6	113	51.85	62.6	56.7	47	38.5	40.1	37.4	38	42.1	41.0	40.7	44.1	44.4	48.2		61	57.8	28.500	48.7	49.4	51.0	51.8	49.6	48.2
Nitrate-N	mg/L	90.3	1.96	15.4	1.81	2.9	2.11	1.51	0.65	0.6		0.57	0.48	0.56	0.38	0.93	0.52	0.67		2.02	1.89	1.640	0.98	1.01	1.47	1.96	1.54	0.78
Sulphate	mg/L	1000	7.605	22	2.97	2.97				2.18					2.97					7.59	6.94			5.24				2.90
Ammonia-N	mg/L		0.005	1	0.005	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	0.02	*0.005*	*0.005*	0.01	*0.005*	*0.005*	*0.005*	*0.005*		*0.005*	*0.005*	*0.050*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Hardness	mg CaCO3/L		125	166	166	166				122					123					130	125			125				121
Calcium	mg/L	1000	18.4	26.7	24	24				17.5	16.7				18.4					19.0	18.6			18.3				17.4
Magnesium	mg/L		19.1	25.8	25.8	25.8				19.1					18.8					19.9	19.1			19.2				18.8
Potassium	mg/L		7.46	9.92	8.2	8.2				8.71					8.66					9.18	9.06			8.95				7.78
Sodium	mg/L		39.5	169	40.6	40.6				35.4					40.6					41.9	43			42.9	38.4	14.3	30.7	39.5
D.R. Phosphorus	mg/L		0.168	0.35	0.161	0.161				0.171	0.172				0.182					0.155	0.169			0.172				0.171
Aluminium	mg/L	5	0.002	25	0.002	0.009	*0.001*	0.002	0.002	*0.001*	*0.001*	0.002	0.002	0.002	*0.001*	*0.001*	0.003	0.005		*0.001*	*0.001*	*0.001*	0.002	*0.001*	*0.001*	*0.001*	0.003	*0.001*
Arsenic	mg/L	0.5	0.002	0.009	0.002	0.002				0.002	0.002				0.002					0.002	0.002			0.002				0.002
Boron	mg/L	5	0.025	345	0.045	0.04	0.05	0.05	0.04	0.04	0.04	*0.015*	*0.015*	0.04	0.03	0.04	0.04	0.03		0.03	*0.015*	0.030	0.03	345	0.03	0.03	*0.015*	0.03
Cadmium	mg/L	0.01	0.0001	0.0005	0.0001	*0.0001*				*0.0001*	*0.0001*				*0.0001*					*0.0001*	*0.0001*			*0.0001*				*0.0001*
Chromium	mg/L	1	0.0005	0.035	0.001	0.001				*0.0005*	*0.0005*				*0.0005*					*0.0005*	*0.0005*			*0.0005*				*0.0005*
Copper	mg/L	0.4	0.002	0.04	0.0021	0.0021				0.0027	0.0018				0.003					0.0013	0.0029			0.0030				0.0021
Iron	mg/L		0.009	21.6	0.01	0.01				*0.0025*	*0.0025*				*0.0025*					*0.0025*	*0.0025*			*0.0025*	*0.005*	*0.005*	*0.005*	*0.0025*
Lead	mg/L	0.1	0.00025	0.0782	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.000250*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L		0.0057	0.627	0.00705	0.0096	0.0077	0.006	0.0064	0.0057		0.0038	0.0045	0.0047	0.0058	0.0044	0.0241	0.0161		0.0038	0.0042	0.0053	0.018	0.0044	0.0028	0.0030	0.0133	0.0040
Mercury	mg/L		0.00025	0.00025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.000250*	*0.00025*	*0.00025*				
Nickel	mg/L	1	0.0006	0.0169	0.0006	0.0006	0.0006	*0.00025*	0.0006	0.0005		0.0007	0.0006	*0.00025*	*0.00025*	*0.00025*	0.0008	0.0008		*0.00025*	*0.00025*	*0.000250*	0.0009	*0.00025*	*0.00025*	*0.00025*	0.0014	0.0006
Zinc	mg/L	20	0.002	0.144	0.005	0.005				*0.001*					*0.001*					*0.001*	*0.001*			*0.001*				*0.001*

F2 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Feb-21	Jan-21	Nov-20	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		3.02	5.27	2.3	2.84	2.3	2.18		1.9	2.19	1.8	2.68	2.44	2.51	3	2.64	3.21	2.76	2.76		2.67		3.100	3.77	3.11	5.27	5.265	2.87	2.995
pH		6 to 9	7	7.8	7.15	7	7	7.3	7.3	7.1		6.9	7.1	7.1	7.6	7.2	7.4	7		7.0		7.3		7.100	7.1	7.2	7.5	7.0	7.3	7.0
Suspended Solids	mg/l		3	140	7	7				6					1.5					2.5		3				3				2.5
Phenol	mg/L		0.01	0.025	0.005	0.005				0.025					0.025					0.025						0.025				0.025
VFA	mg/L		7	25	2.5	2.5				2.5					2.5					2.5						2.5				2.5
TOC	mg/L		1.6	10.2	1.5	1.5				1.8					1.8					1.6		1.6				1.6				1.4
Alkalinity	mg CaCO3/L		53	60	57	57				60	59				56					51		50				53				52
Conductivity	mS/m		28	40.5	22.3	22.2	22.2	22.5	22.4	22.3	22.4	22.2	22.4	22.2	22.3	21.9	21.9	21.8		21.3		21.6		21.600	21.7	22.1	22.2	22.6	22.9	22.3
COD	mg/L		7.5	51	7.5	7.5	7.5	7.5	22	7.5	7.5	7.5	27	19	39	7.5	7.5	14.99		17		19		7.500	7.50	7.5	7.5	7.5	51	7.5
BOD (scBOD frm Apr'20)	mg/L		0.5	5.9	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	0.5	1.5	0.5	0.5	1.5	5.9		1.5		0.5		0.500	0.5	0.5				0.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	50	50	50	50	50	50	50	50	50	2	50	2	0.5	2	3.9		2		2		2	2	2	2	2	2	2
Chloride	mg/L		33.9	52.3	23.3	23.3	23.3	23.8	22.7	24	24	24.1	23.1	22.8	23.7	22.6	22.4	23.3		22.3		22.7		21.800	23	23.2	22.7	23.4	22.8	23.7
Nitrate-N	mg/L	90.3	5	22.5	0.515	0.38	0.54	0.53	0.5	0.31		0.34	0.35	0.40	0.25	0.28	0.28	0.13		0.18		0.25		0.470	0.43	0.33	0.55	0.73	0.74	0.57
Sulphate	mg/L	1000	8	12.5	11.3	11.3				10.7					10.2					9.49		9.1				8.97				10.1
Ammonia-N	mg/L		0.005	0.21	0.005	0.005	0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0		0.005		0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.005
Hardness	mg CaCO3/L		45.5	64	41	41				40					40					38		36				37				39
Calcium	mg/L	1000	7.47	10.2	6.5	6.5				6.21	6.47				6.66					5.81		5.74				6.01				6.32
Magnesium	mg/L		6.5	9.12	5.94	5.94				5.85					5.78					5.59		5.17				5.41				5.55
Potassium	mg/L		5.82	7	5.12	5.12				5.44					5.8					5.22		5.28				5.45				4.47
Sodium	mg/L		31.55	166	25	25				26.7					26.4					26.3		25.6				26.1	24.7	23.6	23.8	25.6
D.R. Phosphorus	mg/L		0.137	0.27	0.144	0.144				0.121	0.133				0.152					0.132		0.136				0.148				0.146
Aluminium	mg/L	5	0.002	1.43	0.003	0.004	0.001	0.003	0.003	0.001	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.003		0.001		0.001		0.001	0.001	0.002	0.001	0.002	0.002	0.001
Arsenic	mg/L	0.5	0.001	0.002	0.002	0.002				0.001	0.001				0.001					0.001		0.001				0.002				0.001
Boron	mg/L	5	0.04	0.06	0.05	0.05	0.06	0.05	0.05	0.05	0.04	0.015	0.04	0.04	0.003	0.04	0.04	0.04		0.04		0.03		0.040	0.04	0.03	0.04	0.03	0.04	0.03
Cadmium	mg/L	0.01	0.0001	0.0005	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001		0.0001				0.0001				0.0001
Chromium	mg/L	1	0.0005	0.003	0.003	0.003				0.0005	0.0005				0.0005					0.0005		0.0005				0.0005				0.0005
Copper	mg/L	0.4	0.0011	0.0071	0.0071	0.0071				0.0012	0.0006				0.0018					0.0010		0.0018				0.0013				0.0009
Iron	mg/L		0.018	1.3	0.03	0.03				0.013	0.026				0.020					0.015		0.009				0.018	0.005	0.005	0.005	0.014
Lead	mg/L	0.1	0.00025	0.013	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0004		0.00025		0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.0039	0.057	0.00545	0.012	0.0049	0.0059	0.005	0.0078		0.0102	0.0061	0.0016	0.0205	0.002	0.0027	0.0252		0.0139		0.005		0.0017	0.004	0.0360	0.0050	0.0017	0.0010	0.0088
Mercury	mg/L		0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0004		0.00025		0.00025		0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.00025	0.009	0.00025	0.0006	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.0007	0.00025	0.00025	0.0004		0.00025		0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.001	0.014	0.002	0.002				0.001					0.001					0.001		0.001				0.002				

F3 Monitoring Bore HDC Levin Landfill

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		5.45	6.6	5.25	5.25	5.8	4.62		4.2	4	4.3	5.15	4.81	4.85	5.35	5.4	5.67	5.165	5.17	5.07	5.560	6.60	5.43	2.83	2.83	5.45	5.44
pH		6 to 9	7	7.9	7.15	6.9	7.1	7.4	7.2	7.1		7.4	7.2	7.1	7.5	7.1	7.4	7.9		7.0	7.3	7.000	7.1	7.8	7.5	7.0	7.0	7.3
Suspended Solids	mg/l		4.5	164	2.5	2.5				2.5					14					2.5	40			3				2.5
Phenol	mg/L		0.01	0.025	0.005	0.005				0.025					0.025					0.025				0.025				0.025
VFA	mg/L		6	25	2.5	2.5				2.5					2.5					2.5				2.5				2.5
TOC	mg/L		1.3	1.7	1.1	1.1				1.3					1.5					1.5	1.4			1.3				1.2
Alkalinity	mg CaCO3/L		46	57	52	52				57	56				49					43	46			53				45
Conductivity	mS/m		21.2	27	18.95	17.8	18.9	20	19	18.6	18.3	26.9	19.4	21.7	18.6	19.5	21.8	21.8		19.2	20.2	23.500	23.5	19.2	18.4	20.6	20.6	20.4
COD	mg/L		7.5	56	7.5	7.5	7.5	20	7.5	<15	7.5	7.5	7.5	7.5	34	7,5	14.99	29		7.5	7.5	7.500	7.5	7.5	7.5	7.5	56	15
BOD (scBOD frm Apr'20)	mg/L		0.5	8	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	0.5	1.5	0.5	0.5	2.9	1.5		1.5	0.5	0.500	0.5	0.5				0.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	50	50	50	50	50	50	50	50	50	2	50	4	0.5	4	2		16	0.5	2	2	2	2	2	2	2
Chloride	mg/L		24.1	45	16.55	14.6	17.1	23.2	16	16.4	16.1	42.4	16.9	23.2	17.9	18	19.5	19.2		17.4	17	21.600	22.2	15.4	14.7	19.4	20.6	21.9
Nitrate-N	mg/L	90.3	1.355	9	1.65	1.62	2.37	1.68	1.05	0.99		0.72	0.64	0.37	1.08	1.36	1.09	1.15		1.53	2.37	2.050	1.55	1.11	1.19	1.93	1.52	0.88
Sulphate	mg/L	1000	5	11.8	4.69	4.69				4.91					5.48					8.39	6.86			7.03				11.8
Ammonia-N	mg/L		0.005	0.1	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0	0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Hardness	mg CaCO3/L		36	42	34	34				32					31					33	35			34				37
Calcium	mg/L	1000	5.36	6.71	5.2	5.2				4.76	4.67				4.77					4.84	5.36			5.18				5.63
Magnesium	mg/L		5.22	6.22	5.17	5.17				4.92					4.54					4.99	5.18			5.08				5.45
Potassium	mg/L		5.11	7	4.34	4.34				4.88					5.18					4.930	5.03			5.11				4.62
Sodium	mg/L		24.6	115	24.85	24.9	24.8	32.9	19.2	23		27.5	24.4	27.0	22.3	25.7	26.8	25.7		22	24.5	26.800	26.1	23.0	20.6	9.08	22.0	22.0
D.R. Phosphorus	mg/L		0.139	0.24	0.151	0.151				0.152	0.152				0.161					0.136	0.143			0.143				0.139
Aluminium	mg/L	5	0.003	8.88	0.002	0.002	0.001	0.074	0.002	0.001	0.002	0.001	0.003	0.002	0.001	0.001	0.003	0.007		0.001	0.002	0.030	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.5	0.001	0.002	0.002	0.002				0.002	0.001				0.002					0.002	0.001			0.002				0.001
Boron	mg/L	5	0.015	0.07	0.035	0.03	0.04	0.06	0.015	0.04	0.03	0.015	0.015	0.015	0.015	0.03	0.02	0.015		0.015	0.015	0.015	0.02	0.015	0.03	0.015	0.015	0.015
Cadmium	mg/L	0.01	0.0001	0.0005	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.0005	0.009	0.003	0.003				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	0.4	0.001	0.016	0.0011	0.0011				0.001	0.00025				0.0005					0.0007	0.0014			0.0005				0.00025
Iron	mg/L		0.007	10.1	0.005	0.005	0.005	0.02	0.005	0.0025	0.0025	0.005	0.01	0.005	0.0025	0.005	0	0.005		0.0025	0.0025	0.010	0.005	0.0025	0.005	0.005	0.005	0.0025
Lead	mg/L	0.1	0.00025	0.009	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.0004	0.00025		0.00025	0.00025	0.000250	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.0015	0.141	0.000375	0.00025	0.0005	0.0031	0.00025	0.00025		0.00025	0.00025	0.0016	0.00025	0.00025	0.0009	0.00025		0.00025	0.0007	0.000250	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Mercury	mg/L		0.00025	0.0006	0.00025	0.00025	0.00025	0.0006	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.0004	0.00025		0.00025	0.00025	0.000250	0.00025	0.00025				
Nickel	mg/L	1	0.00025	0.009	0.00025	0.00025	0.00025	0.0008	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.0004	0.00025		0.00025	0.0005	0.000250	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	20	0.001	0.029	0.003	0.003				0.001					0.001					0.001	0.001			0.001				0.001

HS1A (from Apr 2020) Hokio Stream Upstream

Determinand		ANZECC AE (95%)	Median	Maximum	Annual Median	Jun-24	May-24	Apr-24	Mar-24	Feb-24	Jan-24	Dec-23	Nov-23	Oct-23	Sep-23	Aug-23	Jul-23	Jun-23	May-23	Apr-23	Mar-23	Feb-23	Jan-23	Dec-22	Nov-22	Oct-22	Sep-22	Aug-22	Jul-22
pH		-	7.6	9.3	7.5	7.7	7.7	7.4	7.6	7.6	7.3	7.5	7.4	7.5	7.7	9.1	7.5	7.6	7.3	7.4	7.7	8.6	7.1	7.5	7.4	7.8	7.8	7.3	7.3
Suspended Solids	mg/l	-	28	246	25	41	13	66	21	7		11	19	29	41	79	15	*2.5*	*3*	12	39	35	125	9	112	11.0	37.0	7.0	27
Phenol	mg/L	0.32	0.025	0.025	0.015	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*			*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
VFA	mg/L	-	2.5	2.5	2.5	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*			*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*
TOC	mg/L	-	7	16.2	5.45	4	6.2	7	6.9	8.1		4.8	6.1	4.7	4.4	9	4.7	6.5	5.4	6.8	7	8.4	9.1	7	6	7.7	9.1	7.0	8.2
Alkalinity	mg CaCO3/L	-	55	67	57.5	51	62	66	60	50		55	60	54	52	52	60	61	55	59	47	61	56	55	59	60.0	52.0	39.0	32
Conductivity	mS/m	-	23.5	26.2	24.3	24.6	25.3	25.9	25.3	23.3	25.1	23.7	24.3	23.6	23.3	21.7	23.8	23.4	22.9	23.2	21.8	20.9	25.4	23.4	25.1	24.1	22.8	20.1	20.4
COD	mg/L	-	34	72	34	31	33	30	64	24	51	35	34	22	40	48	30	22	19	28	44	53	48	29	*7.5*	55.0	45.0	47.0	36
BOD (scBOD frm Apr'20)	mg/L	2	1.5	6	0.5	2	*0.5*	*0.5*	*0.5*	2	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	1	*0.5*	*0.5*	*1.5*	*1.5*	*3*	*3*	*3*	6	*1.5*	*1.5*	*3.0*	*1.5*	*1.5*
Faecal C (Ecoli frm Apr'20)	col/100ml	-	165	5400	100	800	*50*	100	100	500	*0.5*	600	100	*50*	200	*50*	*50*	100	800	5400	*50*	900	200	200	*50.0*	80.0	48.0	32.0	300.0
Chloride	mg/L	-	23.3	28.5	23.8	24.5	28.5	28.1	27.5	26.1	27.3	23.1	23.8	23.7	22.9	23.2	22.3	22.8	21.7	23.1	23.6	22.7	24.7	22.9	22.8	21.9	20.1	19.2	20.7
Nitrate-N	mg/L	0.16	0.42	2.57	0.26	0.89	0.22	0.2	0.26	0.18	0.14	0.13	0.42	0.94	1.31	0.07	1.61	1.05	1.46	0.14	0.15	0.07	0.11	0.05	0.94	1.88	2.08	2.57	2.46
Sulphate	mg/L	-	18.3	22.7	18.55	19.8	18.5	15.7	15.3	19.1		19.9	19.1	18.6	18.4	18.9	17.8	15.7	15.3	14.5	16.4	18.1	20.3	21.8	21.9	21.6	21.0	17.3	17.7
Ammonia-N	mg/L	2.1	0.05	0.75	0.05	0.05	*0.005*	0.01	0.08	0.10	0.05	0.06	0.13	0.09	0.17	*0.005*	0.05	0.06	0.08	0.04	0.07	0.02	0.18	0.09	0.16	0.03	0.04	0.06	0.08
Hardness	mg CaCO3/L	-	62	98	61.5	59	62	61	67	53		59	57	64	66	61	98	64	64	65	58	51	69	65	69	65.0	65.0	54.0	59
Calcium	mg/L	-	13.3	24	13.2	12.6	13.3	11.3	13.8	10.5		12	11.6	13.1	13.5	13.3	24	13.4	13	12.2	12.4	10.8	14.6	13.7	15	14.0	13.7	12.2	13.6
Magnesium	mg/L	-	7.01	9.2	7.34	6.6	7.08	8.01	7.81	6.57		6.94	6.75	7.6	7.87	6.63	9.2	7.3	7.72	8.3	6.68	5.9	7.88	7.54	7.74	7.29	7.60	5.64	6.16
Potassium	mg/L	-	2.96	9.59	2.845	2.72	2.92	3.39	2.57	1.73		2.71	2.52	2.77	3.3	2.95	4.3	3.2	3.22	2.45	1.95	1.68	2.97	2.89	3.29	2.96	3.63	3.58	3.44
Sodium	mg/L	-	20	25.5	20.8	20	19.4	24.8	25.5	23.4		20.3	19	20.9	22.5	20.7	25.3	20.3	19.5	20.8	25.2	21.8	22.2	20.4	20.3	19.5	19.6	15.7	16.0
D.R. Phosphorus	mg/L	-	0.036	0.382	0.04	0.043	0.009	0.145	0.203	0.165		0.045	0.04	0.019	0.04	*0.0025*	0.031	0.045	0.1	0.3	0.4	0.203	0.061	0.037	0.036	*0.0025*	0.008	0.028	0.032
Aluminium	mg/L	0.055	0.021	2580	0.021	0.004	0.011	0.007	0.027	0.022	0.106	0.017	0.023	0.021	0.031	0.114	0.014	0.011	0.015	0.025	0.011	2580	0.044	0.013	0.014	0.045	0.023	0.046	0.046
Arsenic	mg/L	0.024	0.0005	0.004	0.0005	*0.0005*	*0.0005*	0.002	0.003	0.002		*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	0.001	0.003	0.004	0.003	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*
Boron	mg/L	0.37	0.06	0.08	0.06	0.04	0.07	0.06	0.08	0.06	0.05	0.05	0.06	0.06	0.05	0.05	0.08	0.03	0.08	0.07	0.06	0.05	0.05	0.07	0.07	0.06	0.05	0.05	0.05
Cadmium	mg/L	0.0002	0.0001	0.0001	0.0001	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*		*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
Chromium	mg/L	0.001	0.0005	0.0005	0.0005	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*		*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*
Copper	mg/L	0.0014	0.0012	0.0026	0.00105	0.0007	0.0008	0.0015	0.0013	0.0019		0.0009	0.0011	0.001	0.0017	0.0011	0.0008	0.0007	0.0012	0.0014	0.0009	0.001	0.0012	0.0026	0.0013	0.0014	0.0017	0.0023	0.0018
Iron	mg/L	-	0.08	0.33	0.075	0.03	0.08	0.12	0.15	0.13		0.06	0.07	0.07	0.09	0.33	0.07	0.134	0.13	0.119	0.148	0.098	0.153	0.093	0.039	0.123	0.250	0.142	0.142
Lead	mg/L	0.0034	0.00025	0.0016	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	0.0006	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Manganese	mg/L	1.9	0.0158	0.234	0.0243	0.0083	0.0053	0.0243	0.0082	0.0101	0.0946	0.0252	0.0386	0.0413	0.0319	0.0116	0.0129	0.0299	0.0171	0.0211	0.0154	0.0098	0.016	0.0361	0.0158	0.0053	0.1220	0.0142	0.0022
Mercury	mg/L	0.0006	0.00025	0.0005	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*
Nickel	mg/L	0.011	0.00025	0.0009	0.00025	*0.00025*	0.0006	0.0006	0.0005	0.0011	0.0007	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	0.0006	0.0006	0.0006	*0.00025*	*0.00025*	0.0009	*0.00025*	*0.00025*	0.0006	*0.00025*	*0.00025*
Zinc	mg/L	0.008	0.002	0.007	0.002	0.003	0.006	0.003	0.002	0.012		*0.001*	0.002	0.002	0.003	*0.001*	*0.001*	0.006	0.006	0.007	0.006	*0.001*	*0.001*	0.007	*0.001*	*0.001*	0.004	0.007	0.003

HS1A (from Apr 2020)	Hokio Stream Upstream

Determinand		ANZECC AE (95%)	Median	Maximum	Jun-22	May-22	Apr-22	Mar-22	Feb-22	Jan-22	Dec-21	Nov-21	Oct-21	Jul-21	Jun-21	May-21	Apr-21	Mar-21	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20	Aug-20	Jul-20	Jun-20	May-20	Apr-20
pH		-	7.6	9.3	7.4	7.5	7.7	9.0	7.8	7.3	7.0	7.8	7.4	7.4	7.7	7.5	8.0	7.7	7.5	8.1	8.6	9.3	7.80	7.8	7.5	7.6	7.6	8.3	7.8
Suspended Solids	mg/l	-	28	246	6	11	11.0	27.0	9.0	29.0	46.0	<6	18.0		112	58	46	33	57	160	104	246	18.00	17	12	23	20	36	23
Phenol	mg/L	0.32	0.025	0.025			0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
VFA	mg/L	-	2.5	2.5			2.5	2.5	2.5	2.5	2.5	2.5	2.5		2.5000	2.5	2.5	2.5	2.5	<5	2.5	2.5	2.50	2.5	2.5	2.5	2.5	2.5	2.5
TOC	mg/L	-	7	16.2	6.1	7.2	6.8	8.1	6.7	8.3	10.8	7.1	5.3		4.4	8.5	9.6	8.4	8.2	14.4	11.8	16.2	8.30	7.2	4.6	7.2	6.3	8.4	8.1
Alkalinity	mg CaCO3/L	-	55	67	43	55	65.0	44.0	50.0	55.0	52.0	63.0	47.0		53	65	59	57	54	44	47	51	44.00	43	43	44	52	67	61
Conductivity	mS/m	-	23.5	26.2	21.5	23.9	25.2	21.3	21.8	22.6	19.9	24.1	21.4	20.6	23.8	24.8	23.0	23.7	23.9	20.3	19.6	21.5	22.30	23.6	23.5	23.4	23.6	25.2	26.2
COD	mg/L	-	34	72	34	31	27.0	26.0	33.0	34.0	72.0	31.0	17.0	18	7.5	40	51	62	51	49	54	40	35.00	29	27	27	22	35	24
BOD (scBOD frm Apr'20)	mg/L	2	1.5	6	3	3	3	3	3	3	3	3	3	3	0.5	3	3	1.5	1	1.5	3	3	0.50	0.5	0.5	0.5	0.5	3	0.5
Faecal C (Ecoli frm Apr'20)	col/100ml	-	165	5400	100		190.0	68.0	1700.0	200.0	1700.0	35.0	170.0	180	110.0000	580	310	600	88	110	80	160	600.00	100	780	1900	92	1700	320
Chloride	mg/L	-	23.3	28.5	22.4	23.6	25.0	22.0	26.7	20.0	16.8	23.6	20.4	20.6	23.5	24.5	23.3	27.1	23.4	19.2	18.8	22.2	21.60	25.5	23.7	25.3	23.9	24.3	26.6
Nitrate-N	mg/L	0.16	0.42	2.57	2.29	0.78	0.08	0.2	0.15	0.81	0.56	0.34	1.3	1.25	0.66	0.420	0.005	0.005	0.200	0.020	0.410	0.005	0.77	1.05	1.03	0.660	0.440	0.140	0.04
Sulphate	mg/L	-	18.3	22.7	18.5	16.8	16.0	20.0	18.3	16.3	14.4	19.7	20.6		18.3	10.1	9.75	16.2	16.5	14.4	16.6	18.8	19.40	22.7	21.8	20.0	18.1	14.4	18.1
Ammonia-N	mg/L	2.1	0.05	0.75	0.04	0.25	0.04	0.1	0.05	0.14	0.05	0.11	0.1	0.09	0.005	0.750	0.005	0.040	0.090	<0.01	0.030	0.005	0.02	0.040	0.040	0.090	0.020	0.010	0.03
Hardness	mg CaCO3/L	-	62	98	55	63	75.0	54.0	59.0	65.0	60.0	65.0	56.0		58	65	61	62	62	52	50	55	62.00	65	60	61	62	65	69
Calcium	mg/L	-	13.3	24	12.2	13.6	16.0	11.8	12.6	14.0	13.2	14.2	12.5		12.8	13.9	13.1	13.5	13.4	11.6	10.4	11.9	13.40	14.0	13.0	12.8	13.8	13.8	14.7
Magnesium	mg/L	-	7.01	9.2	6.05	7.13	8.6	6.0	6.69	7.39	6.6	7.28	6.0		6.22	7.35	6.9	6.95	6.86	5.64	5.82	6.08	7.01	7.2	6.66	6.9	6.8	7.4	7.85
Potassium	mg/L	-	2.96	9.59	3.13	3.88	3.3	2.6	9.59	3.58	4.34	3.0	3.3		2.9300	3.19	2.88	3.33	3.22	2.92	3.20	2.59	2.79	2.87	2.62	3.17	2.78	2.88	3.27
Sodium	mg/L	-	20	25.5	17.1	19.9	21.9	17.2	17.4	18.0	14.6	21.3	17.1		19.0	18.6	20.0	21.8	18.6	17.0	15.6	17.6	18.70	18.2	18.1	18.5	21.0	20.4	22.6
D.R. Phosphorus	mg/L	-	0.036	0.382	0.016	0.028	0.0620	0.0830	0.1180	0.0110	0.0550	0.0500	0.0		0.01	0.042	0.308	0.136	0.023	0.015	0.008	0.007	0.0025	0.0025	0.0100	0.005	0.004	0.005	0.018
Aluminium	mg/L	0.055	0.021	2580	0.019	0.017	0.0120	0.0290	0.0360	0.0350	0.0230	0.0300	0.0	0.021	0.0050	0.014	0.004	0.016	0.326	0.013	0.032	0.016	0.022	0.011	0.008	0.023	0.015	0.008	0.011
Arsenic	mg/L	0.024	0.0005	0.004	0.0005	0.0005	0.0010	0.0010	0.0005	0.0010	0.0010	0.0010	0.0005		0.0005	0.0005	0.004	0.003	0.002	0.001	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Boron	mg/L	0.37	0.06	0.08	0.05	0.05	0.0600	0.0600	0.0600	0.0700	0.0600	0.0500	0.1	0.05	0.0500	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.06	0.05	0.05	0.04	0.06	0.05	0.06
Cadmium	mg/L	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001	0.0001	0.0001	<0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/L	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005	0.0005	0.0005	0.0005	0.0005	<0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	0.0014	0.0012	0.0026	0.0011	0.00025	0.0008	0.0011	0.0014	0.0013	0.0016	0.0021	0.0		0.0010	0.00100	0.00120	0.00100	0.00250	0.00170	0.00190	0.00130	0.0016	0.0012	0.0007	0.00170	0.00070	0.00110	0.0008
Iron	mg/L	-	0.08	0.33	0.072	0.068	0.1670	0.1070	0.1570	0.1350	0.1280	0.0750	0.1		0.019	0.067	0.011	0.029	0.034	0.058	0.057	0.028	0.065	0.089	0.024	0.036	0.027	0.014	0.019
Lead	mg/L	0.0034	0.00025	0.0016	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00160	<0.0005	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	1.9	0.0158	0.234	0.0162	0.0306	0.0396	0.0097	0.0211	0.0950	0.0018	0.0296	0.0	0.0112	0.0125	0.0265	0.0575	0.0443	0.2340	0.0043	0.0062	0.0016	0.01090	0.0029	0.0145	0.0099	0.0062	0.0173	0.0385
Mercury	mg/L	0.0006	0.00025	0.0005	0.00025	0.00025	0.00025	0.0005	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	<0.0005	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Nickel	mg/L	0.011	0.00025	0.0009	0.0005	0.00025	0.00025	0.0005	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00050	0.00025	0.00060	<0.0005	0.00025	0.00025	0.00025	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	0.008	0.002	0.007	0.003	0.001	0.0030	0.0010	0.0060	0.001	0.0020	0.0030	0.001		0.001	0.004	0.001	0.001	0.007	0.002	0.003	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.001

HS1 Hokio Stream Upstream

Determinand		ANZECC AE (95%)	Median	Maximum	Annual Median	Jun-24	May-24	Apr-24	Mar-24	Feb-24	Jan-24	Dec-23	Nov-23	Oct-23	Sep-23	Aug-23	Jul-23	Jun-23	May-23	Apr-23	Mar-23	Feb-23	Jan-23	Dec-22	Nov-22	Oct-22	Sep-22	Aug-22	Jul-22
pH		-	7.6	9.5	7.5	7.6	7.6	7.4	7.5	7.7	7.3	7.5	7.4	7.6	7.5	9.2	7.5	7.7	7.4	7.6	7.8	8.6	7.3	7.5	7.5	7.7000	8.8000	7.4000	7.2
Suspended Solids	mg/l	-	15	137	9	1.5	6	7	2.5	2.5	10	8	13	16	36	25	15	2.5	3	8	6	26	20	18	28	10.0000	29.0000	6.0000	28
Phenol	mg/L	0.32	0.025	0.04	0.015	0.005	0.005	0.005	0.005	0.005			0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
VFA	mg/L	-	2.5	91	2.5	2.5	2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
TOC	mg/L	-	7.1	24.8	5.3	3.8	5.1	6.6	7	7.3	6.1	4.5	5.8	5.3	4.4	9	5.1	7.2	5.4	7.1	7.1	8.3	7.5	7	6.1	7.5000	10.3000	7.3000	7.7
Alkalinity	mg CaCO3/L	-	56	79	58	52	62	66	60	49	58	56	61	54	53	52	58	64	56	60	59	62	62	58	60	59.0000	48.0000	38.0000	36
Conductivity	mS/m	-	24.3	39	24.7	24.7	25.3	26	25.6	23.5	25.3	24	24.9	23.9	23.8	21.7	23.9	23.6	22.6	22.6	22.1	21.1	25.7	23.8	25.3	24.3000	21.9000	20.0000	20.4
COD	mg/L	-	32	130	27	7.5	18	7.5	7.5	19	49	42	34	27	38	39	22	28	19	18	33	57	36	40	21	45.0000	7.5	28.0000	28
BOD (scBOD frm Apr'20)	mg/L	2	3	13.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1.5	1.5	3	3	3	1.5	1.5	1.5	3.0	1.5	4
Faecal C (Ecoli frm Apr'20)	col/100ml	-	230	40000	200	200	50	200	500	50	300	300	200	100	100	50	200	50	50	50	100	1000	300	500	50	80.0000	32.0000	20.0000	50
Chloride	mg/L	-	26.4	300	24.9	24.6	25.9	28	27.6	25.9	26.6	24.5	24.9	9.36	47.1	23.3	22.3	23.1	21	23.9	23.2	23	25.4	26.6	23	22.5000	19.9000	20.6000	20.3
Nitrate-N	mg/L	0.16	0.49	4.5	0.19	0.89	0.19	0.19	0.16	0.19	0.14	0.14	0.44	0.94	1.52	0.06	1.6	1.01	1.46	0.13	0.14	0.07	0.08	0.005	0.93	1.8900	2.4500	2.5300	2.39
Sulphate	mg/L	-	18.75	41	17.7	19.7	16.7	15.5	15.3	19.2	20.7	20.1	19.5	11.2	13.9	18.8	17.7	15.8	15.2	14.9	16	18.1	20.5	22.8	21.7	21.8000	22.0000	17.2000	17.2
Ammonia-N	mg/L	2.1	0.05	1.75	0.05	0.04	0.05	0.03	0.04	0.04	0.04	0.16	0.16	0.08	0.18	0.01	0.06	0.07	0.11	0.02	0.12	0.04	0.23	0.02	0.17	0.0800	0.005	0.0300	0.06
Hardness	mg CaCO3/L	-	63	85	63	61	63	63	66	55	61	57	58	65	67	61	85	62	64	62	58	49	69	65	71	66.0000	61.0000	53.0000	61
Calcium	mg/L	-	13.45	20.6	13.2	13.1	13.7	11.4	13.8	10.9	11.8	11.9	12.1	13.2	13.7	13.4	20.6	12.9	12.9	11.7	12.4	10.4	14.8	13.6	15.4	14.2000	12.4000	12.1000	14.0
Magnesium	mg/L	-	7.24	9.26	7.64	6.88	7.12	8.29	7.64	6.67	7.66	6.7	6.74	7.73	7.92	6.67	8.14	7.28	7.81	7.96	6.66	5.56	7.88	7.43	8	7.4100	7.2000	5.5700	6.33
Potassium	mg/L	-	3.12	5.44	2.73	2.73	2.64	3.2	2.28	1.52	2.41	2.66	2.71	2.87	3.49	3.04	3.93	3.28	3.08	2.47	1.86	1.06	3.13	4.84	3.38	3.0100	2.9900	5.4400	3.39
Sodium	mg/L	-	21.2	87.6	21.3	20.9	20.3	25.1	25.1	24.2	24	19.9	19.3	21.3	22.8	21	22.5	20.4	19.5	19.4	25.2	20.7	22.3	20.7	21.1	19.8000	19.5000	15.5000	16.4
D.R. Phosphorus	mg/L	-	0.048	0.48	0.044	0.039	0.114	0.139	0.173	0.155	0.089	0.048	0.044	0.023	0.037	0.0025	0.03	0.041	0.109	0.277	0.373	0.208	0.071	0.008	0.037	0.0025	0.0025	0.0340	0.032
Aluminium	mg/L	0.055	0.0205	0.69	0.015	0.004	0.006	0.005	0.018	0.019	0.015	0.017	0.025	0.023	0.027	0.01	0.009	0.01	0.015	0.013	0.011	0.019	0.029	0.016	0.027	0.0780	0.0250	0.0290	0.028
Arsenic	mg/L	0.024	0.001	0.006	0.0005	0.0005	0.0005	0.002	0.003	0.002	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.003	0.004	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Boron	mg/L	0.37	0.06	0.8	0.06	0.04	0.08	0.07	0.08	0.06	0.06	0.05	0.06	0.08	0.05	0.05	0.07	0.03	0.08	0.07	0.05	0.05	0.05	0.07	0.07	0.0600	0.0500	0.0500	0.05
Cadmium	mg/L	0.0002	0.0001	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/L	0.001	0.0005	0.14	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	0.0014	0.00115	0.09	0.0011	0.0006	0.0006	0.0013	0.0009	0.0011	0.0011	0.001	0.0013	0.0011	0.0048	0.0012	0.0009	0.0051	0.001	0.001	0.0008	0.0008	0.0012	0.002	0.0013	0.0015	0.0017	0.0021	0.0018
Iron	mg/L	-	0.16	2.6	0.07	0.03	0.07	0.07	0.12	0.11	0.07	0.06	0.08	0.08	0.08	0.03	0.05	0.131	0.156	0.101	0.156	0.074	0.091	0.131	0.076	0.1970	0.1160	0.1110	0.109
Lead	mg/L	0.0034	0.00025	0.025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	1.9	0.03155	1.03	0.0156	0.0118	0.0091	0.0281	0.0156	0.0067	0.0024	0.0264	0.0255	0.04	0.0335	0.0021	0.0136	0.0412	0.0234	0.018	0.0179	0.0054	0.0375	0.0409	0.0155	0.0129	0.0113	0.0165	0.0055
Mercury	mg/L	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Nickel	mg/L	0.011	0.00025	0.048	0.00025	0.00025	0.00025	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0016	0.0006	0.00025	0.001	0.00025	0.00025	0.00025	0.00025	0.00025	0.0005	0.0005	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	0.008	0.001	0.729	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.003	0.001	0.011	0.001	0.002	0.021	0.008	0.003	0.001	0.001	0.004	0.729	0.001	0.0020	0.001	0.0060	0.002

HS1 Hokio Stream Upstream

Determinand		ANZECC AE (95%)	Median	Maximum	Jun-22	May-22	Apr-22	Mar-22	Feb-22	Jan-22	Dec-21	Nov-21	Oct-21	Jun-21	May-21	Apr-21	Mar-21	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20	Aug-20	Jul-20	Jun-20	May-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
pH		-	7.6	9.5	7.6	7.5	7.7000	8.9000	7.6000	7.3000	7.2000	7.7000	7.4000	7.70	7.6	8.0	7.7	7.4	8.8	8.7	9.2	7.80	7.9	7.5	7.6	7.7	8.3	7.7	7.8	8.1	7.9	8.2
Suspended Solids	mg/l	-	15	137	6	11	11.0000	16.0000	8.0000	16.0000	3.0000	7.0000	11.0000	12.00	56	42	34	137	57	33	64	18.00	14	14	21	52	36	39		36		70
Phenol	mg/L	0.32	0.025	0.04			0.0250	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025		0.025
VFA	mg/L	-	2.5	91			2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.50	2.5	2.5	2.5	2.5	2.5	2.5		60		6
TOC	mg/L	-	7.1	24.8	5.9	7.2	6.6000	7.3000	6.3000	8.4000	11.3000	6.8000	5.6000	5.0	7.9	9.6	8.1	8.3	12.6	15.2	14.9	8.00	7.3	4.7	7.1	6.0	9.0	7.9		6.9		9.7
Alkalinity	mg CaCO3/L	-	56	79	45	55	65.0000	45.0000	49.0000	55.0000	57.0000	63.0000	47.0000	56.00	67	60	58	54	48	48	48	44.00	44	43	44	52	65	61		49		77
Conductivity	mS/m	-	24.3	39	21.5	24.0	25.6000	21.6000	21.6000	22.7000	21.8000	24.5000	21.6000	24.20	25.0	23.3	24.0	24.3	20.2	19.7	21.0	22.50	23.7	23.7	23.8	23.9	25.0	26.4	24.9	23.3	22.6	26.4
COD	mg/L	-	32	130	33	39	29.0000	34.0000	36.0000	34.0000	56.0000	20.0000	18.0000	7.5	29	61	77	56	83	87	50	34.00	54	37	24	33	27	28	51	36	27	77
BOD (scBOD frm Apr'20)	mg/L	2	3	13.4	3	3	3	3	3	3	3	3	3	0.5	1.5	3.0	1.5	0.50	11	6	3	0.50	0.5	0.5	0.5	0.5	3	0.5		3		7
Faecal C (Ecoli frm Apr'20)	col/100 ml	-	230	40000	100		900.0000	480.0000	580.0000	3900.0000	49.0000	230.0000	92.0000	110	740	350	400	120	16	120	140	410.00	150	120	1500	190	500	830	810	190	210	550
Chloride	mg/L	-	26.4	300	21.7	24.5	24.6000	21.1000	21.4000	20.6000	21.5000	22.9000	20.8000	24.4	24.5	23.5	24.4	25.3	21.2	18.9	22.2	22.30	25.0	23.9	24.7	24.2	24.0	26.6	24.7	22.7	22.1	27.4
Nitrate-N	mg/L	0.16	0.49	4.5	2.22	0.81	0.0700	0.1600	0.1400	0.8500	0.4800	0.3300	1.2800	0.650	0.420	0.005	0.020	0.220	0.010	0.410	0.005	0.80	1.020	1.020	0.630	0.440	0.110	0.04	0.30	1.43	1.95	0.005
Sulphate	mg/L	-	18.75	41	17.9	17.4	17.0000	18.9000	18.2000	16.3000	15.4000	19.0000	20.6000	18.40	28.4	9.83	14.3	18.2	15.9	16.7	18.7	20.00	22.0	21.7	19.9	18.2	14.5	17.9		21.6		8.5
Ammonia-N	mg/L	2.1	0.05	1.75	0.05	0.28	0.0800	0.0600	0.1000	0.1000	0.3500	0.1200	0.0800	0.010	0.800	0.005	0.010	0.170	0.020	0.030	0.005	0.04	0.005	0.060	0.010	0.090	0.020	0.05	0.12	0.005	0.005	0.005
Hardness	mg CaCO3/L	-	63	85	55	64	70.0000	55.0000	58.0000	67.0000	63.0000	62.0000	56.0000	62.0	65	64	71	65	54	51	57	60.00	65	61	64	64	70	71		60		72
Calcium	mg/L	-	13.45	20.6	12.2	13.7	15.0000	11.9000	12.2000	14.3000	13.8000	13.5000	12.5000	13.70	14.0	13.8	15.6	14.3	11.8	10.6	12.1	12.90	14.2	13.1	13.6	14.0	14.8	15.1		12.9		15.0
Magnesium	mg/L	-	7.24	9.26	6.06	7.22	7.9200	6.0700	6.5500	7.4800	6.9800	6.9500	6.0200	6.670	7.36	7.19	7.88	7.02	6.08	5.93	6.38	6.81	7.26	6.79	7.31	7.07	7.99	8.03		6.81		8.30
Potassium	mg/L	-	3.12	5.44	3.02	3.83	3.7000	2.6300	3.7400	4.0600	4.9100	2.8700	3.4600	3.240	3.18	3.54	3.40	3.29	3.33	3.10	2.61	2.89	2.91	2.66	2.93	2.78	2.96	3.51		3.32		3.17
Sodium	mg/L	-	21.2	87.6	17.1	20.0	20.7000	17.4000	16.7000	18.1000	16.6000	20.0000	17.0000	19.20	18.7	21.5	24.9	19.7	17.7	15.9	18.1	18.30	18.6	18.1	20.7	20.3	21.7	23.3	18.0	19.9	14.8	24.5
D.R. Phosphorus	mg/L	-	0.048	0.48	0.019	0.032	0.0720	0.0790	0.0480	0.0080	0.1120	0.0500	0.0160	0.010	0.047	0.306	0.137	0.038	0.012	0.008	0.007	0.0025	0.0025	0.010	0.0025	0.0025	0.006	0.019		0.0025		0.275
Aluminium	mg/L	0.055	0.0205	0.69	0.032	0.048	0.0100	0.0170	0.0320	0.0660	0.0390	0.0190	0.0200	0.0080	0.016	0.006	0.015	0.690	0.040	0.042	0.012	0.017	0.013	0.013	0.014	0.014	0.007	0.008	0.021	0.027	0.013	0.005
Arsenic	mg/L	0.024	0.001	0.006	0.0005	0.0005	0.0010	0.0010	0.0005	0.0010	0.0010	0.0005	0.0005	0.0005	0.0005	0.004	0.003	0.002	0.001	0.001	0.0005	0.000500	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005		0.003
Boron	mg/L	0.37	0.06	0.8	0.05	0.05	0.0700	0.0600	0.0600	0.0700	0.0600	0.0500	0.0600	0.050	0.06	0.07	0.06	0.06	0.06	0.05	0.04	0.07	0.05	0.05	0.04	0.06	0.06	0.07	0.05	0.05	0.05	0.06
Cadmium	mg/L	0.0002	0.0001	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.000010	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001		0.0001
Chromium	mg/L	0.001	0.0005	0.14	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005		0.0005
Copper	mg/L	0.0014	0.00115	0.09	0.0011	0.00025	0.0007	0.0010	0.0010	0.0012	0.0015	0.0020	0.0015	0.00140	0.00070	0.00170	0.00100	0.00270	0.00140	0.00190	0.00120	0.00170	0.00110	0.00070	0.00120	0.00070	0.01100	0.0009		0.0012		0.00025
Iron	mg/L	-	0.16	2.6	0.098	0.070	0.1380	0.1050	0.1730	0.3570	0.2150	0.1200	0.0960	0.0160	0.048	0.047	0.035	0.030	0.035	0.057	0.027	0.041	0.082	0.025	0.032	0.044	0.028	0.011	0.05	0.068	0.07	0.107
Lead	mg/L	0.0034	0.00025	0.025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00230	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	1.9	0.03155	1.03	0.0166	0.0343	0.0494	0.0081	0.0161	0.1250	0.0019	0.0227	0.0050	0.01650	0.0231	0.0665	0.0638	0.2560	0.0040	0.0075	0.0020	0.00830	0.0029	0.0154	0.0100	0.0091	0.0158	0.0339	0.0404	0.0140	0.0182	0.0915
Mercury	mg/L	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	0.011	0.00025	0.048	0.0005	0.00025	0.00025	0.00025	0.00025	0.0006	0.00025	0.00025	0.00025	0.00060	0.00025	0.0007	0.00025	0.00070	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	0.008	0.001	0.729	0.003	0.001	0.001	0.001	0.0030	0.0090	0.0060	0.0020	0.001	0.0040	0.001	0.002	0.001	0.013	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001		0.001		0.001

HS2	Hokio Stream Beside Landfill

Determinand		ANZECC AE (95%)	Median	Maximum	Annual Median	Jun-24	May-24	Apr-24	Mar-24	Feb-24	Jan-24	Dec-23	Nov-23	Oct-23	Sep-23	Aug-23	Jul-23	Jun-23	May-23	Apr-23	Mar-23	Feb-23	Jan-23	Dec-22	Nov-22	Oct-22	Sep-22	Aug-22	Jul-22
pH		-	7.5	9.4	7.5	7.7	7.6	7.4	7.5	7.7	5.2	7.5	7.4	7.5	7.6	9.1	7.4	7.7	7.2	7.5	7.2	7.8	7.2	7.6	7.6	7.7	8.3	7.3	7.3
Suspended Solids	mg/l	-	18	298	10.5	1.5	2.5	2.5	2.5	6		7	298	21	32	26	14	6	9	40	87	36	63	18	45	14	63	37	53
Phenol	mg/L	0.32	0.025	0.06	0.015	0.005	0.005	0.005	0.005	0.005			0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
VFA	mg/L	-	2.5	137	2.5	2.5	2.5	2.5	2.5	2.5			2.5	2.5	2.5	2.5	5.3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
TOC	mg/L	-	7.4	24.6	5.5	3.9	5.2	6.4	6.9	7.7		5	6.3	5.2	5.8	8.7	4.9	6.5	5.7	6.9	14.1	12.7	14	7	8.2	7.4	10.6	7.7	8.7
Alkalinity	mg CaCO3/L	-	59	119	62	55	65	70	66	55		60	64	58	67	53	60	63	57	59	111	94	119	60	79	63	50	39	35
Conductivity	mS/m	-	25	40.6	25.4	25.4	26.1	27	27.2	25.2	1.7	25	25.6	24.9	27.6	21.9	24.5	24.1	23.4	23.1	39.9	35.2	40.6	24.2	30	24.8	22.8	20.3	20.7
COD	mg/L	-	32	187	42	21	7.5	49	28	31	42	47	30	187	45	50	31	20	27	25	60	68	59	28	41	42	28	35	22
BOD (scBOD frm Apr'20)	mg/L	2	3	14.3	0.5	0.5	0.5	0.5	0.5	3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	3	3	3	1.5	1.5	1.5	3	1.5	4
Faecal C (Ecoli frm Apr'20)	col/100ml	-	200	42000	100	400	50	100	700	50	41	100	100	50	100	100	50	50	600	500	100	1000	100	200	50	76	60	4	300
Chloride	mg/L	-	27.35	305	26	26	27.1	29	29.9	28.0	29.2	27.8	25.4	25.2	26	23.8	23.3	23.9	21.9	23.9	48.7	38.6	34.8	24.9	32.5	22.9	21.2	19.4	21.4
Nitrate-N	mg/L	0.16	0.5	4.4	0.3	0.92	0.25	0.3	0.29	0.34	0.28	0.2	0.46	0.94	1.29	0.12	1.58	1.03	1.52	0.2	0.26	0.19	0.17	0.08	0.83	1.83	2.45	2.58	2.49
Sulphate	mg/L	-	18.4	40	18.4	20	16.6	15.4	15.6	18.5		19.5	18.9	18.9	18	18.8	17.7	15.9	15.3	15.3	9.38	14.7	17.4	22.3	18.4	21.2	23.2	17.3	17.7
Ammonia-N	mg/L	2.1	0.09	7.66	0.1	0.09	0.05	0.04	0.06	0.04	0.1	0.13	0.23	0.19	2.71	0.01	0.1	0.08	0.14	0.02	3.67	1.23	1.38	0.17	1.37	0.11	0.03	0.04	0.08
Hardness	mg CaCO3/L	-	65	134	65	65	66	61	69	55		62	63	69	65	62	87	65	65	67	134	75	88	70	96	69	64	56	61
Calcium	mg/L	-	13.9	29	13.65	14.1	14.3	11	14.7	11.2		12.8	13.3	13.8	13.1	13.5	21.3	13.7	13	12.8	29	15.4	19.4	14.7	20.6	14.9	13.1	12.7	14.0
Magnesium	mg/L	-	7.41	14.9	7.585	7.36	7.33	8	7.87	6.60		7.3	7.15	8.27	7.81	6.77	8.19	7.41	7.78	8.42	14.9	8.83	9.52	8.01	10.8	7.7	7.68	5.89	6.33
Potassium	mg/L	-	3.26	11.2	3	2.98	2.68	3.24	2.46	1.80		2.78	2.78	3.02	4.91	3.1	3.92	3.35	3.23	2.66	11.2	7.62	6.51	3.17	6.46	3.14	3.25	3.65	3.48
Sodium	mg/L	-	21.9	87	22.35	22.2	17.9	24.5	25.5	23.9		20.8	20.2	22.7	24.1	21.3	22.5	20.6	19.7	20.3	49.2	31.4	25.4	21.2	27.7	20.7	21	16.2	16.3
D.R. Phosphorus	mg/L	-	0.0495	0.477	0.0435	0.039	0.04	0.126	0.149	0.139		0.047	0.052	0.036	0.064	0.0025	0.032	0.046	0.068	0.265	0.159	0.143	0.052	0.043	0.034	0.0025	0.0025	0.028	0.035
Aluminium	mg/L	0.055	0.022	0.645	0.012	0.005	0.006	0.008	0.019	0.019	0.013	0.012	0.033	0.012	0.066	0.011	0.008	0.012	0.021	0.017	0.009	0.023	0.025	0.012	0.017	0.039	0.043	0.058	0.033
Arsenic	mg/L	0.024	0.001	0.006	0.0005	0.0005	0.0005	0.002	0.003	0.002		0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.003	0.002	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Boron	mg/L	0.37	0.06	0.6	0.07	0.04	0.06	0.07	0.09	0.06	0.06	0.05	0.07	0.07	0.07	0.06	0.07	0.04	0.08	0.08	0.15	0.14	0.09	0.07	0.12	0.06	0.05	0.06	0.05
Cadmium	mg/L	0.0002	0.0001	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/L	0.001	0.0005	0.35	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005	0.0005	0.0005	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	0.0014	0.00105	0.01	0.00095	0.0007	0.0008	0.001	0.0011	0.0010		0.0009	0.0009	0.001	0.0018	0.001	0.0008	0.0009	0.0019	0.001	0.0006	0.0009	0.0009	0.0014	0.001	0.0010	0.0017	0.0023	0.0019
Iron	mg/L	-	0.202	2.4	0.075	0.05	0.09	0.12	0.18	0.14		0.06	0.12	0.06	0.2	0.04	0.06	0.17	0.148	0.139	0.305	0.316	0.183	0.105	0.099	0.114	0.222	0.161	0.123
Lead	mg/L	0.0034	0.00025	0.025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	1.9	0.042	1.06	0.0257	0.0176	0.0123	0.0344	0.0288	0.0110	0.0088	0.0319	0.0563	0.0516	0.0221	0.0029	0.0257	0.0308	0.0182	0.02	0.124	0.0314	0.0755	0.039	0.0825	0.0135	0.0141	0.0092	0.0038
Mercury	mg/L	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Nickel	mg/L	0.011	0.00025	0.13	0.00025	0.00025	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0011	0.00025	0.00025	0.00025	0.001	0.00025	0.0008	0.0007	0.0008	0.00025	0.0006	0.00025	0.0006	0.00025	0.00025
Zinc	mg/L	0.008	0.002	0.084	0.002	0.002	0.003	0.001	0.003	0.003		0.001	0.001	0.002	0.007	0.001	0.003	0.001	0.033	0.002	0.001	0.001	0.001	0.001	0.001	0.004	0.005	0.004	0.004

HS2 Hokio Stream Beside Landfill

Determinand		ANZECC AE (95%)	Median	Maximum	Jun-22	May-22	Apr-22	Mar-22	Feb-22	Jan-22	Dec-21	Nov-21	Oct-21	Jul-21	Jun-21	May-21	Apr-21	Mar-21	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20	Aug-20	Jul-20	Jun-20	May-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
pH		-	7.5	9.4	7.4	7.4	7.7000	8.6000	7.5000	7.2000	7.3000	7.7000	7.3000	7.3	7.7	7.5	7.8	7.6	7.5	8.2	8.3	9.0	7.80	7.7	7.5	7.6	7.6	8.1	7.7	7.8	7.9	7.7	7.9
Suspended Solids	mg/l	-	18	298	33	9	12.0000	16.0000	10.0000	26.0000	6.0000	25.0000	15.0000		14	60	49	35	52	87	69	118	20.00	17	12	29	87	33	24		31		66
Phenol	mg/L	0.32	0.025	0.06			0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025	0.025	0.025	0.025	0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025		0.025
VFA	mg/L	-	2.5	137			2.5	2.5	2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.50	2.5	2.5	2.5	2.5	2.5	2.5		30		6
TOC	mg/L	-	7.4	24.6	5.6	7.1	6.5000	6.9000	6.6000	8.2000	10.5000	6.9000	6.9000		4.6	7.8	9.2	8.6	7.8	12.5	17.5	15.5	7.90	7.8	4.9	7.7	6.1	8.7	7.6		6.7		9.5
Alkalinity	mg CaCO3/L	-	59	119	44	56	70.0000	47.0000	50.0000	59.0000	52.0000	65.0000	50.0000		56	67	60	61	57	54	46	60	47.00	52	46	45	54	67	65		52		79
Conductivity	mS/m	-	25	40.6	21.7	24.2	26.0000	22.3000	21.7000	23.7000	20.0000	24.8000	22.2000	20.8	24.6	25.7	24.0	25.0	24.9	21.6	20.4	23.5	23.00	25.9	24.5	23.9	24.7	26.2	27.9	25.7	24.5	22.8	28.1
COD	mg/L	-	32	187	26	51	29.0000	39.0000	42.0000	26.0000	42.0000	27.0000	31.0000	16	< 15	44	57	75	47	77	112	57	31.00	33	27	22	24	25	21	48	29	31	86
BOD (scBOD frm Apr'20)	mg/L	2	3	14.3	3	3	3	3	3	3	3	3	3	3	0.5	3	3	1	1	10	3	3	0.50	0.5	0.5	0.5	0.5	3	0.5		3		8
Faecal C (Ecoli frm Apr'20)	col/100 ml	-	200	42000	50		910.0000	270.0000	410.0000	140.0000	60.0000	730.0000	180.0000	210	140	600	330	310	80	190	100	120	210.00	120	88	400	220	900	790	650	190	160	450
Chloride	mg/L	-	27.35	305	22.5	23.9	25.2000	21.9000	21.8000	20.4000	17.5000	23.7000	22.2000	22.2	24.7	26.9	25.0	26.1	25.1	22.6	19.8	24.1	22.40	27.1	24.9	25.2	25.7	25.9	28.0	25.2	24.0	22.3	28.8
Nitrate-N	mg/L	0.16	0.5	4.4	2.27	0.79	0.0900	0.1900	0.1700	0.8000	0.4400	0.3600	1.2500	1.27	0.78	0.500	0.005	0.060	0.220	0.110	0.410	0.020	0.78	1.03	1.03	0.710	0.500	0.170	0.08	0.30	1.47	2.02	0.005
Sulphate	mg/L	-	18.4	40	18.4	16.8	15.7000	18.9000	17.9000	16.2000	14.3000	18.9000	20.0000		18.2	10.5	10.0	14.4	16.6	15.3	16.4	18.1	19.40	21.4	21.5	19.2	18.6	14.7	17.3		21.4		8.4
Ammonia-N	mg/L	2.1	0.09	7.66	0.07	0.26	0.1100	0.1000	0.1400	0.2100	0.0400	0.1400	0.1100	0.17	0.09	0.790	0.030	0.010	0.190	0.010	0.030	0.005	0.08	0.18	0.10	0.090	0.070	0.100	0.14	0.16	0.10	0.02	0.01
Hardness	mg CaCO3/L	-	65	134	57	65	74.0000	58.0000	60.0000	67.0000	63.0000	64.0000	58.0000		63	69	63	65	64	58	52	62	60.00	70	63	61	63	68	74		63		75
Calcium	mg/L	-	13.9	29	12.5	13.9	15.9000	12.7000	12.8000	14.3000	13.7000	13.9000	12.8000		14.0	14.9	13.6	14.2	13.9	12.6	10.9	13.4	12.90	15.3	13.7	13.1	13.9	14.6	15.9		13.5		15.8
Magnesium	mg/L	-	7.41	14.9	6.21	7.28	8.2700	6.3800	6.8300	7.6400	6.9100	7.0800	6.2400		6.73	7.81	7.02	7.13	7.05	6.38	6.12	6.99	6.77	7.74	6.98	6.96	6.87	7.76	8.35		7.04		8.58
Potassium	mg/L	-	3.26	11.2	3.15	3.91	3.4500	2.7600	3.4700	3.7600	4.4500	3.1000	3.9000		3.25	3.85	2.92	3.26	3.36	3.90	3.35	2.97	2.96	3.52	2.83	3.09	2.88	3.11	3.62		3.32		3.40
Sodium	mg/L	-	21.9	87	17.5	20.3	21.0000	17.8000	17.5000	18.4000	15.3000	21.1000	17.9000		21.2	20.1	20.1	22.6	19.5	19.2	16.5	20.8	18.40	19.6	20.2	19.8	21.3	21.7	24.3	17.4	20.1	15.0	25.4
D.R. Phosphorus	mg/L	-	0.0495	0.477	0.024	0.030	0.0690	0.0850	0.0480	0.0230	0.0650	0.0490	0.0210		0.011	0.063	0.304	0.123	0.036	0.013	0.008	0.007	0.0025	0.0025	0.006	0.006	0.004	0.009	0.020		0.0025		0.266
Aluminium	mg/L	0.055	0.022	0.645	0.033	0.021	0.0110	0.0160	0.0290	0.0200	0.0230	0.0140	0.0140	0.024	0.004	0.009	0.003	0.005	0.197	0.022	0.038	0.011	0.02	0.011	0.010	0.015	0.021	0.005	0.007	0.023	0.027	0.013	0.003
Arsenic	mg/L	0.024	0.001	0.006	0.0005	0.0005	0.0010	0.0010	0.0005	0.0010	0.0010	0.0005	0.0005		0.0005	0.0005	0.004	0.002	0.001	0.001	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005		0.003
Boron	mg/L	0.37	0.06	0.6	0.05	0.05	0.0700	0.0600	0.0600	0.0700	0.0600	0.0500	0.0700	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.05	0.04	0.06	0.06	0.07	0.05	0.05	0.05	0.06
Cadmium	mg/L	0.0002	0.0001	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001		0.0001
Chromium	mg/L	0.001	0.0005	0.35	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.004		0.0005
Copper	mg/L	0.0014	0.00105	0.01	0.0009	0.0005	0.0008	0.0008	0.0010	0.0010	0.0017	0.0028	0.0015		0.0009	0.00070	0.00150	0.00090	0.00180	0.00160	0.00180	0.00100	0.0015	0.0011	0.0008	0.00120	0.00070	0.00090	0.0016		0.0014		0.00025
Iron	mg/L	-	0.202	2.4	0.105	0.075	0.1690	0.0950	0.2060	0.1610	0.1740	0.0710	0.1510		0.020	0.067	0.011	0.035	0.027	0.056	0.113	0.036	0.043	0.104	0.029	0.049	0.026	0.021	0.010	0.05	0.077	0.07	0.051
Lead	mg/L	0.0034	0.00025	0.025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00110	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	1.9	0.042	1.06	0.0152	0.0382	0.0360	0.0103	0.0160	0.1170	0.0068	0.0315	0.0116	0.0083	0.0231	0.0444	0.0600	0.0481	0.1780	0.0036	0.0321	0.0026	0.0139	0.0130	0.0227	0.0150	0.0120	0.0232	0.0420	0.0424	0.0252	0.0199	0.105
Mercury	mg/L	0.0006	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	0.011	0.00025	0.13	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0006	0.0006	0.00025	0.00025	0.00025	0.00025	0.00050	0.00025	0.00060	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	0.008	0.002	0.084	0.001	0.003	0.001	0.001	0.002	0.001	0.007	0.011	0.003		0.01	0.001	0.001	0.001	0.004	0.002	0.002	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001		0.001		0.001

HS3	Hokio Stream Downstream

Determinand		ANZECC AE (95%)	Median	Maximum	Annual Median	Jun-24	May-24	Apr-24	Mar-24	Feb-24	Jan-24	Dec-23	Nov-23	Oct-23	Sep-23	Aug-23	Jul-23	Jun-23	May-23	Apr-23	Mar-23	Feb-23	Jan-23	Dec-22	Nov-22	Oct-22	Sep-22	Aug-22	Jul-22
pH		-	7.5	9.3	7.5	7.5	7.4	7.6	7.4	7.5	7.3	7.5	7.4	7.5	7.6	8.9	7.5	7.6	7.5	7.5	7.5	8.3	7.2	7.4	7.5	7.6	8.3	7.4	7.4
Suspended Solids	mg/l	-	20	400	23.5	21	34	76	7	8		12	20	23	34	24	49	9	3	8	21	27	28	88	23	16	57	17	34
Phenol	mg/L	0.32	0.025	0.07	0.015	0.005	0.005	0.005	0.005	0.005			0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
VFA	mg/L	-	2.5	119	2.5	2.5	2.5	2.5	2.5	2.5			7.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
TOC	mg/L	-	7.2	49.7	5.3	4.2	5.4	6.9	7.2	7.2		5.2	5.6	5.2	4.5	9.1	5	6.5	5.4	7	6.8	8.2	8	7	6.7	7.6	11.1	6.9	7.4
Alkalinity	mg CaCO3/L	-	59	82	62	57	66	70	68	57		62	66	60	59	53	62	64	59	63	64	66	63	61	63	63	49	37	34
Conductivity	mS/m	-	25	33	25.8	26	26.7	27.6	27.7	25.8	25.8	25.5	26	25.3	25.4	22.2	25	24.4	23.3	23.3	24.4	22.8	27.3	24.8	26.2	25.5	22.4	20.5	20.7
COD	mg/L	-	33	524	36	30	17	7.5	7.5	7.5	48	146	42	85	38	54	34	22	21	20	33	70	28	28	20	56	44	38	29
BOD (scBOD frm Apr'20)	mg/L	2	3	14.6	0.5	1	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	3	3	3	1.5	1.5	1.5	3	1.5	1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	-	185	17000	82	200	50	100	1400	50	64	100	50	100	200	50	50	100	50	400	50	1500	800	500	32	80	60	12	100
Chloride	mg/L	-	27	305	26.1	26.7	27.7	29.6	30.1	28.7	27.3	25.4	26.1	25.7	25	24.4	23.8	24.3	22.1	24.1	25.9	25.2	27.1	24.5	24	24	20.7	19.2	20.5
Nitrate-N	mg/L	0.16	0.51	3.7	0.36	0.93	0.3	0.36	0.36	0.39	0.18	0.22	0.46	0.92	1.31	0.14	1.62	1.04	1.55	0.22	0.25	0.16	0.14	0.1	0.93	1.84	2.42	2.52	2.39
Sulphate	mg/L	-	18.4	43	18.05	19.6	16.5	15.1	14.9	18.2		19.1	18.6	18.3	17.8	18.9	17.6	15.7	15.4	15.3	15.7	17.9	19.8	21.1	21.3	21	20.9	17	16.9
Ammonia-N	mg/L	2.1	0.088	1.4	0.14	0.14	0.15	0.04	0.14	0.03	0.01	0.12	0.26	0.39	0.37	0.01	0.14	0.13	0.13	0.04	0.15	0.14	0.29	0.18	0.24	0.14	0.005	0.05	0.10
Hardness	mg CaCO3/L	-	66	420	67	66	68	62	73	59		65	62	74	70	62	95	67	66	64	66	54	75	69	73	71	62	55	58
Calcium	mg/L	-	14.3	77.4	14.5	14.4	14.6	11.4	15.5	12.3		13.8	13.2	15.3	14.7	13.5	23.3	14.1	13.2	12.3	14.3	11.5	16.1	15	15.8	15.4	12.8	12.3	13.3
Magnesium	mg/L	-	7.48	55	7.87	7.36	7.64	8.1	8.41	6.91		7.51	7.16	8.65	8.22	6.76	8.93	7.63	7.99	8.03	7.34	6.06	8.4	7.79	8.04	7.91	7.37	5.75	5.94
Potassium	mg/L	-	3.32	5.6	3.265	3.26	2.83	3.52	2.88	2.00		2.96	2.77	3.3	3.72	3.27	4.51	3.54	3.2	2.71	2.33	2.41	4.15	3.09	3.53	3.63	3.06	3.47	3.43
Sodium	mg/L	-	22	533	23.15	22.7	19.2	25.6	27.3	24.8		21.7	20.4	23.8	23.6	21.3	25.2	21.2	20.1	19.6	26.9	21.8	24.5	21.6	21.3	20.9	20.5	15.8	16.1
D.R. Phosphorus	mg/L	-	0.0485	0.473	0.047	0.041	0.047	0.125	0.149	0.135		0.053	0.047	0.053	0.039	0.0025	0.035	0.047	0.093	0.257	0.321	0.202	0.069	0.046	0.037	0.0025	0.0025	0.023	0.034
Aluminium	mg/L	0.055	0.019	15.8	0.016	0.004	0.006	0.005	0.018	0.018	0.02	0.014	0.018	0.025	0.019	0.01	0.016	0.011	0.014	0.015	0.008	0.018	0.023	0.012	0.019	0.066	0.026	0.049	0.031
Arsenic	mg/L	0.024	0.001	0.011	0.0005	0.0005	0.001	0.002	0.003	0.002		0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.003	0.004	0.003	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Boron	mg/L	0.37	0.06	0.5	0.07	0.04	0.06	0.07	0.09	0.06	0.09	0.05	0.07	0.07	0.06	0.06	0.08	0.04	0.09	0.08	0.06	0.06	0.06	0.07	0.07	0.07	0.05	0.05	0.05
Cadmium	mg/L	0.0002	0.0001	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/L	0.001	0.0005	0.04	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	0.0014	0.0012	0.031	0.00105	0.0011	0.0008	0.0011	0.0014	0.0009		0.0008	0.0008	0.0015	0.001	0.0011	0.0007	0.0007	0.0014	0.0013	0.0008	0.0009	0.0101	0.0012	0.0012	0.0015	0.0016	0.002	0.0019
Iron	mg/L	-	0.192	43.2	0.085	0.03	0.09	0.09	0.16	0.14		0.07	0.08	0.11	0.06	0.04	0.1	0.177	0.177	0.116	0.15	0.106	0.129	0.114	0.066	0.192	0.135	0.191	0.115
Lead	mg/L	0.0034	0.00025	0.025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	1.9	0.041	4.34	0.0214	0.0103	0.0066	0.0326	0.0164	0.0135	0.0143	0.0263	0.0547	0.0554	0.0429	0.0026	0.0214	0.039	0.026	0.0228	0.03	0.0136	0.052	0.04	0.0242	0.0161	0.0114	0.0109	0.0055
Mercury	mg/L	0.0006	0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Nickel	mg/L	0.011	0.00025	0.015	0.00025	0.0006	0.0007	0.00025	0.0008	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.002	0.00025	0.001	0.00025	0.00025	0.00025	0.0006	0.00025	0.00025
Zinc	mg/L	0.008	0.002	0.141	0.001	0.006	0.002	0.002	0.007	0.006		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.004	0.002	0.001	0.001	0.001	0.001	0.003	0.003	0.003	0.003

HS3 Hokio Stream Downstream

Determinand		ANZECC AE (95%)	Median	Maximum	Jun-22	May-22	Apr-22	Mar-22	Feb-22	Jan-22	Dec-21	Nov-21	Oct-21	Jul-21	Jun-21	May-21	Apr-21	Mar-21	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20	Aug-20	Jul-20	Jun-20	May-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
pH		-	7.5	9.3	7.6	7.6	7.7000	8.5000	7.5000	7.3000	7.2000	7.9000	7.4000	7.4	7.7	7.5	7.6	7.6	7.5	8.2	8.3	9.1	7.700	7.7	7.5	7.7	7.6	8.0	7.6	7.7	7.8	7.7	7.9
Suspended Solids	mg/l	-	20	400	6	8	12.0000	24.0000	13.0000	19.0000	12.0000	15.0000	13.0000		9.0	400	40	23	54	49	47	43	19.000	15	9	20	85	31	21		34		67
Phenol	mg/L	0.32	0.025	0.07			0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.04	0.025	0.025	0.025	0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025		0.025
VFA	mg/L	-	2.5	119			2.5000	2.5	2.5	2.5	2.5	2.5	2.5		4.9	2.5	2.5	2.5	2.5		2.5	2.5	2.500	2.5	2.5	2.5	2.5	2.5	2.5		30		9
TOC	mg/L	-	7.2	49.7	5.7	7.2	6.5000	7.2000	6.0000	8.4000	10.7000	7.3000	5.6000		4.7	49.7	9.0	8.6	8.7	10.4	15.7	13.2	8.000	7.7	4.8	6.7	6.1	9.5	7.8		6.8		9.0
Alkalinity	mg CaCO3/L	-	59	82	45	56	68.0000	50.0000	51.0000	58.0000	53.0000	68.0000	50.0000		57.0	65	59	62	59	47	49	53	46.000	49	46	48	56	65	65		51		78
Conductivity	mS/m	-	25	33	22.0	24.3	26.4000	22.6000	22.2000	23.2000	20.1000	25.3000	22.0000	20.9	24.5	26.1	24.3	25.3	25.2	20.7	20.3	22.3	23.000	25.2	24.4	24.7	25.0	25.8	27.8	25.9	24.5	23.1	27.8
COD	mg/L	-	33	524	31	38	40.0000	37.0000	40.0000	57.0000	63.0000	51.0000	26.0000	7.5	14.99	67	69	66	45	69	99	67	32.000	31	28	25	36	33	23	53	27	31	107
BOD (scBOD frm Apr'20)	mg/L	2	3	14.6	3	3	3	3	3	3	3	3	3	3	0.9	3	3	1.5	0.500	7	2	2	0.500	0.5	0.5	1.0	0.5	3	0.50		3		9
Faecal C (Ecoli frm Apr'20)	col/100 ml	-	185	17000	200		150.0000	280.0000	410.0000	100.0000	130.0000	58.0000	68.0000	190	120.0	810	330	450	160	120	120	72	310.000	60	62	350	150	600	410	580	200	190	310
Chloride	mg/L	-	27	305	22.9	24.1	25.5000	22.4000	21.2000	21.5000	17.5000	24.4000	21.4000	21.6	24.6	25.8	26.8	26.8	29.3	21.5	19.5	23.0	22.500	26.4	24.8	25.6	25.8	25.2	28.3	25.5	23.7	22.4	29.1
Nitrate-N	mg/L	0.16	0.51	3.7	2.27	0.80	0.1100	0.2000	0.1700	0.8000	0.3400	0.3600	1.2700	1.27	0.76	0.500	0.005	0.090	0.260	0.070	0.410	0.005	0.790	1.01	1.03	0.630	0.540	0.200	0.09	0.31	1.46	2.09	0.005
Sulphate	mg/L	-	18.4	43	18.2	16.8	15.6000	18.9000	18.1000	16.6000	13.6000	18.7000	20.5000		18.2	14.3	10.3	14.8	19.6	15.5	16.5	18.3	19.500	21.5	21.4	19.3	18.4	14.5	17.5		21.2		8.5
Ammonia-N	mg/L	2.1	0.088	1.4	0.09	0.27	0.1400	0.1000	0.1900	0.2500	0.0200	0.1500	0.1200	0.12	0.03	0.730	0.070	0.005	0.230	0.010	0.030	0.005	0.060	0.07	0.09	0.110	0.140	0.040	0.09	0.18	0.04	0.005	0.005
Hardness	mg CaCO3/L	-	66	420	57	70	76.0000	59.0000	59.0000	67.0000	56.0000	68.0000	57.0000		64.0	72	59	70	65	55	52	56	62.000	68	63	65	66	70	73		63		72
Calcium	mg/L	-	14.3	77.4	12.4	15.0	16.4000	13.1000	12.7000	14.3000	12.3000	15.0000	12.7000		14.3	16.2	12.8	15.5	14.6	11.9	10.9	12.0	13.500	14.8	13.7	13.7	14.5	14.8	15.8		13.5		15.4
Magnesium	mg/L	-	7.48	55	6.24	7.90	8.4400	6.5100	6.7300	7.5800	6.1500	7.4900	6.0600		6.95	7.67	6.58	7.59	6.95	6.02	6.04	6.29	6.990	7.45	7.00	7.35	7.27	7.93	8.20		7.14		8.23
Potassium	mg/L	-	3.32	5.6	3.31	4.27	3.7600	2.7800	3.2400	3.8800	4.3800	3.4000	3.7500		3.12	3.64	3.17	3.39	3.38	3.56	3.12	0.79	3.090	3.21	2.46	3.15	3.32	3.05	3.64		3.62		3.53
Sodium	mg/L	-	22	533	17.3	21.8	21.6000	18.6000	17.3000	18.7000	13.7000	22.5000	17.3000		21.5	20.5	19.2	23.6	19.8	18.0	16.2	17.8	19.100	18.9	20.3	20.8	23.2	21.9	23.8	18.5	20.4	15.6	24.8
D.R. Phosphorus	mg/L	-	0.0485	0.473	0.019	0.030	0.0760	0.0880	0.0510	0.0340	0.0520	0.0490	0.0230		0.012	0.017	0.301	0.111	0.045	0.012	0.007	0.007	0.0025	0.0025	0.014	0.005	0.004	0.005	0.024		0.0050		0.268
Aluminium	mg/L	0.055	0.019	15.8	0.029	0.018	0.0100	0.0250	0.0290	0.0240	0.0220	0.0230	0.0160	0.027	0.004	0.413	0.002	0.011	0.214	0.029	0.044	0.012	0.022	0.010	0.008	0.014	0.012	0.009	0.005	0.014	0.034	0.014	0.012
Arsenic	mg/L	0.024	0.001	0.011	0.0005	0.0005	0.0010	0.0010	0.0005	0.0010	0.0010	0.0005	0.0005		0	0.0005	0.004	0.002	0.002	0.001	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005		0.003
Boron	mg/L	0.37	0.06	0.5	0.05	0.06	0.0700	0.0600	0.0600	0.0700	0.0600	0.0600	0.0600	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.060	0.05	0.05	0.04	0.06	0.06	0.07	0.05	0.05	0.05	0.06
Cadmium	mg/L	0.0002	0.0001	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001		0.0001
Chromium	mg/L	0.001	0.0005	0.04	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005		0.0005		0.0005
Copper	mg/L	0.0014	0.0012	0.031	0.0013	0.00025	0.0008	0.0006	0.0010	0.0009	0.0016	0.0018	0.0016		0.001	0.00080	0.00100	0.00090	0.00190	0.00140	0.00180	0.00110	0.0015	0.00120	0.0006	0.00120	0.00080	0.00100	0.0030		0.0017		0.00025
Iron	mg/L	-	0.192	43.2	0.108	0.078	0.1610	0.0900	0.2110	0.1730	0.1920	0.1100	0.1140		0.022	0.727	0.013	0.037	0.036	0.060	0.078	0.031	0.069	0.111	0.035	0.046	0.037	0.018	0.021	0.04	0.106	0.09	0.044
Lead	mg/L	0.0034	0.00025	0.025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0004	0.00060	0.00025	0.00025	0.00120	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	1.9	0.041	4.34	0.0209	0.0349	0.0381	0.0141	0.0167	0.0456	0.0020	0.0380	0.0235	0.0123	0.0217	0.0586	0.0610	0.0624	0.1860	0.0032	0.0086	0.0050	0.0176	0.0119	0.0216	0.0190	0.0150	0.0213	0.0406	0.0475	0.0279	0.0239	0.0921
Mercury	mg/L	0.0006	0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	0.011	0.00025	0.015	0.0007	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0004	0.00025	0.00025	0.00025	0.00060	0.00025	0.00025	0.00025	0.00025	0.0005	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0005	0.00025
Zinc	mg/L	0.008	0.002	0.141	0.004	0.001	0.001	0.001	0.003	0.001	0.010	0.002	0.002		0.002	0.002	0.001	0.001	0.005	0.001	0.001	0.008	0.001	0.001	0.001	0.003	0.001	0.001	0.001		0.001		0.001

Leachate Pond

Determinand		Typical Leachate *	Median	Maximum	Annual Median	Jun-24	May-24	Apr-24	Mar-24	Feb-24	Jan-24	Dec-23	Nov-23	Oct-23	Sep-23	Aug-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Mar-22	Feb-22	Jan-22	Dec-21	Nov-21	Oct-21	Jul-21
pH		5.9 - 8.5	7.8	9.1	7.8	7.7	7.7	7.6	7.9	7.8	7.8	7.8	7.8	7.6	7.8	7.7	7.8	7.5	7.7	7.9	7.7	7.6	7.7	7.9	7.7000	7.8000	7.7000	7.6000	7.8000	7.6
Suspended Solids	mg/l		60.5	197	47	60	23	48	91	89		47	66	30	40	20	38	29	124		46		171	107	67.0000	61.0000	194.0000	114.0000	30.0000	
Phenol	mg/L		0.04	0.31	0.025								*0.025*	*0.025*	*0.025*	0.05	0.07	*0.025*			0.07		0.08	0.06	*0.025*	*0.025*	*0.025*	*0.025*	0.2200	
VFA	mg/L		24	411	2.5	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*			16	*2.5*	*2.5*	24	*2.5*	*2.5*			*25*		30	58	17.0000	21.0000	*25.0000*	*25.0000*	*25.0000*	
TOC	mg/L	17.2 - 822	623	2370	828	921	862	823	828	882		2370	796	805	657	803	841	769	79.4		768		805	742	604.0000	729.0000	624.0000	705.0000	602.0000	
Alkalinity	mg CaCO3/L	264 - 6820	5810	7680	7480	7530	7670	7680	6830	7000		7670	7480	7340	7310	5310	7570	6160	377		7670		7,570	6,990	6630.0000	6740.0000	6180.0000	6250.0000	5280.0000	
Conductivity	mS/m	264 - 27900	880	1910	1690	1910	1860	1900	1860	1.9	1680	1650	1700	1680	1600	1630	1710	1640	130	1760	1670	1770	1,700	1,610	1540.0000	1530.0000	1340.0000	1440.0000	1260.0000	930
COD	mg/L	84 - 5090	1570	6320	3325	2810	3440	362	3910	3000	2800	3210	3620	4080	4410	2720	5990	2830	389	3440	4080	5180	5,930	5,150	3570.0000	6320.0000	2510.0000	5010.0000	2720.0000	1,730
BOD (scBOD frm Apr'20)	mg/L	Dec-67	98	285	105	147	103	119	109	94	103	93	98	119	91	117	107	98	*3*	116	116	130	139	105	93.0000	124.0000	112.0000	82.0000	95.0000	70
Faecal C (Ecoli frm Apr'20)	col/100ml		385	320000	100	100	*50*	*50*	100	*50*	8000	200	4000	*50*	100	1000	*50*	*50*	400	100	*2*	*50*	*50*	*50*	4000.0000	400.0000	2700.0000	*2.0000*	640.0000	500
Chloride	mg/L	100 – 5000**	914	1430	1205	1220	1120	1180	1120	1280	1200	1230	1210	646	958	1430	1230	1240	165	1300	1280	1310	1,310	1,220	1120.0000	1140.0000	1020.0000	1060.0000	962.0000	876
Nitrate-N	mg/L		0.3	18.8	0.5	*0.5*	*0.05*	*0.5*	*0.05*	*0.5*	0.01	*0.5*	2.11	*0.005*	*0.5*	*0.5*	*0.5*	*0.5*	0.01	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5000*	*0.5000*	*0.5000*	*0.5000*	*0.5000*	17.1
Sulphate	mg/L	1 - 780	24.9	294	27.2	48.9	89.9	43.7	81.8	27.2		26.8	19.2	26.1	13	53.7	20.5	17.4	8.76		16.2		36.3	18.3	13.2000	11.9000	12.6000	16.3000	69.5000	
Ammonia-N	mg/L	3.4 - 1440	625	1810	1525	1530	19.3	1520	1410	1530	1480	1600	1500	1550	1520	1610	1810	1590	33.6	1620	1640	1830	1,640	1,530	1410.0000	1540.0000	1230.0000	1310.0000	1070.0000	720
Hardness	mg CaCO3/L		496.5	862	457	485	395	471	451	458		46	457	475	440	503	434	474	72		520		530	521	483.0000	530.0000	479.0000	496.0000	440.0000	
Calcium	mg/L		101.5	214	95.4	95.8	82.4	92.9	86.2	84.6		9.4	98.3	100	99	107	95.4	95.6	16.3		110		112	110	99.9000	106.0000	105.0000	109.0000	99.6000	
Magnesium	mg/L		57.6	93.4	54.7	59.7	46	57.9	57.2	59.8		5.39	51.4	54.7	46.7	57.3	47.5	57	7.56		59.4		60.7	59.6	56.7000	64.1000	52.3000	54.2000	46.5000	
Potassium	mg/L		563	1200	714	834	680	747	622	714		762	694	784	742	563	599	634	92		762		787	718	667.0000	725.0000	585.0000	676.0000	556.0000	
Sodium	mg/L		770	3620	965	1120	965	1090	958	1120		1130	934	1090	920	845	843	1070	140		1170		1,120	1,030	967.0000	988.0000	806.0000	1010.0000	818.0000	
D.R. Phosphorus	mg/L		8.25	17.9	15.2	15.9	14.5	14.2	13.3	15.2		15.6	13.7	15.5	14.7	16.6	15.9	14.2	0.393		15.7		17.9	16.3	14.8000	16.0000	13.1000	13.3000	12.3000	
Aluminium	mg/L		0.307	1.08	0.834	0.89	0.864	1.08	0.816	0.84	0.892	0.073	0.613	0.711	0.828	0.947	0.553	0.716	0.054	0.856	0.907	0.977	0.854	0.835	0.5760	0.7410	0.5120	0.6200	0.6370	0.327
Arsenic	mg/L	45 - 2584	0.254	0.684	0.283	0.296	0.267	0.246	0.283	0.264		0.029	0.276	0.289	0.31	0.331	0.31	0.255	0.041		0.442		0.371	0.416	0.3240	0.3590	0.2200	0.2770	0.3180	
Boron	mg/L		5.69	16.8	7.17	5.56	7.49	7.74	7.57	7.24	7.14	10.2	5.05	6.9	7.11	7.2	5.17	4.36	0.99	6.52	7.78	7.25	6.87	7.29	5.8600	6.8700	5.5100	5.9200	6.5500	4.57
Cadmium	mg/L		0.0001	0.01	0.0001	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*		*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.001*	*0.001*	0.0013	*0.0001*		*0.0001*		*0.001*	*0.0001*	*0.0010*	*0.0010*	*0.0001*	*0.0010*	*0.0001*	
Chromium	mg/L	30 – 1600**	0.208	1.1	0.78	0.967	0.842	0.799	0.905	0.78		0.077	0.75	0.605	0.71	0.951	0.678	0.763	0.065		1.05		0.838	0.866	0.6480	0.7390	0.5760	0.9300	0.5290	
Copper	mg/L	0.005 – 50.4	0.0066	0.0375	0.0066	0.0071	0.0056	0.0078	0.0082	0.0096		0.0022	0.0057	0.0038	*0.00025*	0.0089	0.0066	0.0122	*0.00025*		0.0107		0.0100	0.0233	0.0080	0.0066	0.0082	0.0271	0.0174	
Iron	mg/L		4.42	31.8	7.52	7.86	6.95	7.52	7.98	8.12		0.83	5.34	9.07	7.57	7.3	6.63	6.38	0.286		7.4		4.97	6.26	4.8800	5.0800	4.9800	5.0900	4.4500	
Lead	mg/L	1.6 - 220	0.0016	0.025	0.00165	0.0016	0.0017	0.0024	0.0022	0.0016	*0.00025*	0.0007	0.0008	0.0019	0.0021	0.0025	*0.00025*	0.0051	*0.00025*	*0.0025*	0.0028	*0.0025*	*0.0025*	0.0023	*0.0025*	*0.0025*	0.0043	*0.0025*	0.0033	0.0027
Manganese	mg/L		1.15	8.87	1.16	1.29	1.15	1.2	1.22	1.04	1.12	0.115	1.11	1.23	1.17	1.23	1.02	1.16	0.199	1.17	1.4	1.38	1.30	1.30	1.2200	1.3400	1.1000	1.1800	1.3300	1.08
Mercury	mg/L		0.00025	0.025	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.0025*	*0.0025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.0025*	*0.00025*	*0.0025*	*0.0025*	*0.00025*	*0.0025*	*0.00025*	*0.00025*
Nickel	mg/L		0.0807	0.211	0.1265	0.141	0.128	0.13	0.128	0.119	0.106	0.0134	0.116	0.129	0.111	0.14	0.125	0.107	0.0089	0.119	0.147	0.137	0.141	0.112	0.1060	0.1240	0.1030	0.1220	0.1000	0.0743
Zinc	mg/L	0.001 – 0.42	0.055	0.21	0.067	0.067	0.063	0.1	0.079	0.053		0.01	0.11	0.047	0.098	0.071	0.054	0.196	0.002		0.06		0.078	0.038	0.0490	0.0450	0.0800	0.0620	0.0730	

Leachate Pond

(sampled at pump station as of 2017)

Determinand		Typical Leachate*	Median	Maximum	Jun-21	May-21	Apr-21	Mar-21	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20	Aug-20	Jul-20	Jun-20	May-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
pH		5.9 - 8.5	7.8	9.1	8.0	7.9	7.6	8.2	8.0	7.9	8.0	7.9	7.90	8.1	7.8	7.7	7.9	8.2	7.9	7.7	7.7	7.7	8.0
Suspended Solids	mg/l		60.5	197	21.0	30	48	38	33	57	100	48	92.00	51	45	150	80	90	35		40		136
Phenol	mg/L		0.04	0.31	< 0.05	0.025	0.025	0.025	0.025		0.025	0.025	0.025	0.025	0.025	0.04	0.04	0.06	0.25		0.025		0.025
VFA	mg/L		24	411	<50	2.500	140	16	11		2.5	9	13.00	2.5	2.5	36	5	6	2.5		12		45
TOC	mg/L	17.2 - 822	623	2370	589.00	931	741	643	551	582	503	683	596.00	547	680	592	622	804	804		530		820
Alkalinity	mg CaCO3/L	264 - 6820	5810	7680	5710.00	7000	6740	6480	5520	5680	4860	5890	5870.00	5100	6460	5490	5780	6370	6750		4950		7260
Conductivity	mS/m	264 - 27900	880	1910	1410.00	1690	1620	1570	1360	1330	1.1	1470	1360.00	1280	1460	135	1420	1490	1610	1430	1210	1350	1.7
COD	mg/L	84 - 5090	1570	6320	4970.00	4980	4650	2760	5080	3880	2340	3560	2650.00	2880	2880	2470	2200	1550	2330	2220	2270	3690	3680
BOD (scBOD frm Apr'20)	mg/L	Dec-67	98	285	66.00	134	149	104	79	172	71	108	67.00	76	96	73	79	81	98		146		146
Faecal C (Ecoli frm Apr'20)	col/100ml		385	320000	200.00	390	500	2	270	45500	110	2100	24.00	9100	130	65000	100	200	24	12	96	2000	1000
Chloride	mg/L	100 – 5000**	914	1430	1130.00	1350	1240	1270	1050	1200	816	1050	973.00	943	1380	1010	1170	1150	1210	1010	857	1010	1290
Nitrate-N	mg/L		0.3	18.8	10.40	0.50	0.05	0.50	0.05	0.50	9.30	0.58	0.66	4.48	0.50	11.70	8.93	11.80	0.25	0.50	0.05	0.60	0.05
Sulphate	mg/L	1 - 780	24.9	294	137.00	74.8	35.2	44.9	24.9	54.5	137	61.7	76.10	144	120	216	294	210	54.8		85.5		137
Ammonia-N	mg/L	3.4 -1440	625	1810	1200.00	1460	1500	1390	1280	1120	969	1300	1130.00	1010	1340	1140	1170	1300	1450	1270	1010	1100	1620
Hardness	mg CaCO3/L		496.5	862	595.00	520	480	438	409	436	446	458	497.00	483	533	577	514	517	522		414		607
Calcium	mg/L		101.5	214	124.00	109	101	89.6	87	93.7	99.3	96.2	108.00	105	115	131	113	106	106		85.3		119
Magnesium	mg/L		57.6	93.4	68.90	60.2	55.4	52.0	46.4	48.9	47.9	52.9	54.90	53.1	59.8	60.6	55.9	61.4	62.3		48.8		74.7
Potassium	mg/L		563	1200	1200.00	746	803	694	738	645	546	639	642.00	574	690	625	832	7.85	648		555		750
Sodium	mg/L		770	3620	1200.00	1120	1010	1020	841	811	747	907	847.00	716	941	625	887	1050	993	815	738	932	1140
D.R. Phosphorus	mg/L		8.25	17.9	10.60	15.2	14.3	15.3	12.4	15.1	8.41	11.2	8.74	8.25	13.7	8.73	6.99	9.71	13.0		9.04		11.9
Aluminium	mg/L		0.307	1.08	1.070	0.964	0.795	0.787	0.709	0.576	0.377	0.575	0.541	0.377	0.557	0.402	0.577	0.026	0.586	0.506	0.307	0.186	0.683
Arsenic	mg/L	45 - 2584	0.254	0.684	0.6840	0.407	0.359	0.376	0.278	0.314	0.295	0.282	0.254	0.257	0.290	0.306	0.405	0.001	0.388		0.312		0.399
Boron	mg/L		5.69	16.8	16.80	6.94	6.89	6.32	6.48	6.05	5.77	5.97	6.64	5.83	6.88	5.57	8.06	0.07	5.69	5.97	5.34	7.05	8.03
Cadmium	mg/L		0.0001	0.01	0.0001	0.0010	0.0100	0.0100	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0010	0.0001	0.0010		0.0001		0.0002
Chromium	mg/L	30 – 1600**	0.208	1.1	1.10	1.060	0.693	0.833	0.784	0.598	0.521	0.604	0.576	0.500	0.602	0.506	0.697	0.0005	0.709		0.208		0.628
Copper	mg/L	0.005 – 50.4	0.0066	0.0375	0.03750	0.0176	0.0137	0.0087	0.0080	0.0120	0.0187	0.0100	0.0142	0.0158	0.0095	0.0290	0.0225	0.0007	0.0073		0.0044		0.0080
Iron	mg/L		4.42	31.8	5.340	4.09	4.64	4.24	4.26	4.21	3.27	4.21	4.73	3.81	5.86	4.41	4.30	5.61	5.25	4.42	2.53	4.70	6.18
Lead	mg/L	1.6 - 220	0.0016	0.025	0.00640	0.0025	0.0250	0.0025	0.0027	0.0025	0.0025	0.0027	0.0034	0.0021	0.0031	0.0028	0.0052	0.00025	0.0025	0.0017	0.0009	0.0023	0.0020
Manganese	mg/L		1.15	8.87	1.920	1.30	1.28	1.22	1.17	1.03	1.09	1.00	1.09	0.96	1.10	1.13	1.16	0.0992	1.04	1.15	0.852	1.22	1.11
Mercury	mg/L		0.00025	0.025	0.00025	0.00250	0.02500	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0025				
Nickel	mg/L		0.0807	0.211	0.2110	0.134	0.137	0.127	0.111	0.109	0.0947	0.109	0.107	0.0953	0.112	0.111	0.147	0.00025	0.125	0.107	0.0729	0.123	0.126
Zinc	mg/L	0.001 – 0.42	0.055	0.21	0.210	0.086	0.100	0.004	0.054	0.057	0.073	0.072	0.076	0.156	0.104	0.119	0.155	0.001	0.068		0.039		0.049

G1S

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		14.255	16.7	13.78	14.44	13.78	13.78		13.55	13.8000	13.57	13.76	13.7900	13.9800	14.3200	13.9500	14.47	14.2900	14.29	14.35	14.3750	14.30	14.52	14.21	14.11	14.32	14.53
pH		6 to 9	6.4	7.2	6.6	6.5	6.5	6.7	6.8	6.9		6.5	6.6	6.8	6.9000	6.7000	7.0000	6.6		6.7	6.9	6.6000	6.6	6.9	6.6	6.5	6.3	6.4
Suspended Solids	mg/l		87	6360	13	13				43					95.0000					49	41			2.5				3
Phenol	mg/L		0.01	0.04	0.005	0.005				0.025					0.0250					0.025				0.025				N/a
VFA	mg/L		8	256	2.5	2.5				2.5					2.5000					2.5				2.5				N/a
TOC	mg/L		21.25	45.7	25.7	25.7				15.5					31.6000					32.4	45.7			38.4				11.0
Alkalinity	mg CaCO3/L		74	181	70	70				81	92				92.0000					69	91			58				40
Conductivity	mS/m		54.55	181	55.1	33.4	55.3	62.9	54.9	45.5	46.2	49.3	56.3	41.4	53.6000	46.2000	53.2000	53.5		39.6	37.2	43.5000	65.7	65.9	81.6	122	126	136
COD	mg/L		60.5	125	35.5	64	39	32	18	48	45	84	72	90	97.0000	104.0000	99.0000	63.0		91	125	105.0000	74	99	107	43	58	111
BOD (scBOD frm Apr'20)	mg/L		1.5	5.9	0.5	0.5	0.5	0.5	0.5	1.5	1.5	1.5	0.5	3	3	3	3	5.9		3.0	3.0	0.5000	0.5	0.5				1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	52000	50	50	50	50	50	50	50	50	2	50	28.0000	300.0000	50	3.9		2	2	2	2	16	2	2	2	2
Chloride	mg/L		102.5	513	111	50.2	101	148	121	81.5	72	76.2	100	63.4	102.0000	72.2000	106.0000	119.0		66.3	46	59.1000	139	130	156	276	330	362
Nitrate-N	mg/L	90.3	0.06	1.27	0.11	0.01	0.04	0.29	0.18	0.05		0.05	0.11	0.02	0.0050	0.0050	0.0300	0.02		0.03	0.005	0.0500	0.07	0.06	0.05	0.05	0.25	0.30
Sulphate	mg/L	1000	9.395	1920	9.07	9.07				7.05					6.2800					6.27	3.3			33.8				60.9
Ammonia-N	mg/L		0.05	9.97	0.04	0.04	0.04	0.01	0.05	0.03	0.03	0.04	0.04	0.05	0.0600	0.0600	0.0500	0.05		0.05	0.05	0.0400	0.04	0.04	0.04	0.05	0.06	0.08
Hardness	mg CaCO3/L		101.5	373	39	39				45					58.0000					41	39			59				214
Calcium	mg/L	1000	20.3	73.9	7.3	7.3				7.98	8.77				11.0000					7.56	7.57			11.1				43.0
Magnesium	mg/L		12.5	45.7	5.05	5.05				6					7.5200					5.34	4.89			7.61				25.9
Potassium	mg/L		5.5	27.4	3.5	3.5				4.6					5.4900					3.93	3.95			5.93				10.1
Sodium	mg/L		64.7	170	62.95	55.3	77.2	60.4	65.5	69.5		81.8	87	60.8	92.2000	74.6000	85.1000	80.5		69.6	67.4	69.6000	101	94.2	117	170	151	144
D.R. Phosphorus	mg/L		0.027	0.097	0.097	0.097				0.025	0.04				0.0780					0.071	0.072			0.038				0.022
Aluminium	mg/L	5	0.047	0.194	0.046	0.106	0.04	0.045	0.047	0.152	0.065	0.124	0.105	0.122	0.1220	0.1730	0.1210	0.077		0.138	0.194	0.1570	0.075	0.137	0.113	0.021	0.013	0.014
Arsenic	mg/L	0.5	0.002	0.002	0.002	0.002				0.001	0.002				0.0020					0.002	0.002			0.002				0.001
Boron	mg/L	5	0.015	0.25	0.04	0.03	0.04	0.04	0.05	0.03	0.03	0.015	0.015	0.015	0.015	0.015	0.015	0.02		0.015	0.015	0.0150	0.02	0.015	0.015	0.015	0.015	0.015
Cadmium	mg/L	0.01	0.0001	0.0002	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.0005	0.003	0.002	0.002				0.0005	0.0005				0.0020					0.002	0.003			0.001				0.0005
Copper	mg/L	0.4	0.0044	0.0404	0.0072	0.0072				0.0071	0.0056				0.0068					0.0080	0.0113			0.0086				0.0025
Iron	mg/L		4.015	25.1	1.805	1.79	2.42	1.37	1.82	1.3	2.05	2.43	2.96	2.96	3.6300	4.2400	3.2200	2.68		2.89	3.67	3.3400	4.29	3.49	4.62	7.44	8.29	14.8
Lead	mg/L	0.1	0.0007	0.034	0.00025	0.00025	0.00025	0.00025	0.0007	0.0012		0.00025	0.0013	0.0007	0.0005	0.0014	0.0014	0.0004		0.00025	0.00025	0.00025	0.00025	0.00025	0.0006	0.00025	0.00025	0.00025
Manganese	mg/L		0.154	1.02	0.0567	0.0355	0.0545	0.0733	0.0589	0.0585		0.0675	0.0686	0.0565	0.0671	0.0744	0.0737	0.0546		0.0461	0.0609	0.1760	0.078	0.0635	0.136	0.176	0.180	0.269
Mercury	mg/L		0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0004		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.0013	0.0037	0.00065	0.0014	0.0007	0.0006	0.0006	0.0013		0.0017	0.0017	0.0016	0.0018	0.0015	0.0013	0.0007		0.0016	0.0020	0.0016	0.0012	0.0016	0.0020	0.0007	0.0007	0.0010
Zinc	mg/L	20	0.003	0.021	0.001	0.001				0.012					0.0080					0.001	0.002			0.003				0.002

G1D

Determinand		NZDW MAV	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		14.65	15.85	14.34	15.04	14.34	14.34		14.103	14.14	14.17	14.35	14.26	14.51	14.89	14.47	15	14.81	14.81	14.50	14.8100	14.75	15.05	14.8	14.635	14.65	15.85
pH		7 to 8.5*	7.1	7.8	7.05	7	7	7.3	7.1	7.2		6.8	7.1	7.0	7	7.4	7.4	7.2		7.1	7.2	7.0000	7.2	7.7	7.2	7.2	7.0	7.6
Suspended Solids	mg/l		3.5	49	8	8				11					2.5					2	22			2.5				3
Phenol	mg/L		0.01	0.025	0.005	0.005				0.025					0.025					0.025				0.025				N/a
VFA	mg/L		6	25	2.5	2.5				2.5					2.5					2.5				2.5				N/a
TOC	mg/L		2	16.7	1.8	1.8				1.9					4.6					1.9	1.8			2.0				2.0
Alkalinity	mg CaCO3/L		63	71	61	61				64	64				64					58	56			59				63
Conductivity	mS/m		27.5	70	27.5	26.1	27.5	27.5	28	27.8	28.2	28.2	27.6	27.5	28.8	27.6	27.5	28.2		28.1	27.6	28.1000	27.9	28.3	28.0	28.0	28.6	28.6
COD	mg/L		7.5	63	7.5	7.5	7.5	7.5	7.5	32	16	7.5	15	7.5	30	7.5000	7.5000	18		7.5000	19	7.5000	7.5	7.5	7.5	7.5	63	17
BOD (scBOD frm Apr'20)	mg/L		0.5	19	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	0.5	3	3	0.5	1.5	0.5		3.0	0.5	0.5000	0.5	0.5				1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	NIL	2	5000	0.5	0.5	0.5	0.5	5	0.5	50	50	2	50	110	9	50	2		2	2	2	2	2	2	2	2	2
Chloride	mg/L	250*	31.95	55	31.35	28.9	30.3	32.8	32.4	33.1	31.7	32	30.9	31.1	34	30.9	31	32.2		31.5	30.7	31.7000	33	31.5	31.5	31.9	31.5	32.7
Nitrate-N	mg/L	11.3	0.005	0.5	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.29	0.005	0.005	0.005		0.005	0.005	0.0050	0.005	0.005	0.005	0.005	0.005	0.005
Sulphate	mg/L	250*	15	1790	18.3	18.3				22.3					19.6					19.5	18.2			20.1				20.2
Ammonia-N	mg/L	1.17	0.09	0.14	0.095	0.1	0.09	0.08	0.1	0.14	0.1	0.1	0.09	0.10	0.11	0.09	0.09	0.08		0.09	0.1	0.1000	0.1	0.10	0.09	0.10	0.09	0.10
Hardness	mg CaCO3/L	200*	52.5	61	58	58				57					57					56	51			50				49
Calcium	mg/L		8.63	10.9	8.9	8.9				8.53	9.06				8.98					8.35	8.05			7.83				8.06
Magnesium	mg/L		7.54	8.69	8.66	8.66				8.69					8.38					8.5	7.45			7.51				6.97
Potassium	mg/L		5.59	7.82	5.51	5.51				6.17					7.82					6.07	6.02			6.27				5.58
Sodium	mg/L	200*	29.9	37.7	33.6	33.6				28.2					30.2					31	30.7			32.0	32.0	37.7	19.0	31.7
D.R. Phosphorus	mg/L		0.047	0.314	0.035	0.035				0.023	0.019				0.206					0.034	0.047			0.030				0.047
Aluminium	mg/L	0.1*	0.002	0.036	0.001	0.001	0.001	0.001	0.003	0.004	0.001	0.001	0.001	0.001	0.004	0.0010	0.0010	0.009		0.0010	0.006	0.0010	0.001	0.002	0.001	0.001	0.001	0.004
Arsenic	mg/L	0.01	0.002	0.003	0.002	0.002				0.002	0.002				0.002					0.002	0.003			0.003				0.003
Boron	mg/L	1.4	0.03	0.06	0.05	0.05	0.06	0.05	0.05	0.05	0.04	0.015	0.015	0.04	0.04	0.04	0.04	0.05		0.04	0.04	0.0400	0.04	0.04	0.05	0.015	0.05	0.04
Cadmium	mg/L	0.004	0.0001	0.0002	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	0.05	0.0005	0.002	0.002	0.002				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	2	0.00025	0.0031	0.00025	0.00025				0.00025	0.00025				0.0031					0.00025	0.0008			0.00025				0.00025
Iron	mg/L	0.2*	0.385	2.43	0.37	0.37				0.315	0.23				1.21					0.675	0.528			0.44	0.70	0.19	1.49	0.647
Lead	mg/L	0.01	0.00075	0.0275	0.00025	0.00025	0.00025	0.00025	0.00025	0.0008		0.00025	0.0006	0.00025	0.0006	0.0006	0.00025	0.0021		0.00050	0.00090	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L	0.4	0.065	0.109	0.07075	0.0614	0.0706	0.0728	0.0709	0.0677		0.0623	0.0614	0.0606	0.0637	0.0604	0.0628	0.0602		0.0641	0.0627	0.0616	0.067	0.0703	0.0645	0.0580	0.0650	0.0616
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	0.08	0.00025	0.0007	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Zinc	mg/L	1.5*	0.001	0.054	0.001	0.001				0.001					0.006					0.001	0.001			0.001				0.001

G2S

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Jan-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
Water level	mBGL		2.1475	2.71	2.2	2.45	2.2	2.12		2.03	2.19	2.13	2.15	1.86	2.11	2	1.9	2.31	2.36	2.36	1.87	1.800	2.11	2.55	2.38	2.145	2.18	2.51
pH		6 to 9	6.8	7.9	6.9	6.7	6.7	7.4	7.1	7.3		6.4	7.1	7.3	7.8	7.4	7.3	6.7		6.8	7.2	7.200	7.2	7.0	6.9	7.0	6.6	7.1
Suspended Solids	mg/l		9	852	11	11				14					4					2	3.5			8				2.5
Phenol	mg/L		0.01	0.025	0.005	0.005				0.025					0.025					0.025				0.025				N/a
VFA	mg/L		6	70	2.5	2.5				2.5					2.5					2.5				2.5				N/a
TOC	mg/L		9.15	28.3	9.7	9.7				7.2					9					1.4	10.9			15.6				14.6
Alkalinity	mg CaCO3/L		276	523	324	324				217	259				164					276	287			427				523
Conductivity	mS/m		133	452	114	106	110	134	118	93.3	157	215	185	127	61.1	122	129	222		133	155	235.000	104	190	267	133	186	177
COD	mg/L		33.5	148	39	41	37	31	46	31	27	95	16	38	45	35	7.5	89		66	38	66.000	40	53	69	22	90	80
BOD (scBOD frm Apr'20)	mg/L		0.5	3	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	0.5	1.5	0.5	0.5	1.5	3		3.0	0.5	0.500	0.5	0.5				2.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	2	50	50	50	50	50	50	50	50	50	2	50	4	0.5	2	2		2.000	2.000	2.000	2.0	2.0	2.0	2	2	2
Chloride	mg/L		229.5	715	204	140	173	288	235	146	342	585	517	249	81.8	153	163	481		227	311	584.000	136	323	616	194	327	246
Nitrate-N	mg/L	90.3	0.005	9.72	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.05		0.05	0.005	0.050	0.005	0.005	0.005	0.005	0.05	0.005
Sulphate	mg/L	1000	2.79	19.7	11.6	11.6				6.33					5.8					5.51	3.48			5.86				1.07
Ammonia-N	mg/L		0.01	0.15	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.04	0.005	0.005	0.01	0.005	0.06	0.02		0.02	0.02	0.005	0.0	0.02	0.02	0.005	0.01	0.005
Hardness	mg CaCO3/L		222	559	224	224				115					81					237	260			304				312
Calcium	mg/L	1000	49.2	117	40.5	40.5				21.7	64.5				15.7					44.3	51.8			61.0				66.5
Magnesium	mg/L		26.25	65.5	30	30				14.9					10					30.6	31.6			36.8				35.4
Potassium	mg/L		24.25	43.2	10.5	10.5				13.3					9.45					18.0	23.5			25.5				25.0
Sodium	mg/L		185	375	156	156				126					96.4					156	185			272	281	187	224	244
D.R. Phosphorus	mg/L		0.023	0.418	0.022	0.022				0.019	0.012				0.029					0.017	0.018			0.018				0.024
Aluminium	mg/L	5	0.004	0.208	0.003	0.005	0.001	0.001	0.007	0.001	0.002	0.004	0.006	0.011	0.004	0.003	0.004	0.005		0.003	0.003	0.001	0.003	0.003	0.001	0.004	0.001	0.001
Arsenic	mg/L	0.5	0.0005	0.003	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Boron	mg/L	5	0.635	1.27	0.63	0.79	0.61	0.64	0.62	0.6	0.6	0.4	0.64	0.69	0.6	0.92	1.09	1.05		1.02	0.84	0.950	1.06	1.21	1.15	0.57	0.98	1.27
Cadmium	mg/L	0.01	0.0001	0.0004	0.0001	0.0001				0.0001	0.0001				0.0001					0.0001	0.0001			0.0001				0.0001
Chromium	mg/L	1	0.0005	0.0005	0.0005	0.0005				0.0005	0.0005				0.0005					0.0005	0.0005			0.0005				0.0005
Copper	mg/L	0.4	0.0042	0.0091	0.0073	0.0073				0.0042	0.003				0.008					0.0065	0.0039			0.0010				0.0080
Iron	mg/L		0.049	3.08	0.06	0.06				0.264	0.036				0.114					0.169	0.034			0.032	0.08	0.12	0.44	0.048
Lead	mg/L	0.1	0.00025	0.0086	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.0814	0.416	0.25	0.22	0.216	0.28	0.341	0.0843		0.33	0.135	0.0527	0.0503	0.0762	0.108	0.272		0.160	0.119	0.201	0.0838	0.215	0.416	0.0928	0.163	0.133
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.0033	0.0053	0.00195	0.0031	0.002	0.0019	0.0016	0.0018		0.0012	0.0023	0.0026	0.0018	0.0036	0.0031	0.0035		0.0034	0.0031	0.0026	0.0036	0.0046	0.0038	0.0033	0.0042	0.0043
Zinc	mg/L	20	0.003	0.044	0.009	0.009				0.001					0.001					0.002	0.001			0.006				0.001

Tatana extra sampling TD1 (Formerly SW3 prior to Apr 2020)

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Jun-24	May-24	Apr-24	Mar-24	Feb-24	Jan-24	Dec-23	Nov-23	Oct-23	Sep-23	Aug-23	Jul-23	Jun-23	May-23	Apr-23	Mar-23	Feb-23	Jan-23	Dec-22	Nov-22	Oct-22	Sep-22	Aug-22	Jul-22
pH		6 to 9	7.4	8	7.4	7.4	7.3	7.3	7.8	7.4	7.1	7.4	7.7	7.8	7.9	7.2	7.7	7.2	7.6	8.0	7.5	7.7	6.7	7	7.7	7.7	7.1	7.2	7.4
Suspended Solids	mg/l		29	5230	137	229	119	173	137	594		390	220	100	18	1.5	18	7	37	23	136	25	5230	90	69	92	13	9	2
Phenol	mg/L		0.025	0.025	0.015	0.005	0.005	0.005	0.005	0.005			0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
VFA	mg/L		2.5	6	2.5	2.5	2.5	2.5	2.5	2.5			5.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
TOC	mg/L		24.2	175	22.8	26	27.4	22.8	27.1	32.1		18.2	43.2	20	19.4	20.6	20.8	24	31.0	15.9	23.6	29	175	31.5	30.6	32	19	23.4	18.1
Alkalinity	mg CaCO3/L		230.5	684	337	337	221	273	528	345		204	340	359	480	188	335	236	225	212	326	237	630	85	389	382	117	117	109
Conductivity	mS/m		77.8	192	93.25	97.6	74.2	82.5	136	92.8	122	62.2	90.3	93.7	120	60.3	95.6	78.1	71.5	65.9	95.2	81.5	150	29.8	110	110	40.9	43.2	38.2
COD	mg/L		106	2840	113	147	125	37	255	196	93	142	278	101	75	82	77	69	98	83	132	106	2840	260	121	236	67	86	74
BOD (scBOD frm Apr'20)	mg/L		3	51	0.5	1.5	0.5	0.5	1.5	2	0.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5	2	3	3	3	51	1.5	1.5	1.5	3.0	1.5	1.5
Faecal C (Ecoli frm Apr'20)	col/100ml	100	100	9000	75	50	50	200	300	50	36	50	50	100	100	200	100	50	100	50	5500	9000	200	200	1000	48	> 240	68	
Chloride	mg/L		83.1	321	84.15	85.8	85.9	87.2	96.2	81.5	90.9	61	76.2	77.2	89.6	67.5	82.5	84.8	83.7	68.5	87.5	103	100	36.5	101	100	49.5	51.3	43.4
Nitrate-N	mg/L	90.3	0.57	5.99	1.365	1.13	0.59	0.31	2.0	0.82	0.14	1.3	2.78	1.98	2.22	2.27	1.43	1.62	0.005	0.250	0.700	0.57	0.53	0.005	0.7	3.77	0.35	1.74	1.590
Sulphate	mg/L	1000	2.15	8.15	1.29	3.14	6.54	1.66	0.2	1.29		0.86	1.01	1.07	1.06	7.54	3.08	7.74	1.39	2.36	1.45	4.88	1.2	6.42	1.93	1.94	3.39	2.86	4.39
Ammonia-N	mg/L		7.91	57.8	12.6	16	7.91	11.9	24.9	15.4	22.7	2.59	7.87	10.1	17.1	5.63	13.3	17.8	8.25	7.77	11.70	6.37	12.9	0.03	10.7	10.8	2.24	0.95	1.85
Hardness	mg CaCO3/L		165.5	405	248	262	155	231	311	183		170	248	271	371	152	295	153	161	140	225	175	334	73	317	296	102	104	95
Calcium	mg/L	1000	33.7	90.5	57.3	63.3	33.5	51.1	72.8	39.1		36.5	57.3	64.8	90.5	31.2	72.4	26.4	32.0	26.3	52.2	33.9	74.6	16.6	68.4	61.5	19.4	20.7	19.2
Magnesium	mg/L		20.15	48.7	25.2	25.2	17.2	25.2	31.4	20.7		19.1	25.4	26.5	35	17.9	27.8	21.2	19.6	18.0	23.1	22	35.7	7.63	35.4	34.6	12.9	12.7	11.4
Potassium	mg/L		21.7	49.2	22.5	28.3	20.6	22.5	26.3	26.4		15.6	16.9	21.9	26.3	22.2	25.1	24.8	19.3	21.1	21.5	33.1	29.3	2.66	32.5	33.9	8.5	13.2	12.4
Sodium	mg/L		59.7	134	60	71.5	55.6	58.7	74.4	48.2		51.4	57.3	67.2	82.7	60	67.2	71.7	63.8	62.4	69.2	79.4	82.4	32.3	90.1	90.1	44.6	34.4	34.6
D.R. Phosphorus	mg/L		0.0275	0.063	0.025	0.038	0.027	0.026	0.035	0.019		0.025	0.028	0.02	0.023	0.014	0.023	0.063	0.033	0.018	0.034	0.026	0.03	0.028	0.028	0.022	0.032	0.019	0.020
Aluminium	mg/L	5	0.0155	0.071	0.009	0.008	0.01	0.009	0.008	0.004	0.006	0.024	0.014	0.009	0.007	0.029	0.019	0.02	0.024	0.015	0.008	0.02	0.004	0.01	0.016	0.014	0.024	0.024	0.033
Arsenic	mg/L	0.5	0.001	0.007	0.0005	0.0005	0.0005	0.001	0.001	0.0005		0.001	0.001	0.0005	0.001	0.0005	0.0005	0.002	0.002	0.0005	0.0005	0.001	0.001	0.0005	0.001	0.0005	0.0005	0.0005	0.0005
Boron	mg/L	5	0.285	1.35	0.33	0.27	0.34	0.35	0.52	0.33	0.32	0.19	0.35	0.3	0.33	0.31	0.44	0.26	0.25	0.31	0.25	0.56	0.39	0.05	0.57	0.53	0.09	0.15	0.14
Cadmium	mg/L	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/L	1	0.0005	0.004	0.0005	0.0005	0.001	0.0005	0.002	0.0005		0.0005	0.001	0.001	0.002	0.0005	0.0005	0.004	0.0005	0.0005	0.0010	0.001	0.001	0.0005	0.002	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	0.4	0.00065	0.002	0.0006	0.00025	0.00025	0.00025	0.0009	0.00025		0.0006	0.0006	0.00025	0.0011	0.0012	0.0006	0.002	0.0005	0.0007	0.0007	0.0008	0.00025	0.00025	0.0008	0.0013	0.00025	0.0007	0.0009
Iron	mg/L		0.59	3.24	0.3	0.2	0.36	0.38	0.19	0.07		2.69	0.36	0.2	0.12	0.45	0.3	0.811	3.24	0.46	0.25	1.04	0.617	0.155	0.17	0.33	2.41	1.03	2.11
Lead	mg/L	0.1	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Manganese	mg/L		0.284	1.27	0.5565	0.433	0.0513	0.411	1.02	0.0126	0.537	0.73	0.776	0.598	0.851	0.133	0.576	0.0737	0.297	0.086	0.584	0.266	0.816	0.0589	0.999	0.514	0.016	0.066	0.029
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Nickel	mg/L	1	0.0015	0.0039	0.00175	0.0017	0.0015	0.0017	0.0022	0.0014	0.0021	0.0011	0.0015	0.0018	0.0024	0.002	0.002	0.0022	0.0015	0.0014	0.0014	0.0022	0.0021	0.00025	0.0028	0.003	0.0008	0.0012	0.0009
Zinc	mg/L	20	0.003	0.018	0.004	0.004	0.001	0.005	0.003	0.001		0.003	0.001	0.004	0.015	0.017	0.008	0.018	0.0030	0.0060	0.0050	0.004	0.001	0.001	0.005	0.003	0.003	0.007	0.0050

Tatana extra sampling TD1 (Formerly SW3 prior to Apr 2020)

Determinand		ANZECC STOCK	Median	Maximum	Jun-22	May-22	Apr-22	Mar-22	Feb-22	Jan-22	Dec-21	Nov-21	Oct-21	Jul-21	Apr-21	Mar-21	Oct-20	Jul-20	Apr-20	Jan-20	Oct-19	Jul-19	Apr-19
pH		6 to 9	7.4	8	7.1	6.6	6.8	7.8	8.0	6.8	6.7	7.9	7.2	7.1	7.200	7.600	7.4	7.0	7.1	7.7	7.8	7.2	7.3
Suspended Solids	mg/l		29	5230	43	2190	94	21	19	111	22	112	15		61		66		284	14	131	19	6
Phenol	mg/L		0.025	0.025			0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025		0.025		0.025				
VFA	mg/L		2.5	6			2.5	2.5	2.5	2.5	2.5	2.5	2.5		2.500		6.000		6				
TOC	mg/L		24.2	175	25.1	50.6	15.0	22.2	3.2	70.2	19.4	24.4	28.1		25.500		44.500		23.8				
Alkalinity	mg CaCO3/L		230.5	684	62	98	104	407	192	262	92	125	182		154.000		684.000		151				
Conductivity	mS/m		77.8	192	30.2	30.4	41.0	105.0	59.8	75.8	27.8	41.8	60.4	40.4	63.100	53.700	192	184	55.7	91.1	63.3	52.4	93.2
COD	mg/L		106	2840	107	275	115	52	123	291	113	468	98	81	50.000	39.000	354	562	75	92	124	109	271
BOD (scBOD frm Apr'20)	mg/L		3	51	3	3	3	3	3	6	7	3	3	3	3.000	1.500	1	3	3	21	17	3	3
Faecal C (Ecoli frm Apr'20)	col/100ml	100	100	9000	50		50	1000	300	2200	1100	50	200	48	38.000	24.000	40	7500	140	380	250	380	2000
Chloride	mg/L		83.1	321	43.3	24.6	56.0	87.3	68.4	82.5	26.2	50.8	71.8	61.6	77.300	57.400	177	321	69.3	101	72.3	69.2	172
Nitrate-N	mg/L	90.3	0.57	5.99	1.510	0.005	0.030	0.050	0.005	0.005	0.060	0.005	0.390	0.08	3.800	0.540	0.24	1.21	0.0050	5.99	0.26	0.19	0.57
Sulphate	mg/L	1000	2.15	8.15	7.13	2.59	5.44	0.49	1.50	0.13	8.15	0.97	3.57		6.260		0.62		6.71				
Ammonia-N	mg/L		7.91	57.8	0.18	0.76	0.12	14.80	5.93	5.98	0.66	0.45	0.53	0.63	0.040	0.010	57.8	43.2	4.61	10.9	6.4	3.6	4.2
Hardness	mg CaCO3/L		165.5	405	67	86	89	296	133	208	81	91	139		137.000		405		115				
Calcium	mg/L	1000	33.7	90.5	12.9	22.2	17.3	72.8	25.1	42.3	17.1	17.8	26.8		26.200		81.6		21.1				
Magnesium	mg/L		20.15	48.7	8.50	7.46	11.1	27.7	17.0	24.9	9.3	11.4	17.4		17.300		48.7		15.0				
Potassium	mg/L		21.7	49.2	7.2	7.34	8.6	23.6	17.7	39.9	10.4	10.7	19.1		22.000		49.2		15.5				
Sodium	mg/L		59.7	134	30.4	21.8	45.5	64.7	53.8	70.0	20.1	46.5	59.4		57.600		134		51.3				
D.R. Phosphorus	mg/L		0.0275	0.063	0.034	0.013	0.043	0.027	0.049	0.028	0.030	0.057	0.017		0.044		0.014		0.024				
Aluminium	mg/L	5	0.0155	0.071	0.071	0.049	0.023	0.004	0.021	0.022	0.018	0.028	0.025	0.064	0.010	0.009	0.009	0.022	0.009				
Arsenic	mg/L	0.5	0.001	0.007	0.001	0.001	0.0005	0.002	0.002	0.007	0.002	0.002	0.002		0.0005		0.001		0.001				
Boron	mg/L	5	0.285	1.35	0.015	0.04	0.10	0.36	0.22	0.27	0.08	0.18	0.30	0.11	0.270	0.220	1.35	0.810	0.18				
Cadmium	mg/L	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001		0.0001		0.0001				
Chromium	mg/L	1	0.0005	0.004	0.0005	0.0005	0.0005	0.0010	0.0005	0.0010	0.0005	0.0005	0.0005		0.0005		0.001		0.0005				
Copper	mg/L	0.4	0.00065	0.002	0.0007	0.0006	0.00025	0.0017	0.00025	0.0007	0.0010	0.0012	0.0006		0.00025		0.0009		0.00025				
Iron	mg/L		0.59	3.24	1.33	0.692	1.32	0.15	1.56	2.84	2.28	2.43	2.09		0.158		0.312		1.26	0.26	1.12	1.49	0.57
Lead	mg/L	0.1	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025				
Manganese	mg/L		0.284	1.27	0.231	0.337	0.012	0.767	0.121	1.270	0.468	0.472	0.157	0.0868	0.0168	0.021	0.936	0.36	0.200	0.179	0.446	0.117	0.0295
Mercury	mg/L		0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025				
Nickel	mg/L	1	0.0015	0.0039	0.0007	0.0006	0.0005	0.0018	0.0015	0.0025	0.0007	0.0010	0.0020	0.0011	0.0015	0.0015	0.0039	0.0032	0.0009				
Zinc	mg/L	20	0.003	0.018	0.0030	0.003	0.0020	0.0030	0.0030	0.0050	0.0090	0.0020	0.0050		0.001		0.003		0.001				

Xd1

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Mar-21
Water level	mBGL		2.365	3.3	2.35	3.3	2.3	2.35		2.0500	2.3800	2.34	2.52	2.3300	2.5200	2.8100	2.4400	3.08	2.2900	2.2900	
pH		6 to 9	7.6	7.8	7.55	7.4	7.5	7.8	7.6	7.7		7.8	7.4	7.5	7.5000	7.6	7.5000	7.6		7.5000	7.70
Suspended Solids	mg/l		24	146	17	6	24	25	10	16					146.0000	38	72.0000			9.0000	
Phenol	mg/L		0.025	0.025	0.025	0.005		0.025	0.025	0.025					0.0250		0.0250			0.0250	
VFA	mg/L		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5					2.5000		2.5000			2.5000	
TOC	mg/L		4.6	4.8	4.45	4.3	4.3	4.6	4.6	4.4					4.8000	4.2	4.6000			4.7000	
Alkalinity	mg CaCO3/L		184	203	185	184	186	184	187	188	203				176.0000	184	180.0000			162.0000	
Conductivity	mS/m		53.75	54.3	53.65	53.4	53.7	53.6	53.7	53.6	53.8	53.6	53.3	53.6	54.3000	53.9	54.3000	53.8		54.1000	54.10
COD	mg/L		22	43	13.75	7.5	43	7.5	20	22	22	16	7.5	7.5	27.0000	23	31.0000	34		20.0000	36.00
BOD (scBOD frm Apr'20)	mg/L		1.5	5.9	0.5	0.5	0.5	0.5	0.5	0.5	1.5	3	3	3	3.0000	5.9	1.5000	3		1.5000	0.50
Faecal C (Ecoli frm Apr'20)	col/100ml	100	6	50	50	3	50	50	50	0.5	50	50	2	8	8.0000	16	2	2		4.0000	2.00
Chloride	mg/L		57.45	62.7	56.45	57.8	58	39	55.1	57.3	57.6	57.1	57.2	57.9	56.9000	58.2	62.7000	57.2		57.9000	59.70
Nitrate-N	mg/L	90.3	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005	0	0.0050	0.0050		0.0050	0.005
Sulphate	mg/L	1000	0.01	13.4	0.01	0.01	0.01	0.01	0.01	0.01					13.4000	0.01	0.0100			0.0100	
Ammonia-N	mg/L		0.375	0.41	0.38	0.38	0.39	0.38	0.37	0.41	0.35	0.29	0.36	0.41	0.3600	0.39	0.3800	0.39		0.3600	0.09
Hardness	mg CaCO3/L		153	170	152.5	134	152	153	170	168					149.0000	161	149.0000			167.0000	
Calcium	mg/L	1000	35.1	39.1	34.25	31	34.5	34	37.2	38.1					35.1000	38.1	35.0000			39.1000	
Magnesium	mg/L		16	18.8	16.2	13.8	15.9	16.5	18.8	17.7					14.9000	16	15.0000			16.7000	
Potassium	mg/L		5.32	6.33	5.33	5.06	5.6	5	6.33	6.31					5.3200	5.47	5.3100			5.3200	
Sodium	mg/L		46.9	50	46.9	44	49.6	49.8	44.2	44.2					46.9000	47.7	45.1000			50.0000	
D.R. Phosphorus	mg/L		0.11	0.155	0.117	0.115	0.155	0.119	0.104	0.103	0.109				0.0760	0.111	0.1180			0.1090	
Aluminium	mg/L	5	0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.002	0.004	0.0030	0.0010		0.0010	0.01
Arsenic	mg/L	0.5	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005					0.0005	0	0.0005			0.0005	
Boron	mg/L	5	0.06	0.64	0.055	0.07	0.04	0.05	0.06	0.07	0.64	0.05	0.04	0.05	0.0500	0.06	0.0500	0.07		0.0600	0.06
Cadmium	mg/L	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001				0.0001	0.0001	0.0001			0.0001	
Chromium	mg/L	1	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005				0.0005	0	0.0005			0.0005	
Copper	mg/L	0.4	0.00025	0.0012	0.00025	0.00025	0.00025	0.00025	0.0012	0.00025	0.00025				0.0008	0.0004	0.00025			0.00025	
Iron	mg/L		0.05	0.095	0.045	0.03	0.05	0.05	0.04	0.076					0.0950	0.067	0.0480			0.0710	
Lead	mg/L	0.1	0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.0004	0.00025	0.00025		0.0003	0.00025
Manganese	mg/L		0.499	0.579	0.506	0.497	0.515	0.482	0.576	0.579		0.521	0.5	0.472	0.4990	0.497	0.4710	0.486		0.5010	0.46
Mercury	mg/L		0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.0004	0.00025	0.00025		0.0003	0.00025
Nickel	mg/L	1	0.00025	0.0011	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.0004	0.00025	0.00025		0.0003	0.00
Zinc	mg/L	20	0.001	0.008	0.001	0.001	0.001	0.001	0.001	0.001					0.0080	0.001	0.0010			0.0010	

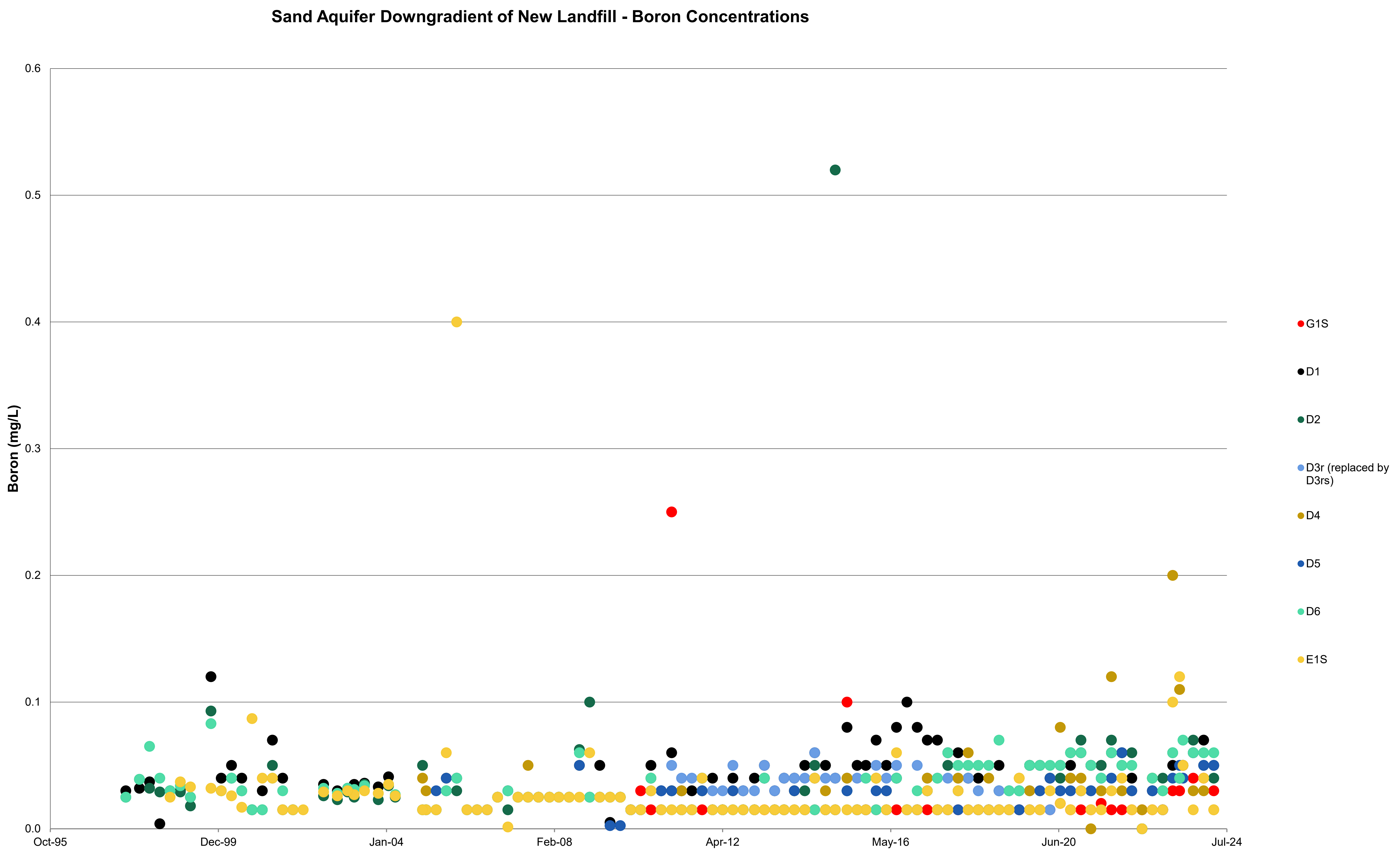
Xs1

Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Mar-21
Water level	mBGL		0.485	0.82	0.64	0.48	0.64	0.65		0.2600	0.6800	0.4	0.34	0.4000	0.7300	0.0300	0.4700	0.49	0.8200	0.82	
pH		6 to 9	6.8	7.3	7	6.8	7	7	7.3	6.7		7.1	6.5	6.6	6.8	6.6	6.5	6.6		6.7	7.2
Suspended Solids	mg/l		56	82	54.5	76	67	42	34	35					75	79	45			43	82
Phenol	mg/L		0.025	0.025	0.025	0.005		0.025	0.025	0.025					0.025		0.025			0.025	0.025
VFA	mg/L		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5					2.5		2.50			2.50	2.50
TOC	mg/L		25.5	31.6	25.2	27	24.6	25.5	24.9	31.6					25.5	26.5	25.7			24.8	2.4
Alkalinity	mg CaCO3/L		551	592	520	592	576	464	303	373	590				557	569	331			513	551
Conductivity	mS/m		135.5	143	125.5	143	139	112	72.2	92.1	142	141	88.8	76.9	137	136	86.6	91.4		139	135
COD	mg/L		75.5	95	71.5	54	95	76	67	78	87	81	67	77	91	26	68	64		75	82
BOD (scBOD frm Apr'20)	mg/L		3	74	1	2	1.5	0.5	0.5	1	1.5	3	3	3	3	74	3	3		3	3
Faecal C (Ecoli frm Apr'20)	col/100ml	100	50	400	50	50	50	50	400	50	2	50	2	50	2	99.999	8	20		2.00	2.00
Chloride	mg/L		112	130	80.8	130	112	49.6	37.4	56.1	114	119	56	39.7	123.0	124	52.5	54.6		112	125
Nitrate-N	mg/L	90.3	0.005	0.05	0.0125	0.02	0.05	0.005	0.005	0.005		0.05	0.005	0.01	0.05	0	0.005	0.05		0.05	0.005
Sulphate	mg/L	1000	3.88	29.7	2.405	0.04	0.01	4.77	6.57	6.04					1.53	1.99	29.7			3.09	4.67
Ammonia-N	mg/L		11.25	14.2	13.4	14	12.8	14.2	11.4	12.5	10.9	12.4	11.3	9.84	7.88	8.69	11.2	10.5		3.20	3.11
Hardness	mg CaCO3/L		360	457	333	379	341	325	258	292					418	449	273			435	457
Calcium	mg/L	1000	80.3	97.1	72.35	70	74.7	80.3	62.2	73.1	85.4				82.2	97.1	69.3			90.3	93.5
Magnesium	mg/L		43.5	54.2	33.8	49.6	37.4	30.2	24.8	26.6					51.5	50.2	24.1			50.9	54.2
Potassium	mg/L		19.7	29.6	20.35	29.6	26.3	14.4	13.9	12.6					24.4	20.3	12.2			23.50	19.10
Sodium	mg/L		85.35	103	75.8	92.1	78.6	73	38.2	52.3					103.0	99.5	45.3			92	102
D.R. Phosphorus	mg/L		0.0175	0.093	0.016	0.018	0.046	0.014	0.012	0.029	0.011				0.017	0.015	0.025			0.093	
Aluminium	mg/L	5	0.0045	0.01	0.004	0.003	0.005	0.003	0.009	0.005	0.005	0.003	0.01	0.009	0.003	0.004	0.006	0.010		0.004	0.003
Arsenic	mg/L	0.5	0.0005	0.001	0.0005	0.0005	0.0005	0.0005	0.001	0.0005	0.0005				0.0005	0	0.001			0.0005	0.0005
Boron	mg/L	5	0.48	0.63	0.405	0.57	0.63	0.24	0.14	0.22	0.61	0.57	0.14	0.09	0.56	0.45	0.09	0.09		0.59	0.51
Cadmium	mg/L	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001				0.0001	0.0001	0.0001			0.0001	0.0001
Chromium	mg/L	1	0.001	0.001	0.00075	0.001	0.001	0.0005	0.0005	0.0005	0.001				0.001	0.001	0.0005			0.001	0.001
Copper	mg/L	0.4	0.00025	0.0047	0.00025	0.00025	0.00025	0.00025	0.0047	0.00025	0.00025				0.0009	0.0004	0.00025			0.00025	0.00
Iron	mg/L		2.71	16.4	3.935	4.39	3.48	5.58	2.55	6.42	1.1				0.804	2.71	2.61			16.40	1.63
Lead	mg/L	0.1	0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.0004	0.00025	0.00025		0.00025	0.00025
Manganese	mg/L		1.3	1.61	1.102	0.698	0.774	1.58	1.43	1.61		1.47	1.26	1.43	0.922	1.3	1.6	1.60		0.831	0.884
Mercury	mg/L		0.00025	0.0004	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025		0.00025	0.00025	0.00025	0.00025	0.0004	0.00025	0.00025		0.00025	0.00025
Nickel	mg/L	1	0.0022	0.0027	0.0019	0.0025	0.0023	0.0015	0.0008	0.0008		0.0024	0.001	0.0006	0.0022	0.0027	0.0006	0.0008		0.0024	0.0025
Zinc	mg/L	20	0.0025	0.005	0.0035	0.004	0.003	0.001	0.005	0.001					0.004	0.002	0.001			0.001	0.004

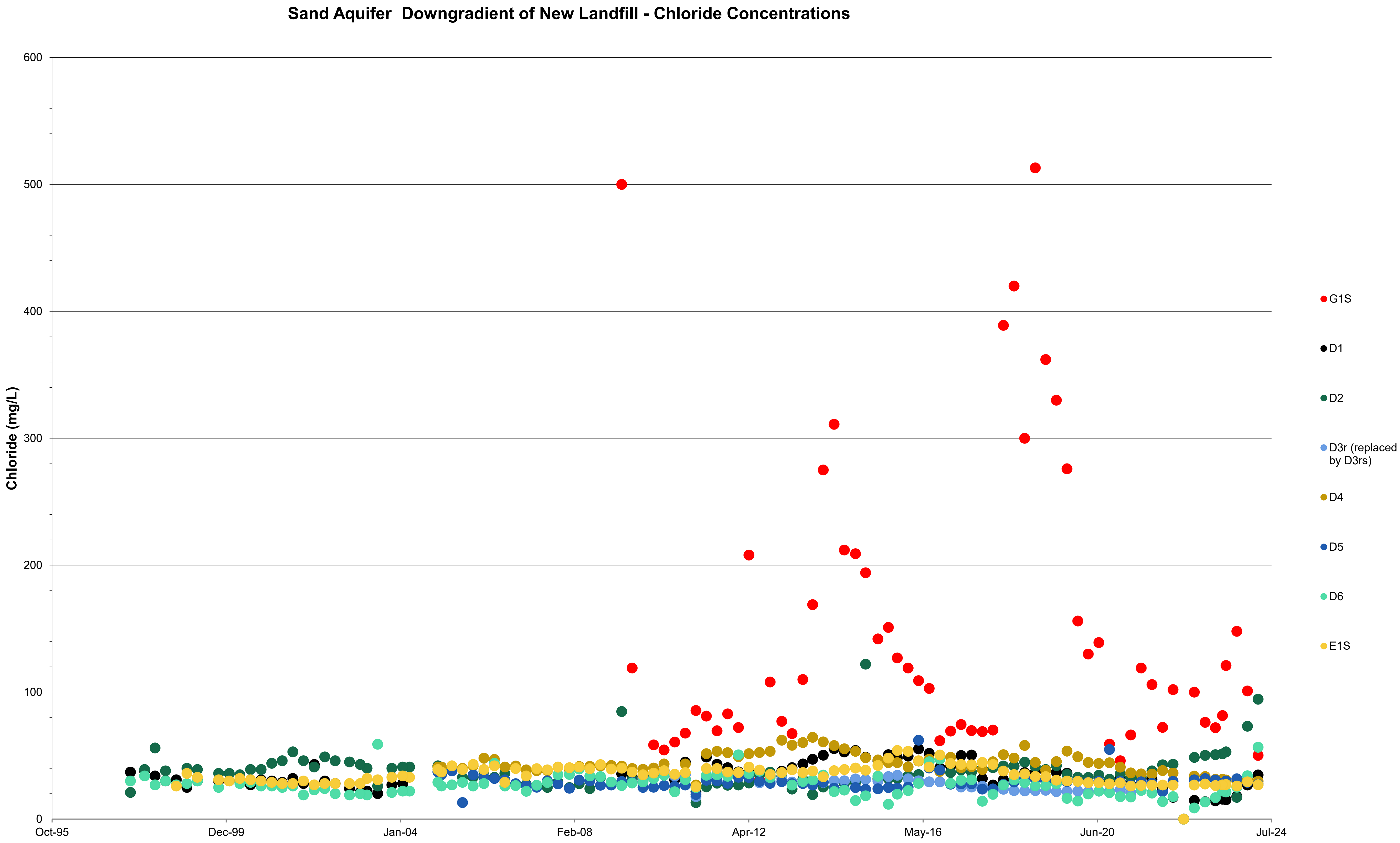
Xs2

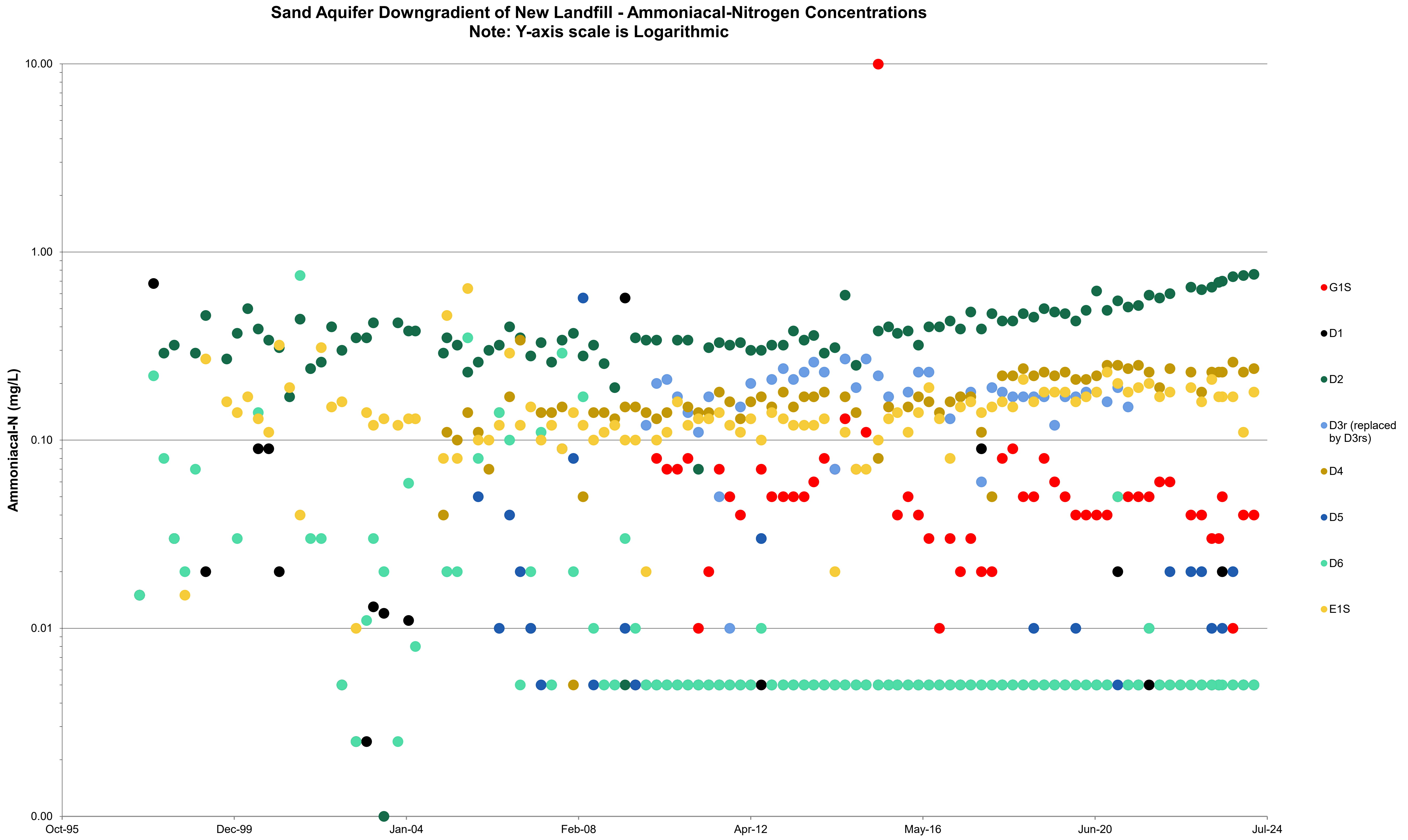
Determinand		ANZECC STOCK	Median	Maximum	Annual Median	Apr-24	Jan-24	Oct-23	Jul-23	Jun-23	Apr-23	Jan-23	Oct-22	Jul-22	Apr-22	Jan-22	Oct-21	Jul-21	Jun-21	Apr-21	Mar-21
Water level	mBGL		2.455	2.77	2.53	2.53	2.6	2.5		2.0700	2.7000	2.41	2.06	2.2600	2.5800	2.0400	2.3000	2.37	2.7700	2.77	
pH		6 to 9	6.8	7.8	6.7	6.6	6.7	7	6.7	6.7		7.8	6.7	7.0	7.0	7.1	6.8000	6.8		6.9	6.9
Suspended Solids	mg/l		13	27	10.75	19	*2.5*	26	*2.5*	21					9	27	7.0000			17	8
Phenol	mg/L		0.025	0.025	0.025	*0.005*		*0.025*	*0.025*	*0.025*					*0.025*		*0.025*			*0.025*	*0.025*
VFA	mg/L		2.5	2.5	2.5	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*					*2.5*		*2.50*			*2.50*	*2.50*
TOC	mg/L		2.25	24.7	2.15	2.5	2.3	2	1.8	1.8					2.4	2	2.2000			2.7	24.7
Alkalinity	mg CaCO3/L		57	65	59.5	65	60	57	59	60	48				54	48	49.0000			58	8
Conductivity	mS/m		19.75	22.4	20.1	22.4	20.6	18	19.6	20.2	20	18.8	16.8	16.6	18.2	16.4	16.6000	21.2		21.8	21.4
COD	mg/L		7.5	73	7.5	*7.5*	29	*7.5*	*7.5*	*7.5*	*7.5*	*7.5*	*7.5*	*7.5*	37	14.99	*7.5*	*7.5*		*73*	*7.5*
BOD (scBOD frm Apr'20)	mg/L		1.5	15	0.5	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*1.5*	*3*	*3*	*3*	15	5.9	*3*	*3*		*1.5*	*1.5*
Faecal C (Ecoli frm Apr'20)	col/100ml	100	31	50	50	*50*	*50*	*50*	*50*	*50*	*2*	*50*	*2*	*50*	*2*	31	*2*	12		16	*2*
Chloride	mg/L		16.45	21.7	16.45	21.3	17.3	13.3	15.6	14.9	18.9	19.4	14.9	11.3	12.4	12.6	11.5000	18.0		20.8	21.7
Nitrate-N	mg/L	90.3	0.66	1.64	0.695	0.73	0.63	0.84	0.66	0.82		1.64	1.34	1.05	0.88	0.66	0.6500	0.37		0.41	0.58
Sulphate	mg/L	1000	8.875	13.7	8.54	7.61	8.73	8.35	9.81	11.9					7.49	7.42	9.0200			12.8	13.7
Ammonia-N	mg/L		0.02	0.1	0.02	0.01	0.05	0.02	0.02	0.02	0.03	0.01	*0.005*	*0.005*	0.03	0.01	0.1000	0.07		0.02	0.02
Hardness	mg CaCO3/L		53	64	57	58	64	47	56	61					46	43	41.0000			54	52
Calcium	mg/L	1000	10.9	13.9	11.75	11.1	13.9	10.2	12.4	13.1	10.9				9.82	9.49	8.7000			11.2	10.8
Magnesium	mg/L		6.135	7.25	6.665	7.25	7.14	5.29	6.19	6.74					5.29	4.65	4.7800			6.45	6.08
Potassium	mg/L		3.98	5.66	4.73	5.44	5.66	3.31	4.02	4.8					4.36	3.83	3.3100			3.94	3.88
Sodium	mg/L		16.2	18.6	17.15	18	18.6	16.3	15.7	14.1					16.1	13.8	14.2000			17.6	17.6
D.R. Phosphorus	mg/L		0.018	0.034	0.022	0.015	0.034	0.018	0.026	0.016	0.011				0.015	0.022	0.0150			0.023	0.018
Aluminium	mg/L	5	0.0075	0.015	0.007	0.01	0.004	0.004	0.011	0.013	0.007	0.006	0.007	0.007	0.013	0.006	0.0080	0.015		0.007	0.008
Arsenic	mg/L	0.5	0.0005	0.0005	0.0005	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*				*0.0005*	0	*0.0005*			*0.0005*	*0.0005*
Boron	mg/L	5	0.04	0.06	0.04	0.04	0.05	0.04	0.04	0.04	0.06	0.04	*0.015*	*0.015*	0.04	0.04	*0.0150*	0.06		0.04	0.04
Cadmium	mg/L	0.01	0.0001	0.0001	0.0001	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*				*0.0001*	0.0001	*0.0001*			*0.0001*	*0.0001*
Chromium	mg/L	1	0.0005	0.0005	0.0005	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*				*0.0005*	0	*0.0005*			*0.0005*	*0.0005*
Copper	mg/L	0.4	0.0011	0.0215	0.00135	0.0011	0.0016	0.0009	0.0215	0.0008	0.0014				0.0014	0.0008	0.0007			0.0008	0.0015
Iron	mg/L		0.11	0.22	0.095	0.06	0.22	0.08	0.11	0.041	0.132				0.074	0.05	0.1580			0.111	0.219
Lead	mg/L	0.1	0.00025	0.0004	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	0.0004	*0.00025*	*0.00025*		*0.00025*	*0.00025*
Manganese	mg/L		0.0725	0.131	0.0741	0.126	0.094	0.0542	0.0416	0.0414		0.0598	0.0314	0.0133	0.0737	0.0491	0.0725	0.107		0.106	0.131
Mercury	mg/L		0.00025	0.0004	0.00025	*0.00025*	*0.00025*	*0.00025*	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	0.0004	*0.00025*	*0.00025*		*0.00025*	*0.00025*
Nickel	mg/L	1	0.00025	0.0008	0.00025	*0.00025*	*0.00025*	0.0007	*0.00025*	*0.00025*		*0.00025*	*0.00025*	*0.00025*	*0.00025*	0.0004	*0.00025*	*0.00025*		*0.00025*	0.0008
Zinc	mg/L	20	0.004	0.016	0.0045	0.016	0.005	0.004	*0.001*	*0.001*					0.005	0.001	*0.0010*			0.004	0.006

Appendix F Leachate indicator graphs

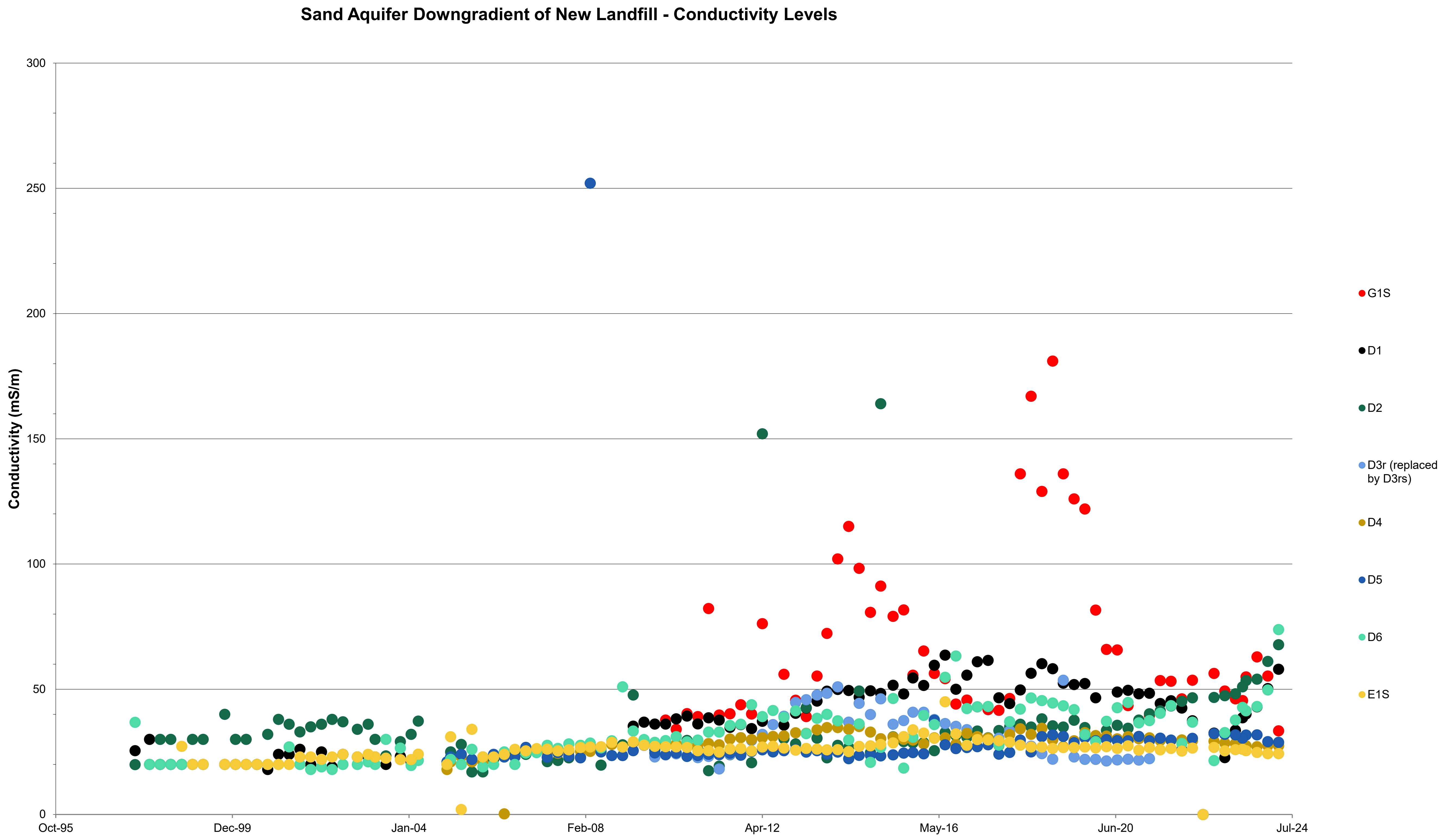


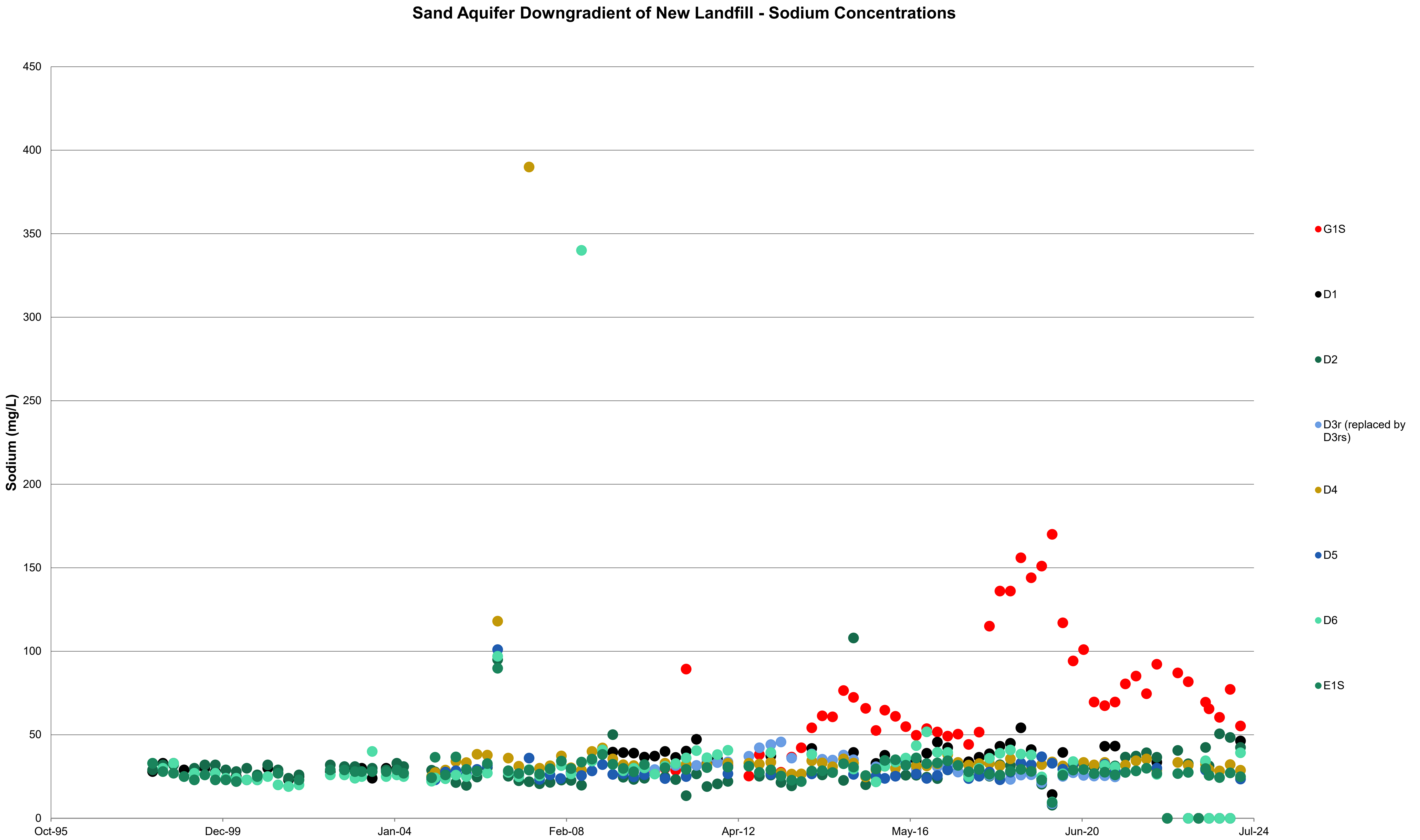
Sand Aquifer Downgradient of New Landfill - Boron Concentrations
Boron (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
G1S
D1
D2
D3r (replaced by D3rs)
D4
D5
D6
E1S

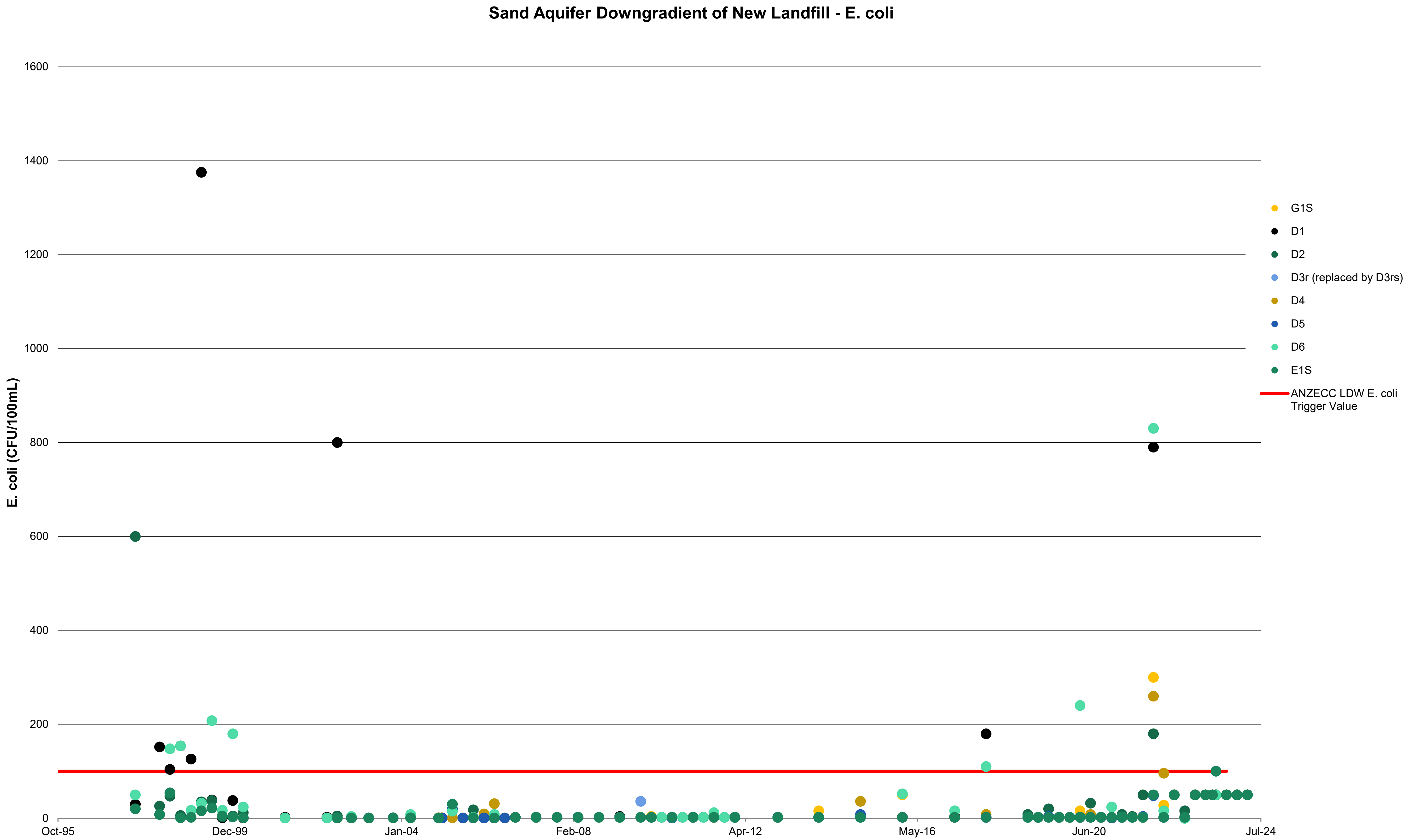

Sand Aquifer Downgradient of New Landfill - Chloride Concentrations
Chloride (mg/L)
600
500
400
300
200
100
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
G1S
D1
D2
D3r (replaced by D3rs)
D4
D5
D6
E1S



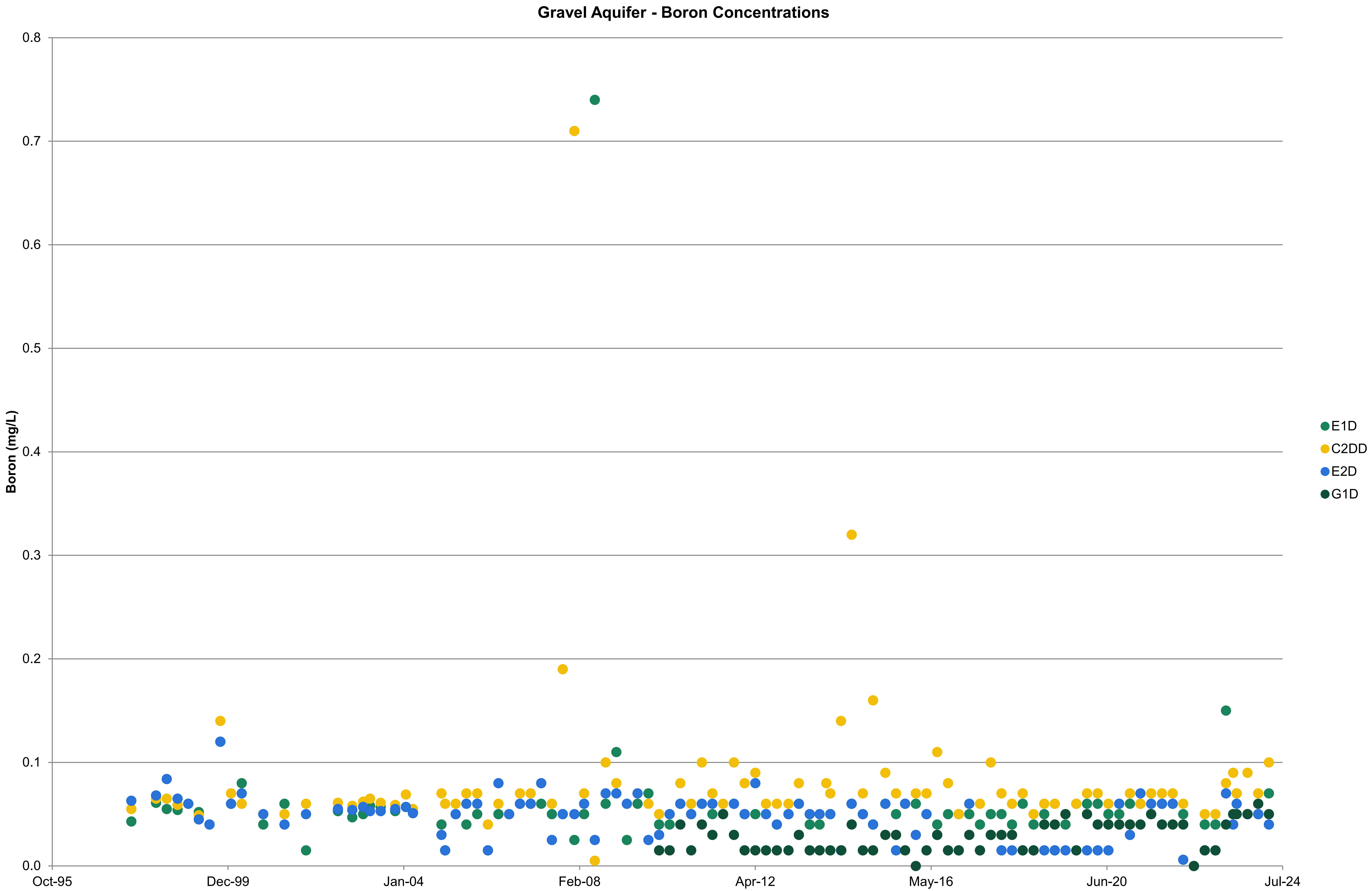
Sand Aquifer Downgradient of New Landfill - Ammoniacal-Nitrogen Concentrations
Note: Y-axis scale is Logarithmic
Ammoniacal-N (mg/L)
10.00
1.00
0.10
0.01
0.00
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
G1S
D1
D2
D3r (replaced by D3rs)
D4
D5
D6
E1S


Sand Aquifer Downgradient of New Landfill - Conductivity Levels
Conductivity (mS/m)
300
250
200
150
100
50
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
G1S
D1
D2
D3r (replaced by D3rs)
D4
D5
D6
E1S

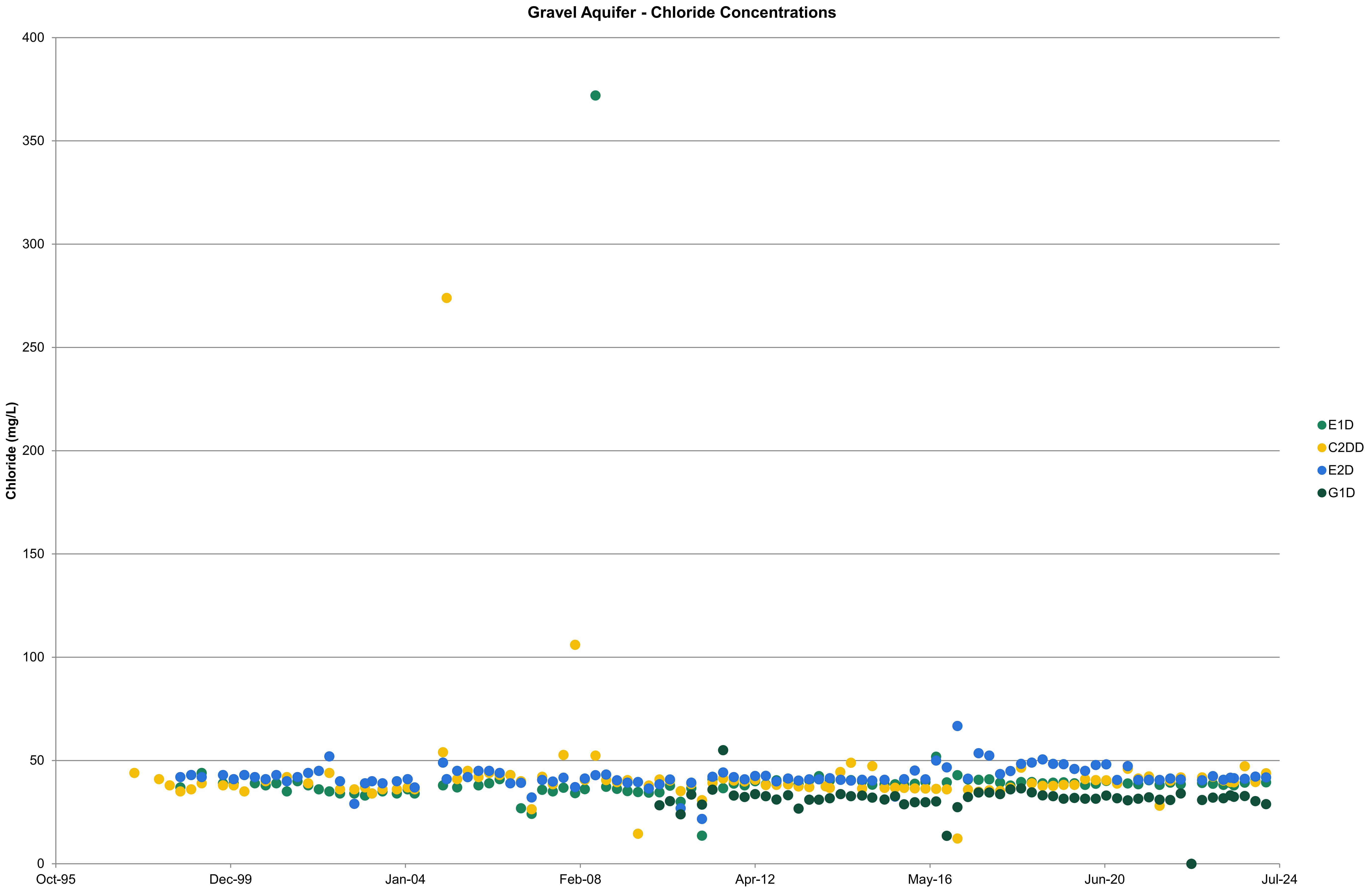

Sand Aquifer Downgradient of New Landfill - Sodium Concentrations
Sodium (mg/L)
450
400
350
300
250
200
150
100
50
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
G1S
D1
D2
D3r (replaced by D3rs)
D4
D5
D6
E1S



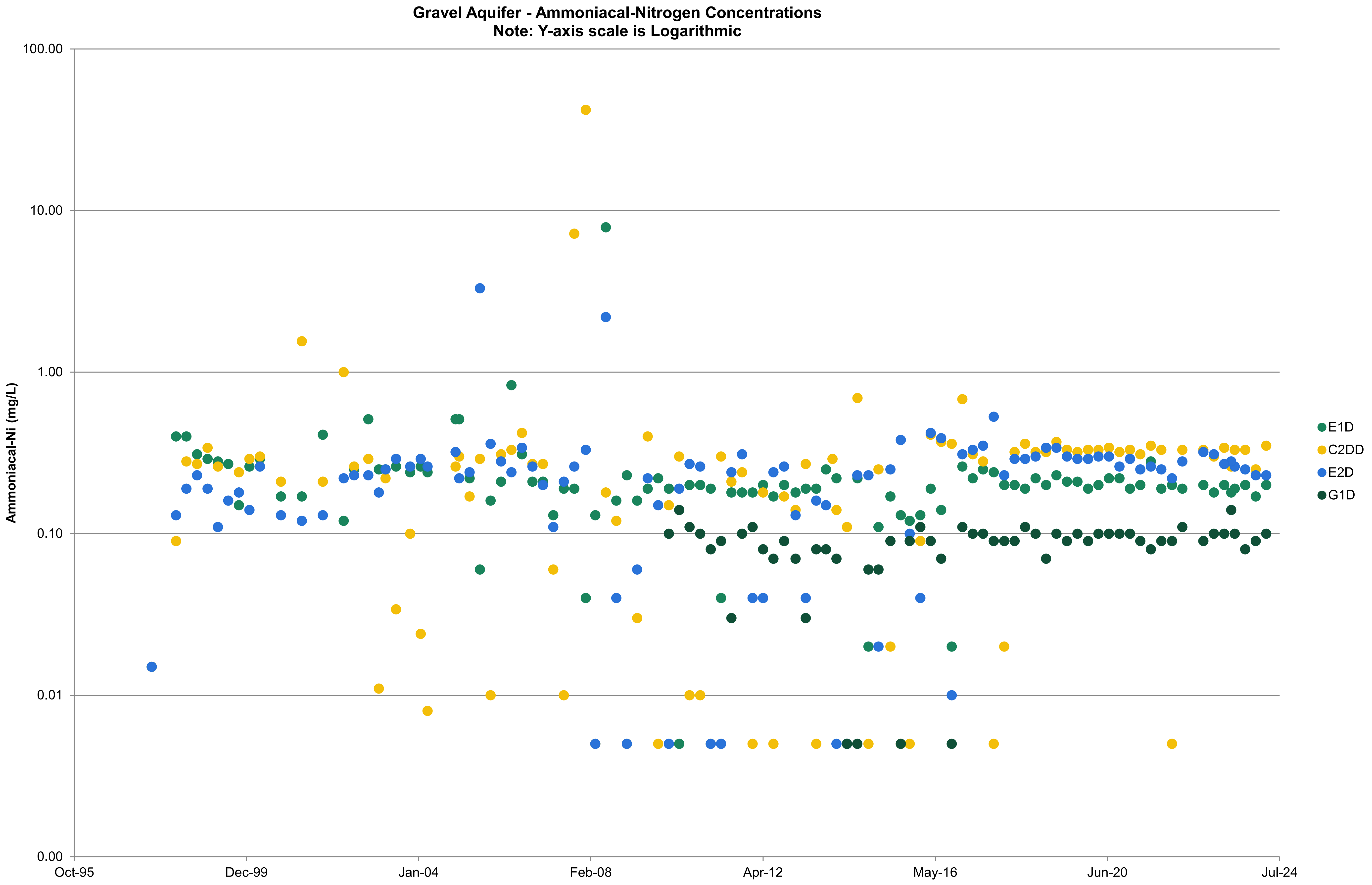
Sand Aquifer Downgradient of New Landfill - E. coli
E. coli (CFU/100mL)
1600
1400
1200
1000
800
600
400
200
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
G1S
D1
D2
D3r (replaced by D3rs)
D4
D5
D6
E1S
ANZECC LDW E. coli Trigger Value



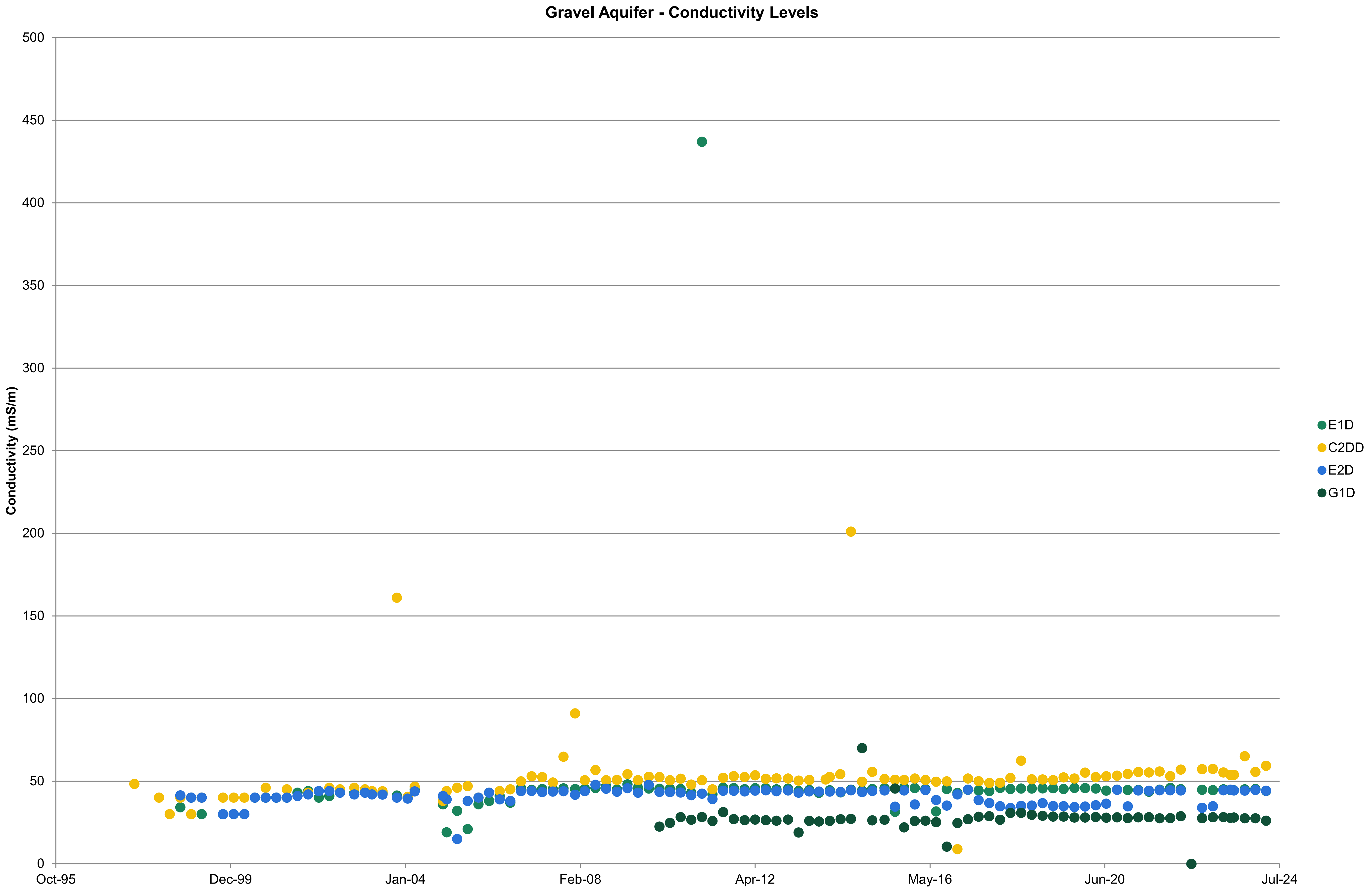
Gravel Aquifer - Boron Concentrations
Boron (mg/L)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
E1D
C2DD
E2D
G1D



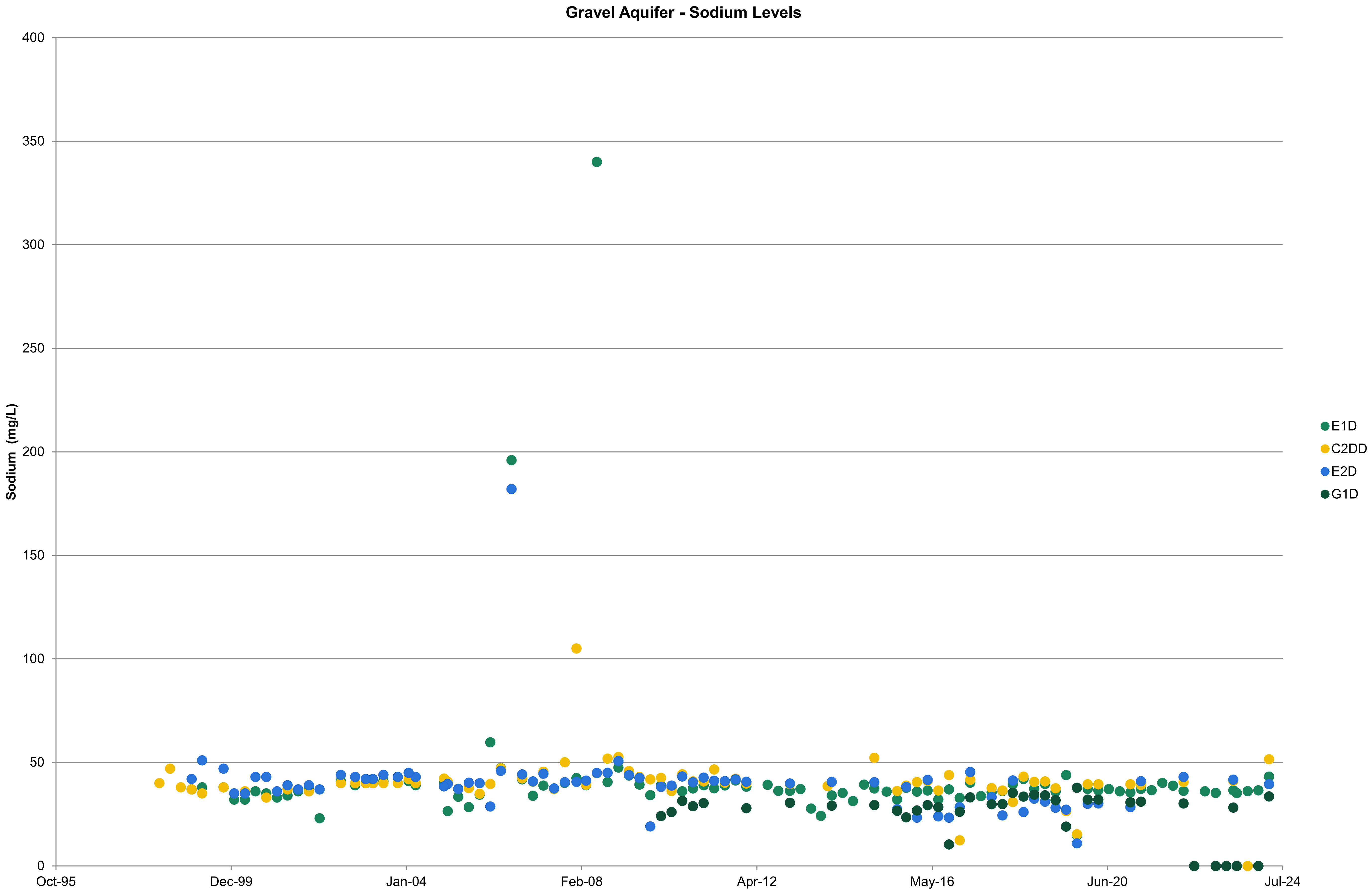
Gravel Aquifer - Chloride Concentrations
Chloride (mg/L)
400
350
300
250
200
150
100
50
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
E1D
C2DD
E2D
G1D

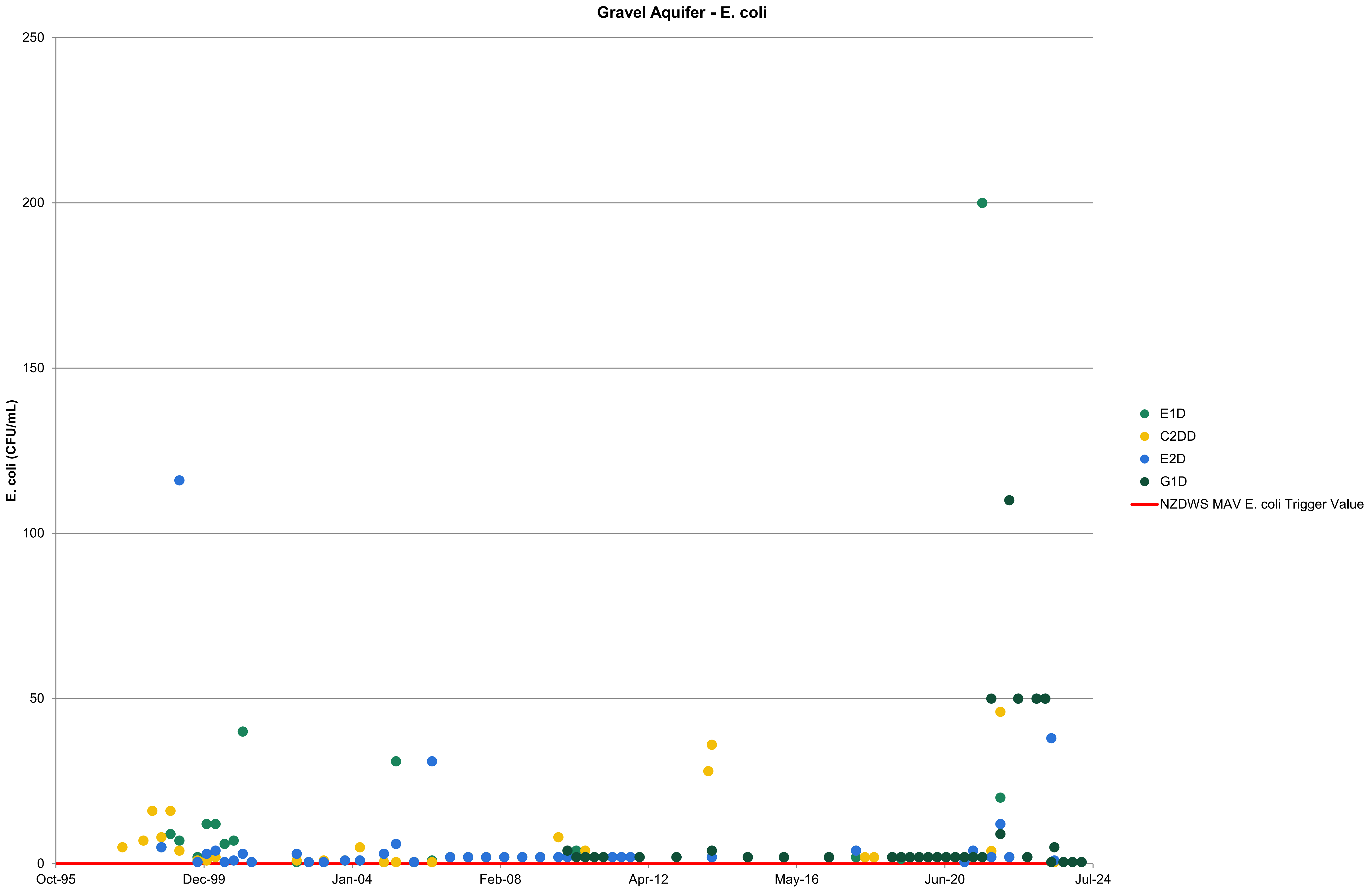


Gravel Aquifer - Ammoniacal-Nitrogen Concentrations
Note: Y-axis scale is Logarithmic
100.00
10.00
1.00
0.10
0.01
0.00
Ammoniacal-Ni (mg/L)
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
E1D
C2DD
E2D
G1D

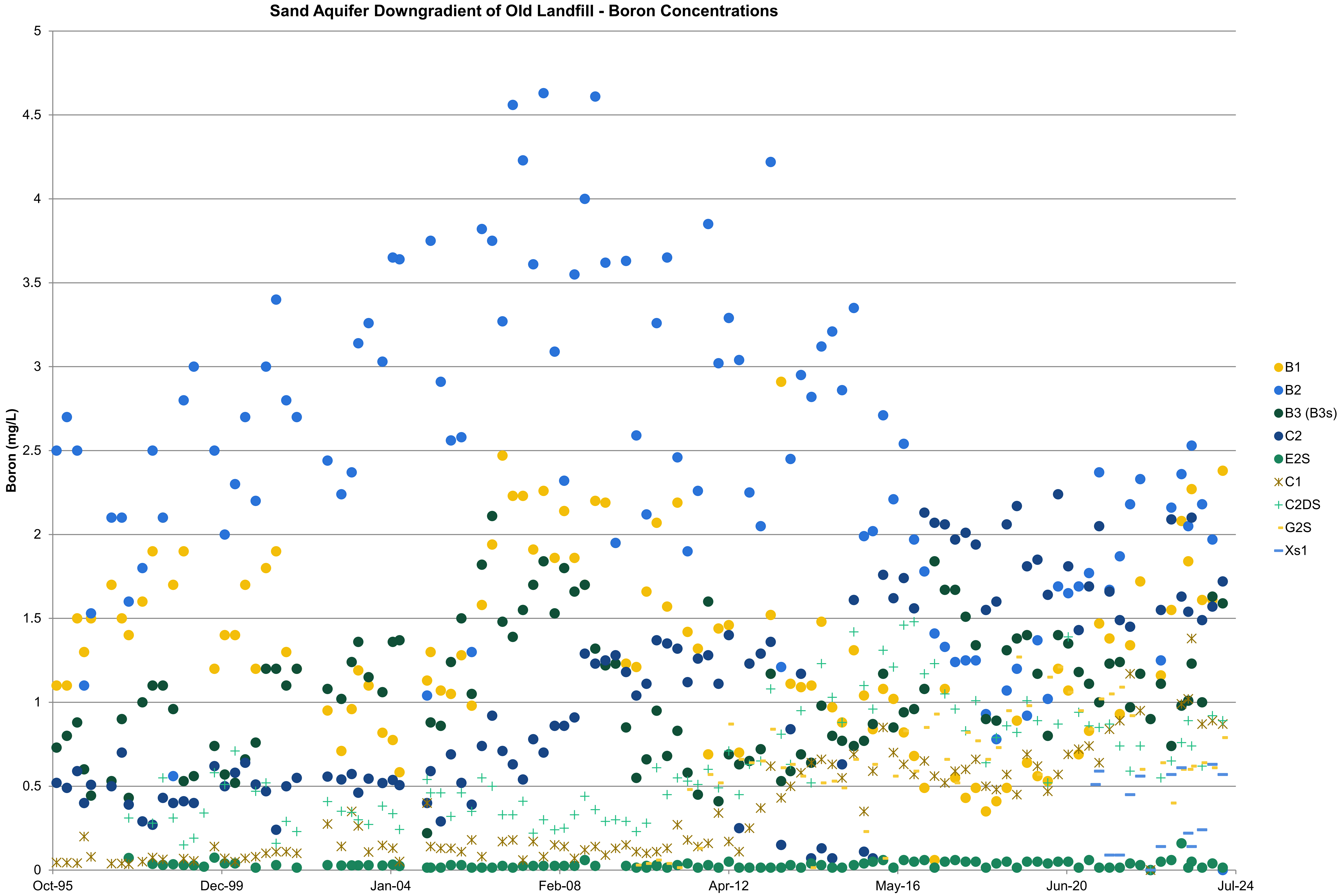


Gravel Aquifer - Conductivity Levels
Conductivity (mS/m)
500
450
400
350
300
250
200
150
100
50
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
E1D
C2DD
E2D
G1D

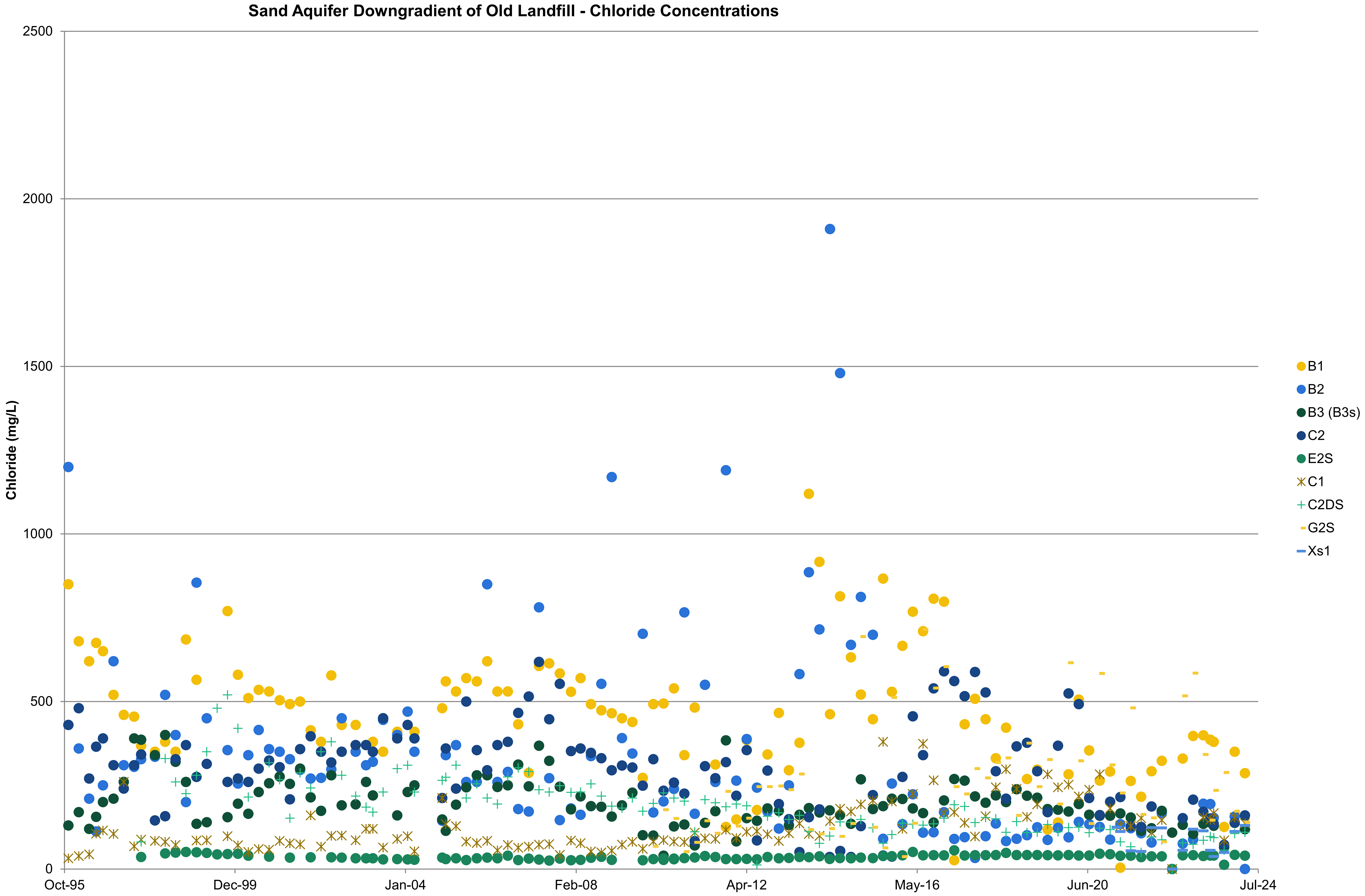

Gravel Aquifer - Sodium Levels
Sodium (mg/L)
400
350
300
250
200
150
100
50
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
E1D
C2DD
E2D
G1D



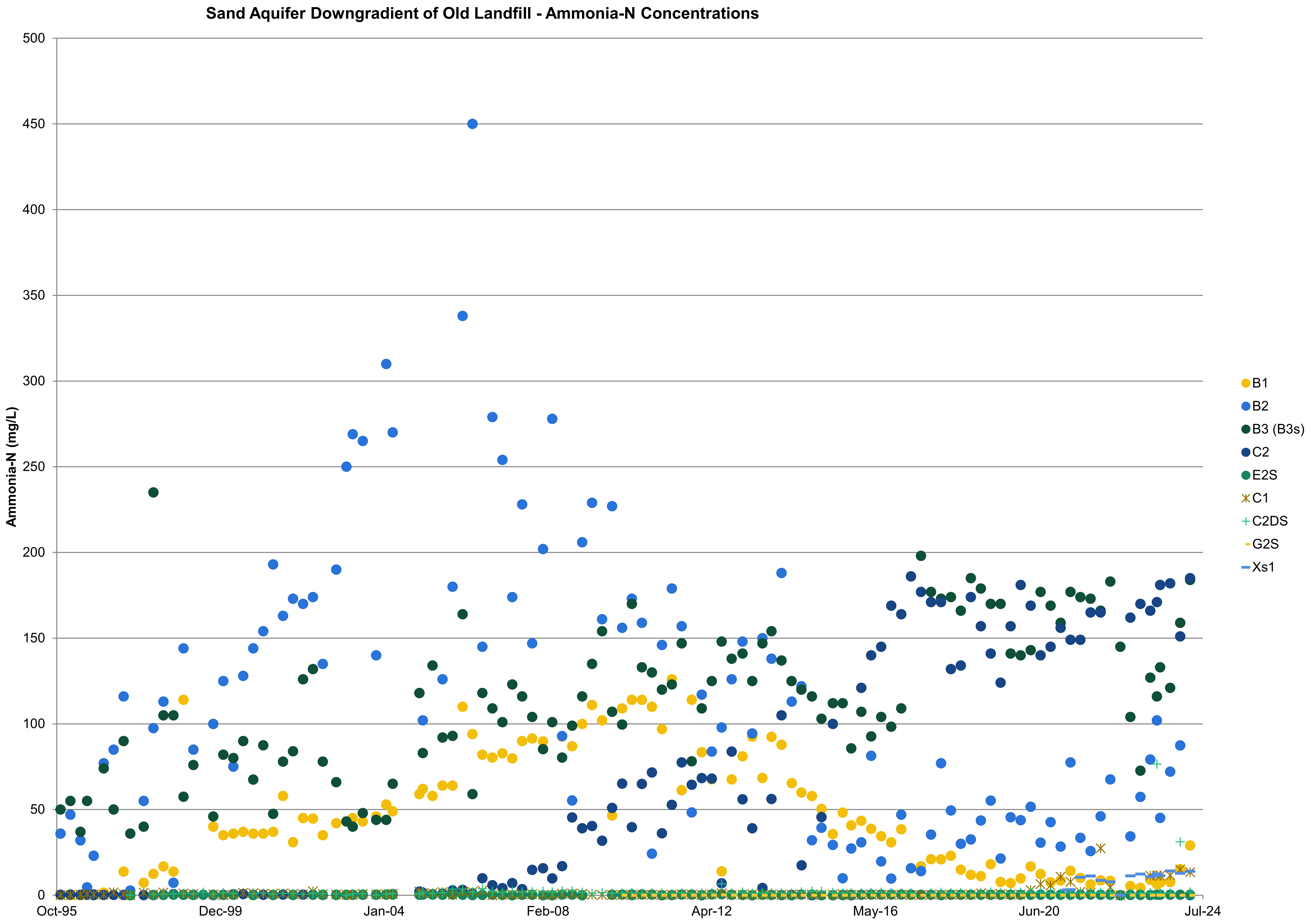
Gravel Aquifer - E. coli
250
200
150
100
50
0
E. coli (CFU/mL)
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
E1D
C2DD
E2D
G1D
NZDWS MAV E. coli Trigger Value



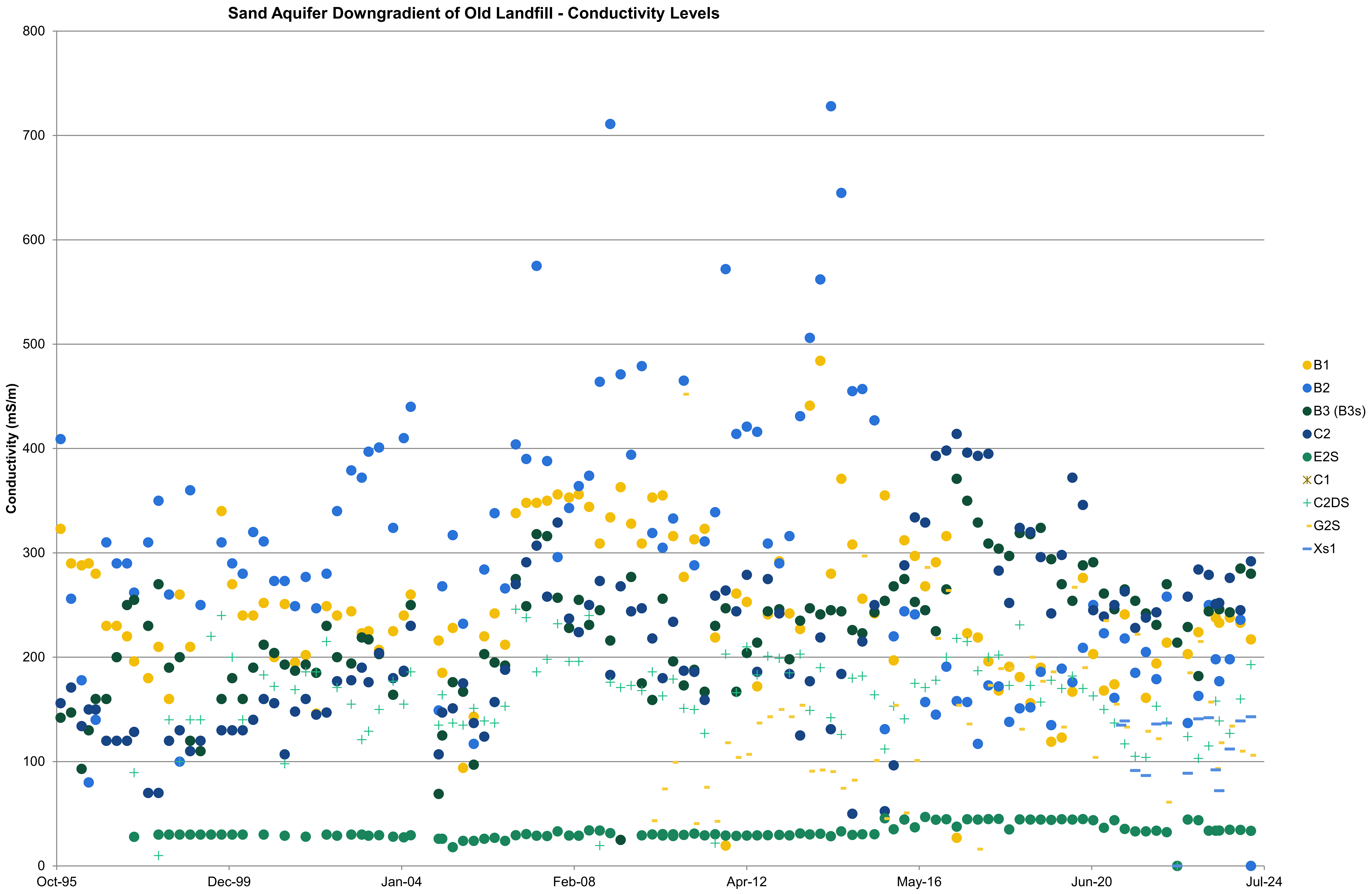
Sand Aquifer Downgradient of Old Landfill - Boron Concentrations
Boron (mg/L)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
B1
B2
B3 (B3s)
C2
E2S
C1
C2DS
G2S
Xs1

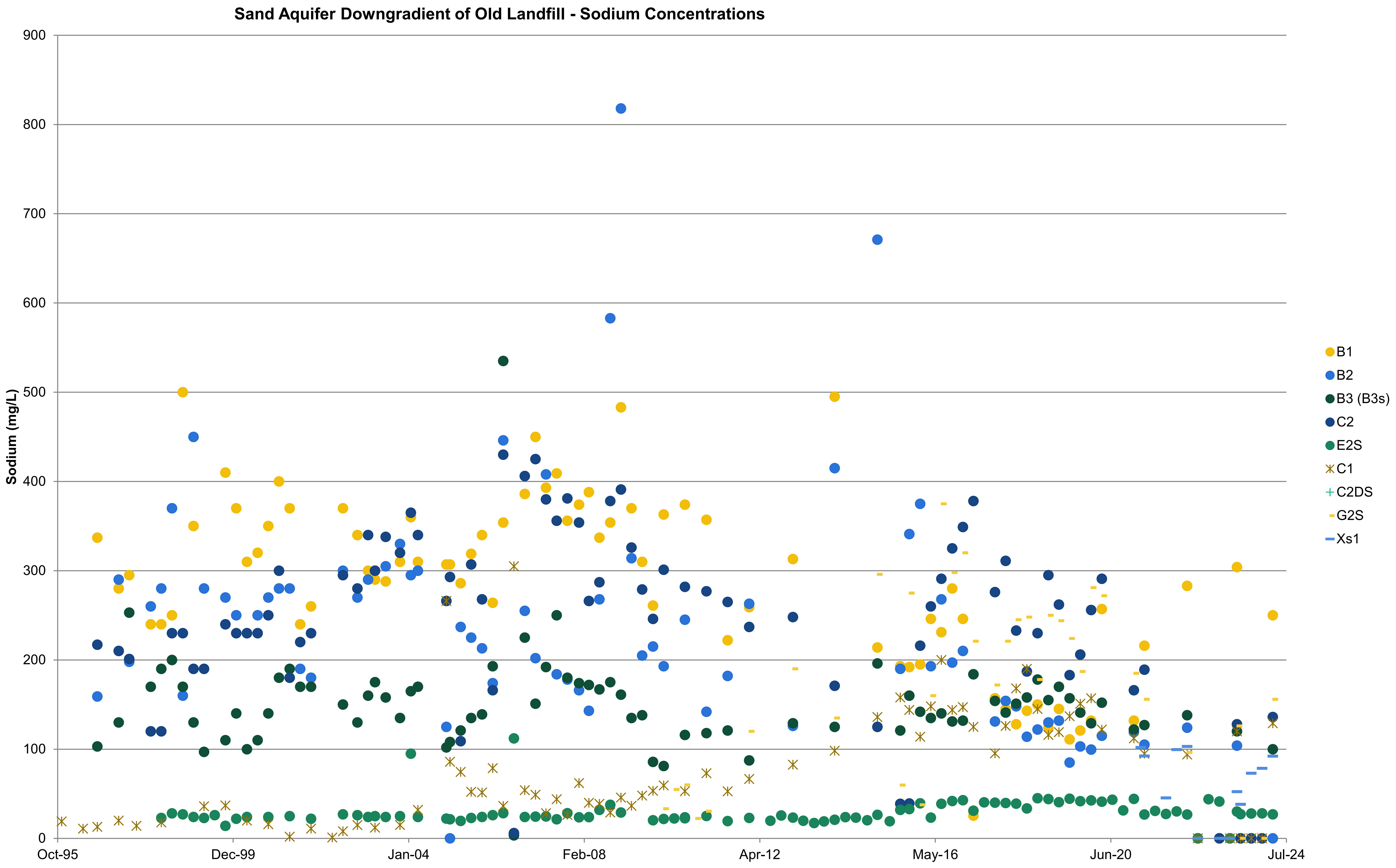


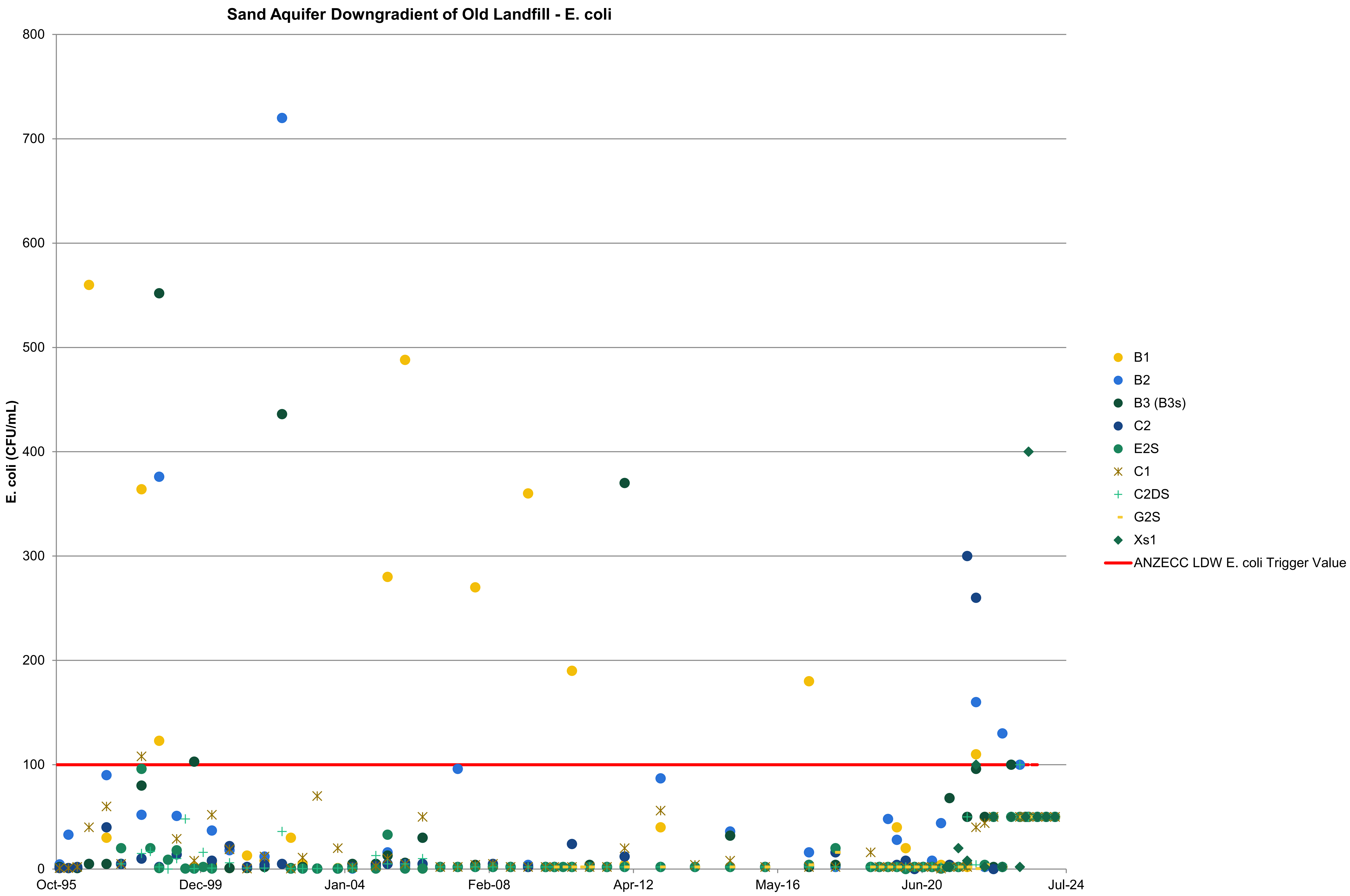
Sand Aquifer Downgradient of Old Landfill - Chloride Concentrations
Chloride (mg/L)
2500
2000
1500
1000
500
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
B1
B2
B3 (B3s)
C2
E2S
C1
C2DS
G2S
Xs1



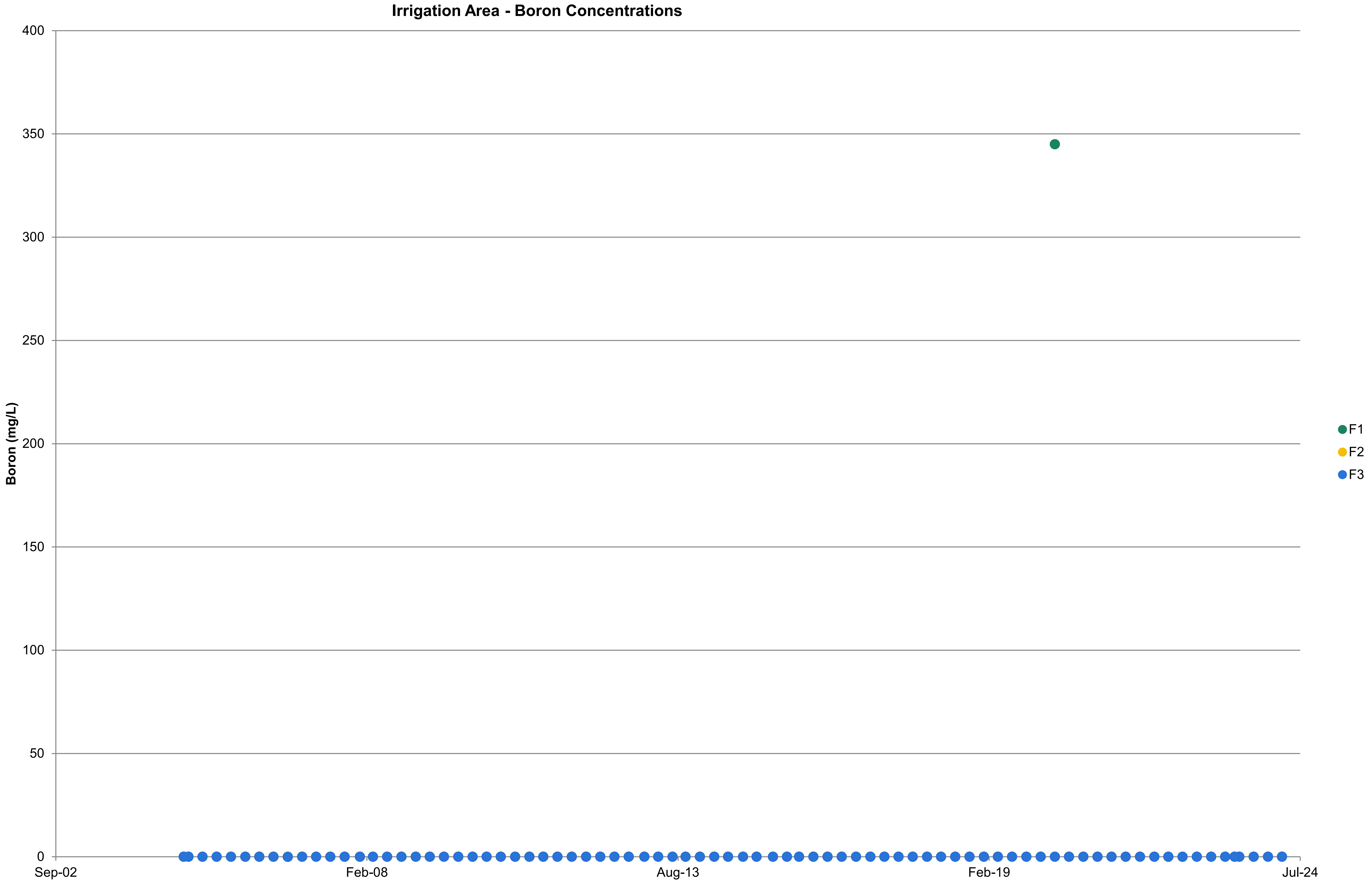
Sand Aquifer Downgradient of Old Landfill - Ammonia-N Concentrations
Ammonia-N (mg/L)
500
450
400
350
300
250
200
150
100
50
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
B1
B2
B3 (B3s)
C2
E2S
C1
C2DS
G2S
Xs1


Sand Aquifer Downgradient of Old Landfill - Conductivity Levels
Conductivity (mS/m)
800
700
600
500
400
300
200
100
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
B1
B2
B3 (B3s)
C2
E2S
C1
C2DS
G2S
Xs1

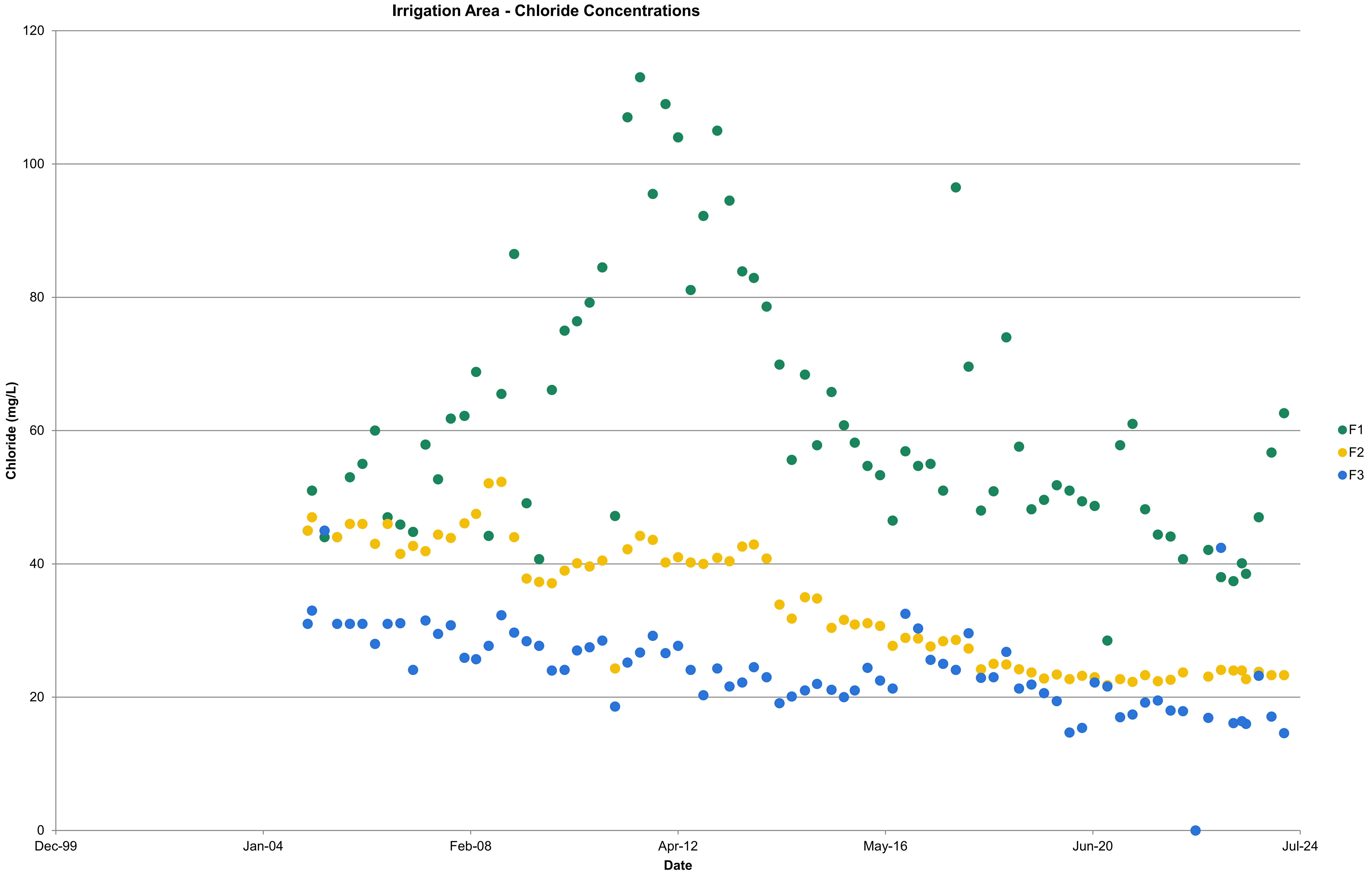

Sand Aquifer Downgradient of Old Landfill - Sodium Concentrations
Sodium (mg/L)
900
800
700
600
500
400
300
200
100
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
B1
B2
B3 (B3s)
C2
E2S
C1
C2DS
G2S
Xs1

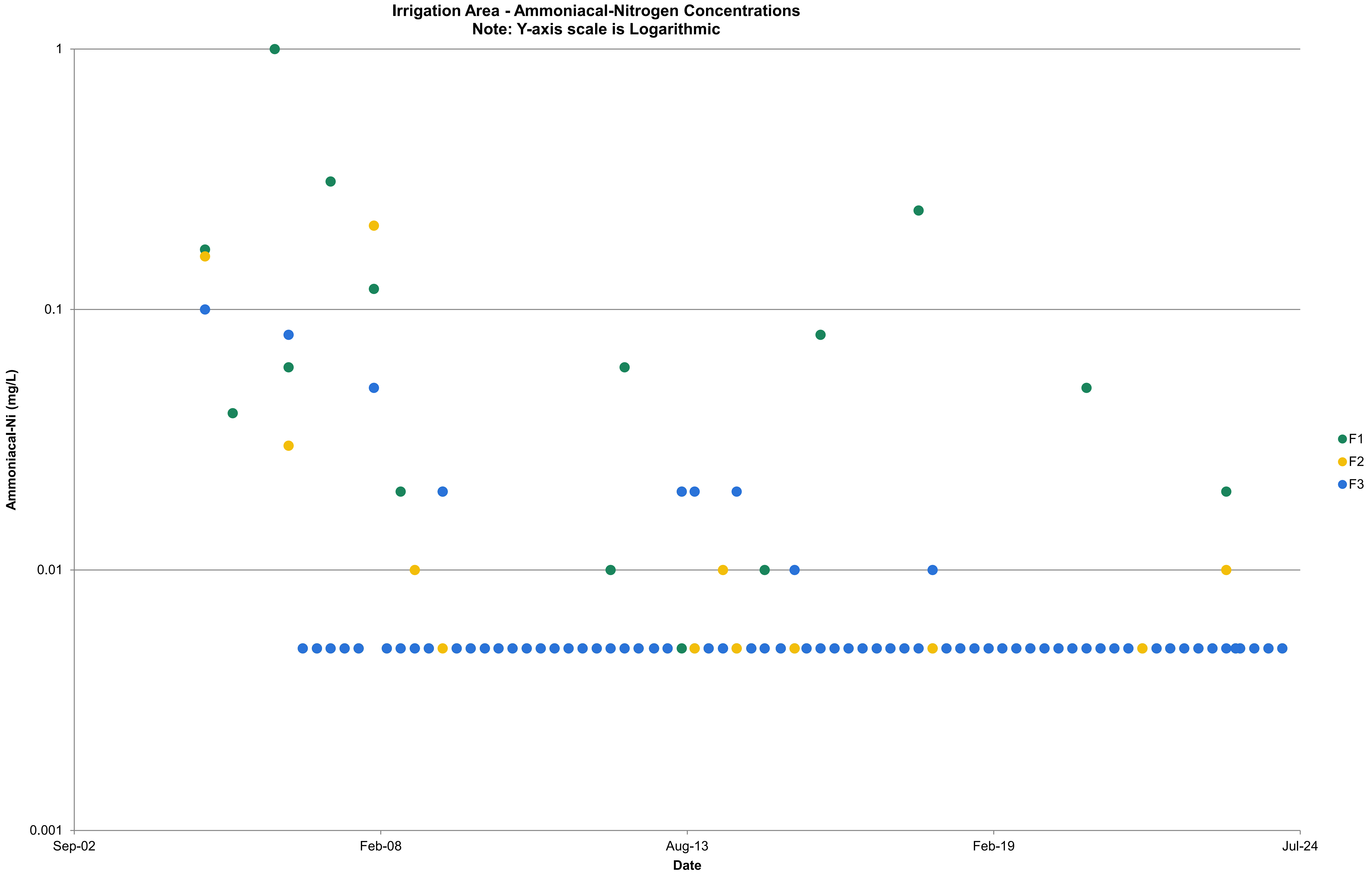


Sand Aquifer Downgradient of Old Landfill - E. coli
E. coli (CFU/mL)
800
700
600
500
400
300
200
100
0
Oct-95
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
B1
B2
B3 (B3s)
C2
E2S
C1
C2DS
G2S
Xs1
ANZECC LDW E. coli Trigger Value

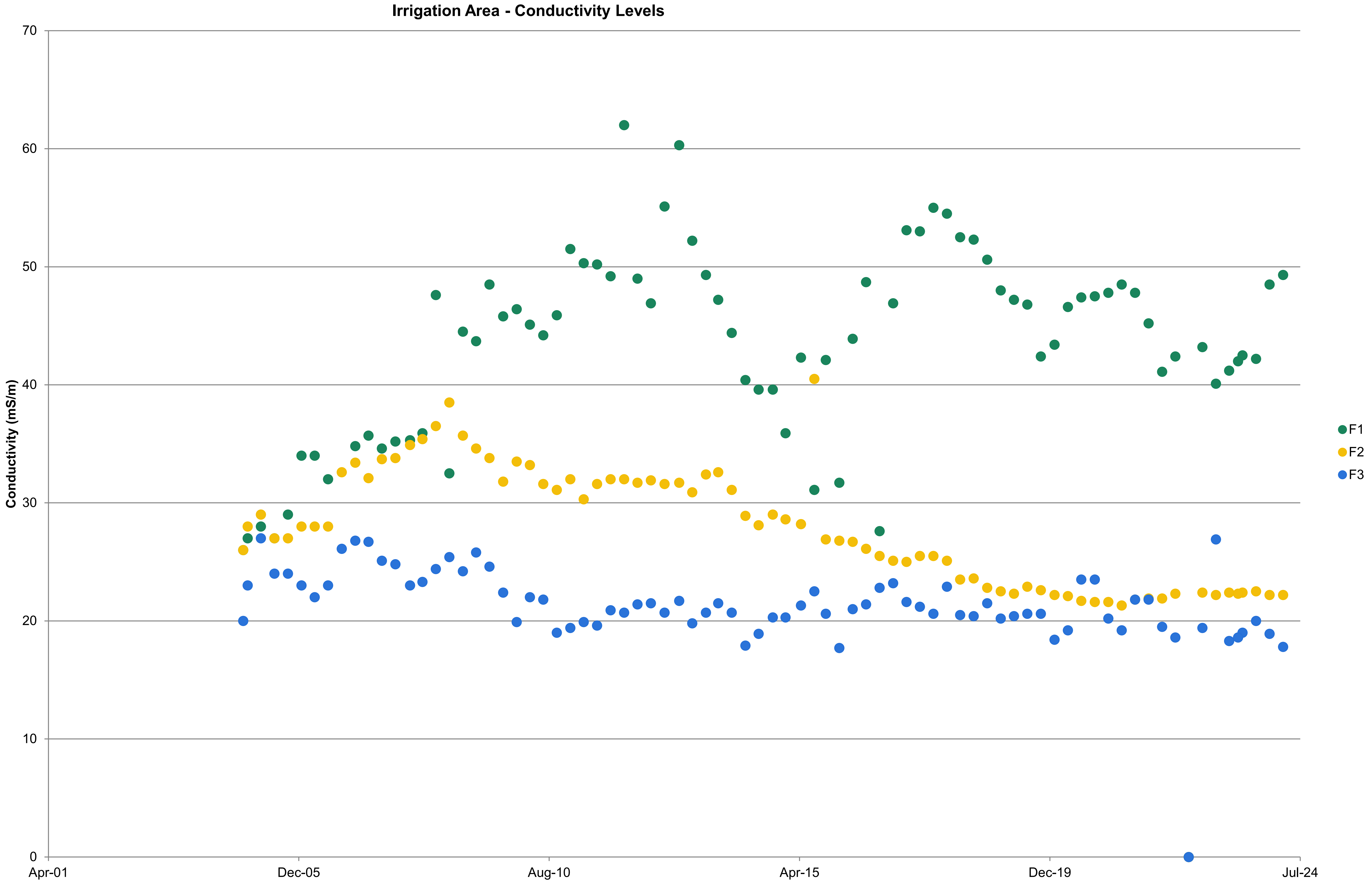


Irrigation Area - Boron Concentrations
Boron (mg/L)
400
350
300
250
200
150
100
50
0
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
F1
F2
F3

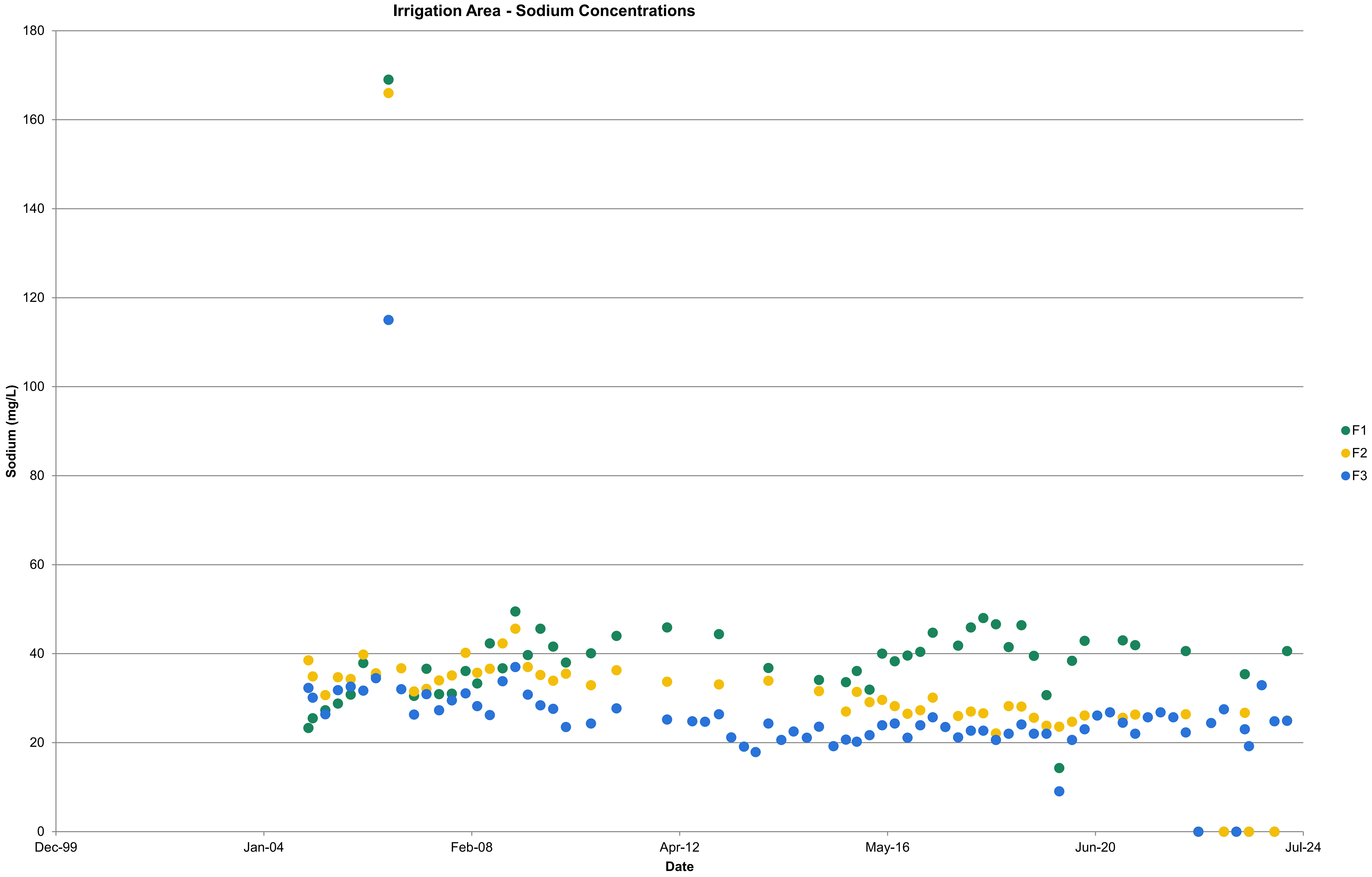

Irrigation Area - Chloride Concentrations
120
100
80
60
40
20
0
Chloride (mg/L)
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
Date
F1
F2
F3



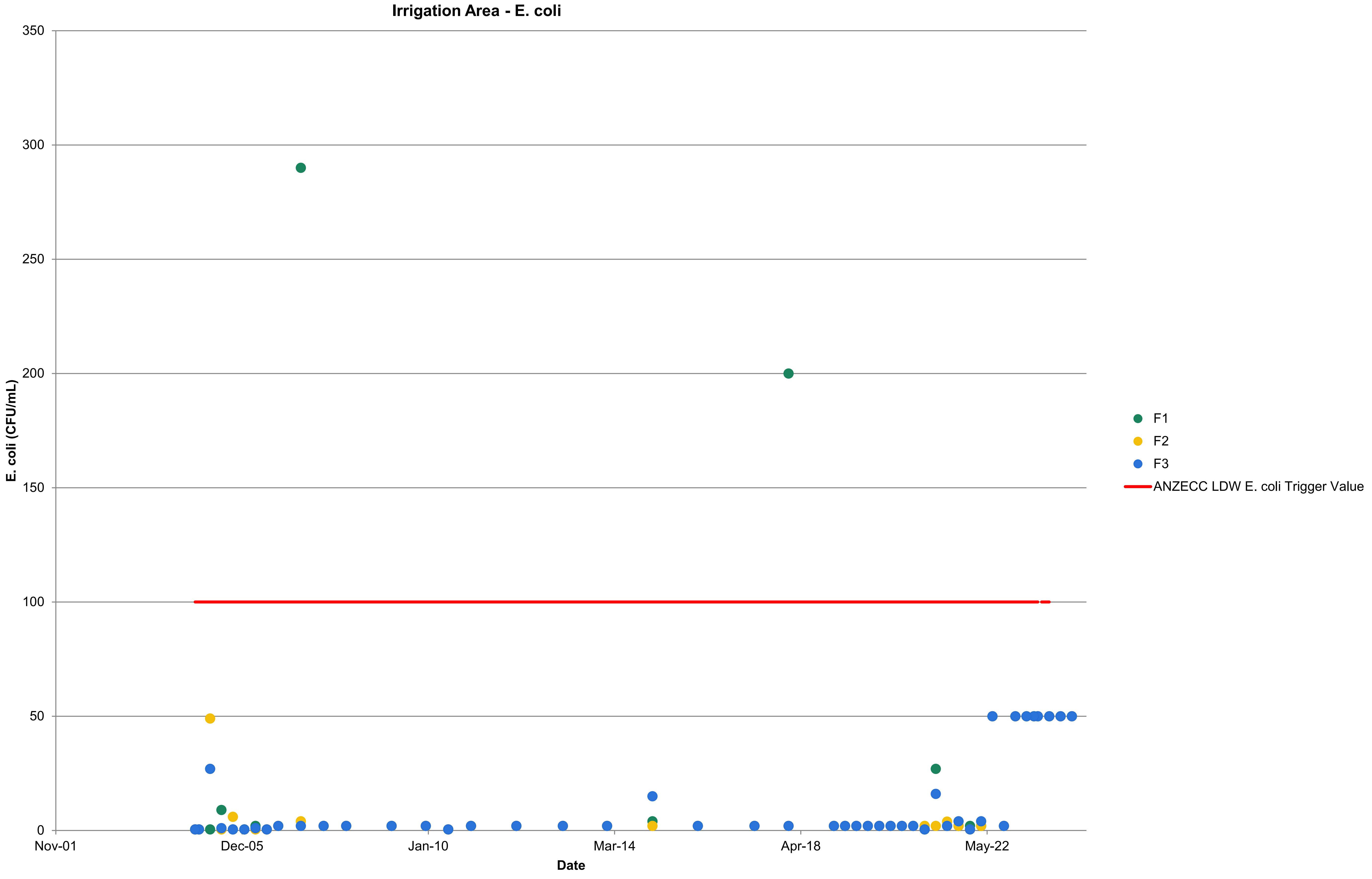
Irrigation Area - Ammoniacal-Nitrogen Concentrations
Note: Y-axis scale is Logarithmic
Ammoniacal-Ni (mg/L)
1
0.1
0.01
0.001
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
Date
F1
F2
F3



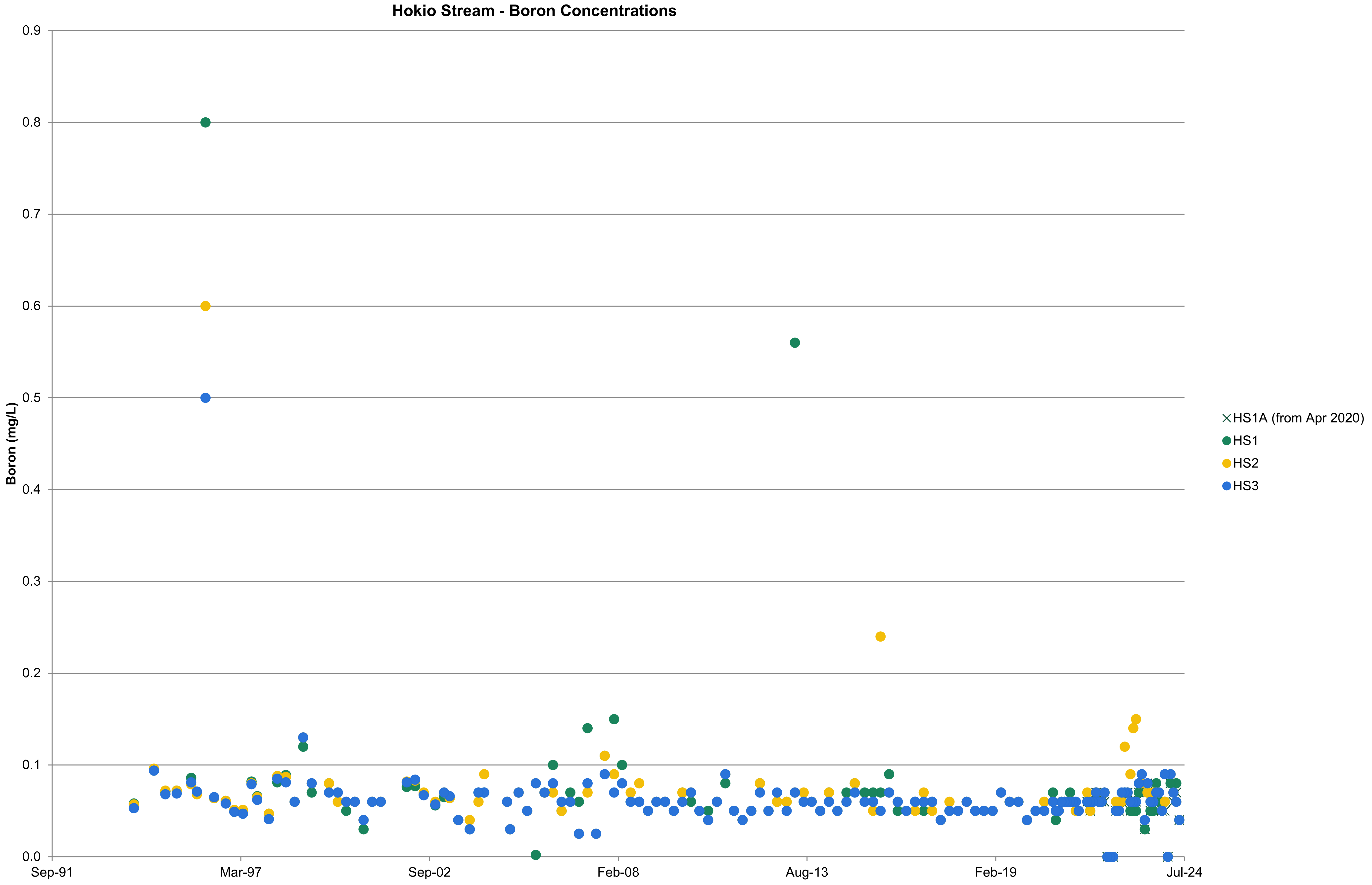
Irrigation Area - Conductivity Levels
Conductivity (mS/m)
70
60
50
40
30
20
10
0
Apr-01
Dec-05
Aug-10
Apr-15
Dec-19
Jul-24
F1
F2
F3

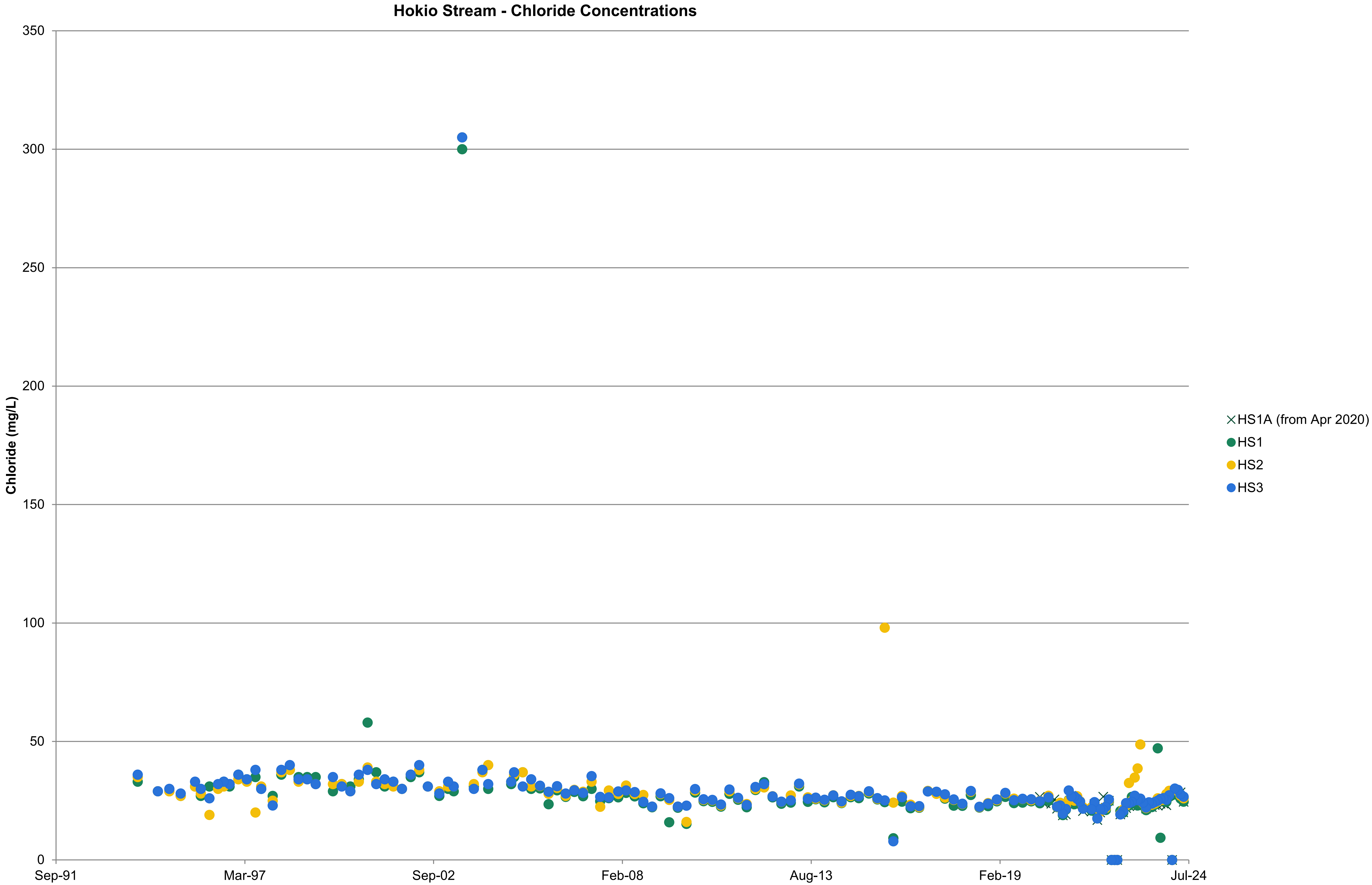


Irrigation Area - Sodium Concentrations
Sodium (mg/L)
180
160
140
120
100
80
60
40
20
0
Dec-99
Jan-04
Feb-08
Apr-12
May-16
Jun-20
Jul-24
Date
F1
F2
F3

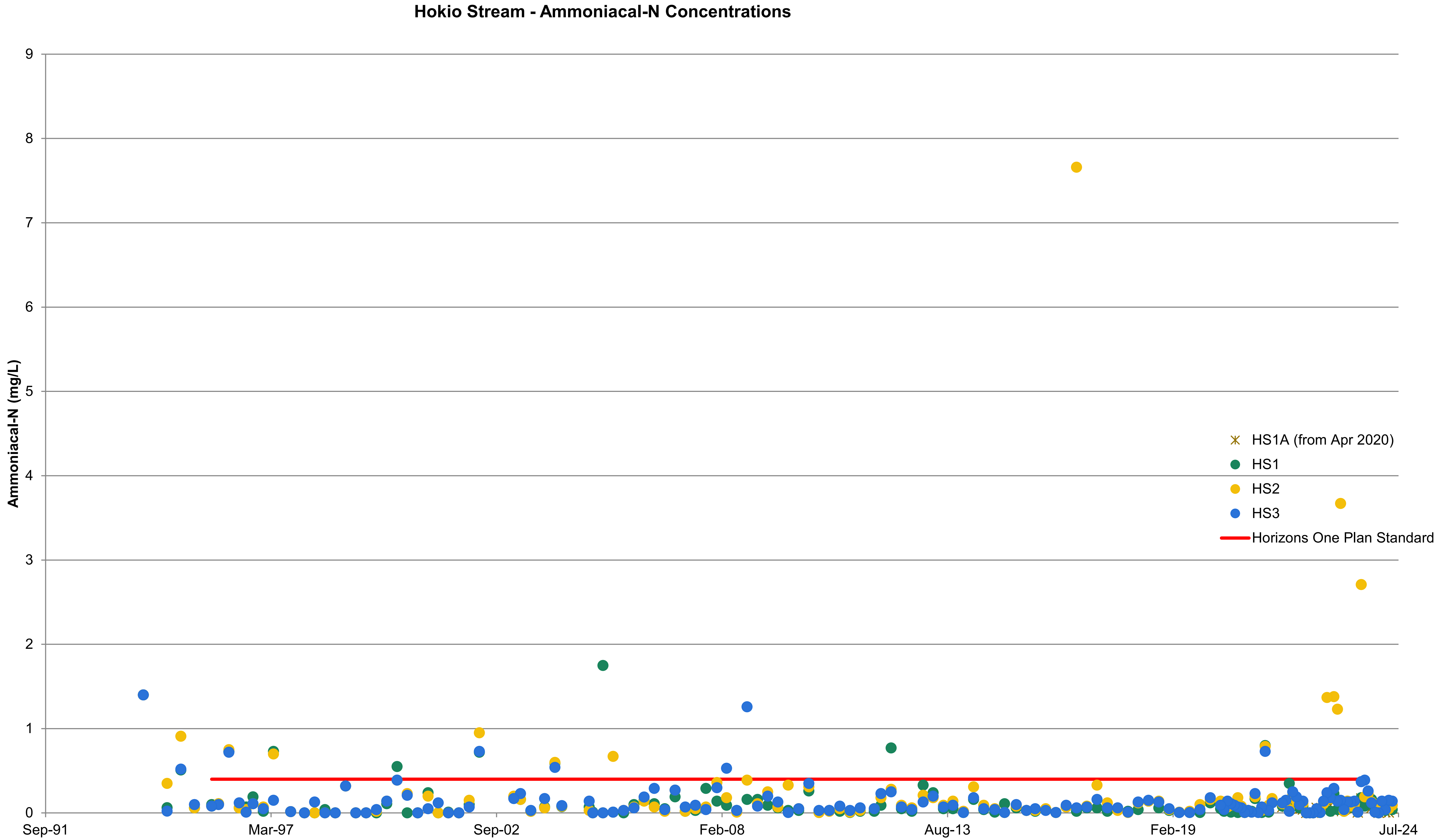


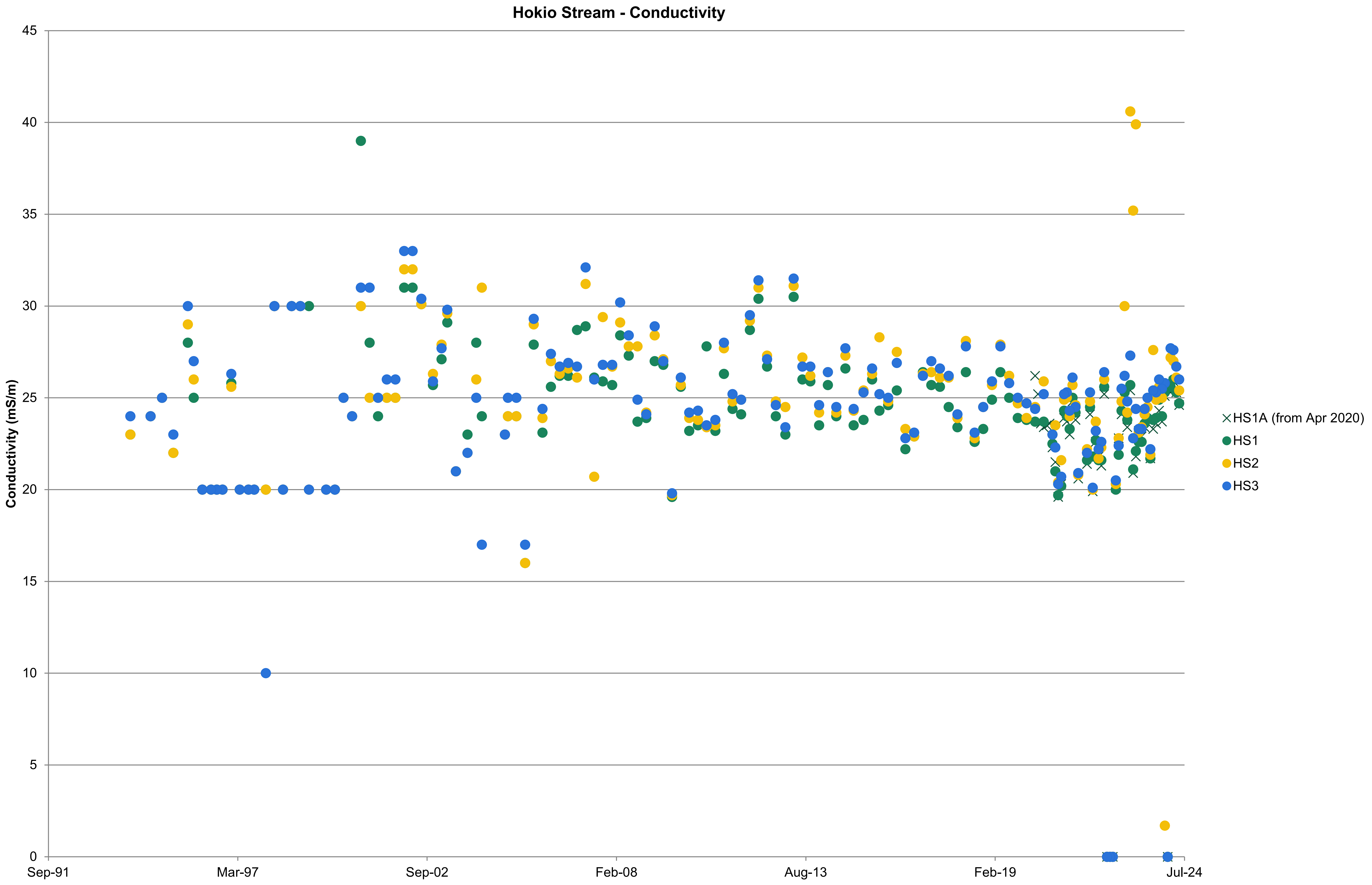
Irrigation Area - E. coli
350
300
250
200
150
100
50
0
E. coli (CFU/mL)
Nov-01
Dec-05
Jan-10
Mar-14
Apr-18
May-22
Date
F1
F2
F3
ANZECC LDW E. coli Trigger Value


Hokio Stream - Boron Concentrations
Boron (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Sep-91
Mar-97
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
HS1A (from Apr 2020)
HS1
HS2
HS3

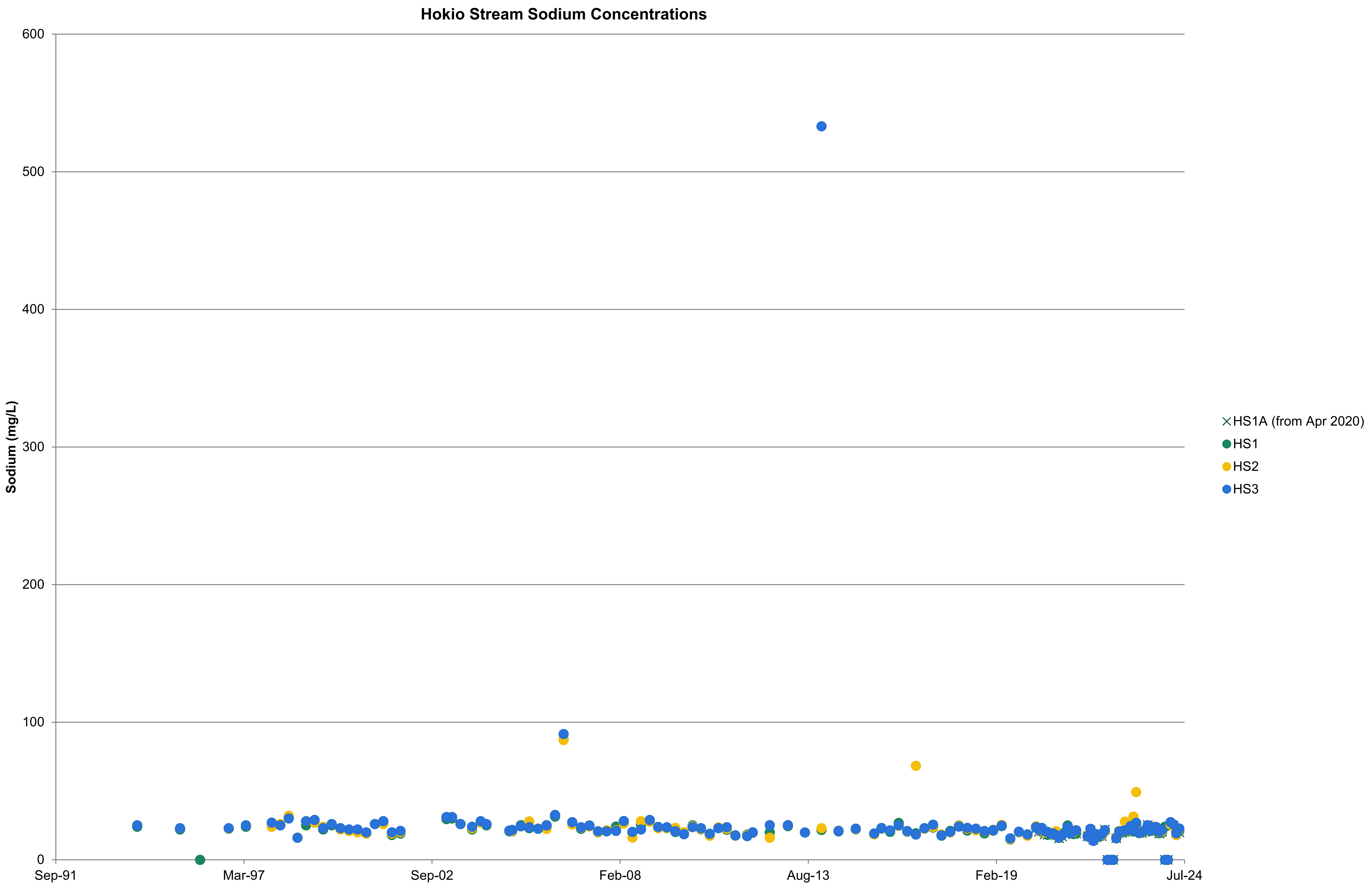


Hokio Stream - Chloride Concentrations
Chloride (mg/L)
350
300
250
200
150
100
50
0
Sep-91
Mar-97
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
HS1A (from Apr 2020)
HS1
HS2
HS3

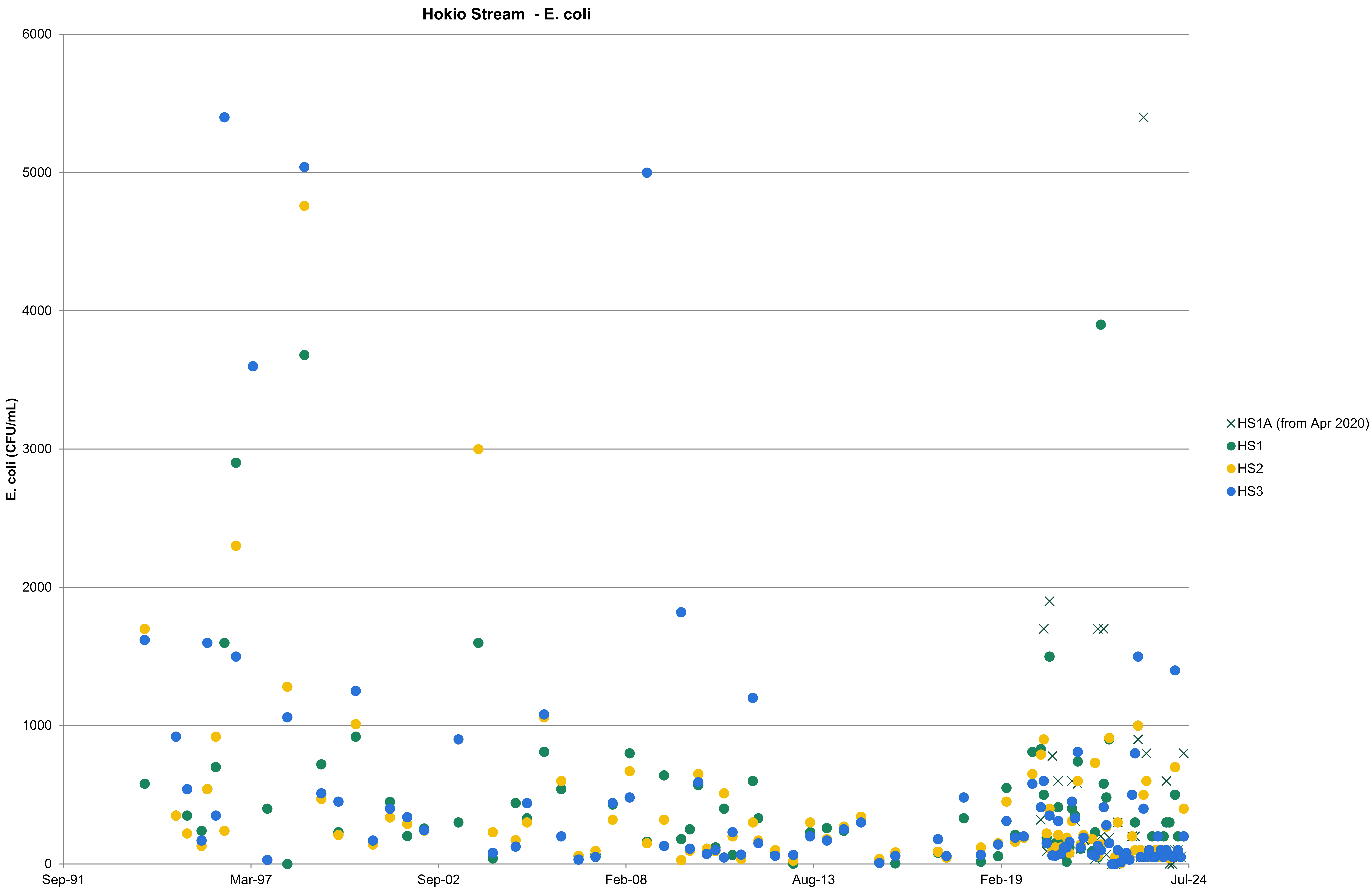

Hokio Stream - Ammoniacal-N Concentrations
Ammoniacal-N (mg/L)
9
8
7
6
5
4
3
2
1
0
Sep-91
Mar-97
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
HS1A (from Apr 2020)
HS1
HS2
HS3
Horizons One Plan Standard



Hokio Stream - Conductivity
Conductivity (mS/m)
45
40
35
30
25
20
15
10
5
0
Sep-91
Mar-97
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
HS1A (from Apr 2020)
HS1
HS2
HS3



Hokio Stream Sodium Concentrations
Sodium (mg/L)
600
500
400
300
200
100
0
Sep-91
Mar-97
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
HS1A (from Apr 2020)
HS1
HS2
HS3



Hokio Stream - E. coli
E. coli (CFU/mL)
6000
5000
4000
3000
2000
1000
0
Sep-91
Mar-97
Sep-02
Feb-08
Aug-13
Feb-19
Jul-24
HS1A (from Apr 2020)
HS1
HS2
HS3

Appendix G Mass contaminant load calculations and Earthtech Consulting Ltd report (July 2024)

LEVIN LANDFILL MASS CONTAMINANT LOAD CALCULATIONS

DOWN-GRADIENT BORES
B2, B3, C1, C2, C2DS, G2S, Xs1

Aquifer Thickness x Depth (W x D)

Aquifer Front Area = Thickness x Depth		Thickness (m)		
		13	15	17
Width (m)	350	4,550	5,250	5,950
	450	5,850	6,750	7,650
	550	7,150	8,250	9,350

Hydraulic Conductivity (K)

0.0000277 m/s = 2.39 m/day — Assume range from 2 to 3m/day

2 — 2.5 — 3 — Based on field data collected July 2012

Hydraulic Gradient (i)

Assume = 0.01

Concentration of Analytes in g/m3 (=C from B2, B3, C1, C2, C2DS, G2S and Xs1) - **including background**

	NH4 - N	Boron	Chloride	Sodium	Nitrate - N	DRP
Average of max. values last 5 years	82.166	1.491	280.957	165.800	19.370	0.043
Average of median values last 5 years	54.017	1.038	137.300	121.100	4.817	0.019

Discharge Volume (Q = W x D x K X i) in m3/day

W x D ↓	K→	2	2.5	3
4550		91.0	113.8	136.5
6750		135.0	168.8	202.5
9350		187.0	233.8	280.5

Mass Load (Q x C) in kg/day

DOWN-GRADIENT BORES
B2, B3, C1, C2, C2DS, G2S and Xs1
Includes background

	W x D	C				
NH4-N	4550	82.17	Max.	7.48	9.35	11.22
		54.02	Med.	4.92	6.14	7.37
	6750	82.17	Max.	11.09	13.87	16.64
		54.02	Med.	7.29	9.12	10.94
	9350	82.17	Max.	15.36	19.21	23.05
		54.02	Med.	10.10	12.63	15.15
Boron	4550	1.491	Max.	0.136	0.170	0.204
		1.038	Med.	0.094	0.118	0.142
	6750	1.491	Max.	0.201	0.252	0.302
		1.038	Med.	0.140	0.175	0.210
	9350	1.491	Max.	0.279	0.349	0.418
		1.038	Med.	0.194	0.243	0.291
Chloride	4550	281.0	Max.	25.57	31.96	38.35
		137.3	Med.	12.49	15.62	18.74
	6750	281.0	Max.	37.93	47.41	56.89
		137.3	Med.	18.54	23.17	27.80
	9350	281.0	Max.	52.54	65.67	78.81
		137.3	Med.	25.68	32.09	38.51
Sodium	4550	165.8	Max.	15.09	18.86	22.63
		121.1	Med.	11.02	13.78	16.53
	6750	165.8	Max.	22.38	27.98	33.57
		121.1	Med.	16.35	20.44	24.52
	9350	165.8	Max.	31.00	38.76	46.51
		121.1	Med.	22.65	28.31	33.97
Nitrate N	4550	19.3700	Max.	1.76	2.20	2.64
		4.8171	Med.	0.44	0.55	0.66
	6750	19.3700	Max.	2.61	3.27	3.92
		4.8171	Med.	0.65	0.81	0.98
	9350	19.3700	Max.	3.62	4.53	5.43
		4.8171	Med.	0.90	1.13	1.35
DRP	4550	0.043	Max.	0.004	0.005	0.006
		0.019	Med.	0.002	0.002	0.003
	6750	0.043	Max.	0.006	0.007	0.009
		0.019	Med.	0.003	0.003	0.004
	9350	0.043	Max.	0.008	0.010	0.012
		0.019	Med.	0.004	0.005	0.005

SURFACE WATER (HOKIO STREAM) **Includes background**
HS1 and HS3

From Results data spreadsheet
Average of HS1A and HS1 (values in g/m3)

	NH4 - N	Boron	Chloride	Sodium	Nitrate N	DRP
max. values last 5 years	0.775	0.080	37.800	25.350	2.550	0.378
median values last 5 years	0.050	0.060	23.400	19.950	0.415	0.037

HS3 (values in g/m3)

	NH4 - N	Boron	Chloride	Sodium	Nitrate N	DRP
max. values last 5 years	0.730	0.090	30.100	27.300	2.520	0.321
median values last 5 years	0.120	0.060	24.700	20.650	0.385	0.040

Hokio Stream Characteristics

Minimum flow = **q** = 176 L/s = 15206 m3/day

	Conc (upstream = u/s)	**q** x **C** (u/s) in kg/day
NH4-N	0.05	0.76
Boron	0.06	0.91
Chloride	23.4	355.83
Sodium	19.95	303.37
Nitrate N	0.415	6.31
DRP	0.0365	0.56

Q + q = Combined Flow (m3/day)

W x D ↓ \ K→		2	2.5	3
4550		15297.4	15320.2	15342.9
6750		15341.4	15375.2	15408.9
9350		15393.4	15440.2	15486.9

Calculated Concentration Downstream, in Hokio Stream
Accounting for background

NH4-N	1500	82.17		0.54	0.66	0.78	Min	0.37
		54.02		0.37	0.45	0.53	Max	1.54
	4000	82.17		0.77	0.95	1.13		
		54.02		0.52	0.64	0.76		
	7500	82.17		1.05	1.29	1.54		
		54.02		0.71	0.87	1.03		
Boron	1500	1.491		0.07	0.07	0.07	Min	0.07
		1.038		0.07	0.07	0.07	Max	0.09
	4000	1.491		0.07	0.08	0.08		
		1.038		0.07	0.07	0.07		
	7500	1.491		0.08	0.08	0.09		
		1.038		0.07	0.07	0.08		
Chloride	1500	281.0		24.93	25.31	25.69	Min	24.08
		137.3		24.08	24.25	24.41	Max	28.06
	4000	281.0		25.67	26.23	26.78		
		137.3		24.40	24.65	24.90		
	7500	281.0		26.53	27.30	28.06		
		137.3		24.78	25.12	25.46		
Sodium	1500	165.8		20.82	21.03	21.25	Min	20.55
		121.1		20.55	20.70	20.85	Max	22.59
	4000	165.8		21.23	21.55	21.87		
		121.1		20.84	21.06	21.28		
	7500	165.8		21.72	22.16	22.59		
		121.1		21.18	21.48	21.78		
Nitrate N	1500	19.3700		0.53	0.56	0.58	Min	0.44
		4.8171		0.44	0.45	0.45	Max	0.76
	4000	19.3700		0.58	0.62	0.66		
		4.8171		0.45	0.46	0.47		
	7500	19.3700		0.65	0.70	0.76		
		4.8171		0.47	0.48	0.49		
DRP	1500	0.0430		0.037	0.037	0.037	Min	0.036
		0.0194		0.036	0.036	0.036	Max	0.037
	4000	0.0430		0.037	0.037	0.037		
		0.0194		0.036	0.036	0.036		
	7500	0.0430		0.037	0.037	0.037		
		0.0194		0.036	0.036	0.036		

LEVIN LANDFILL MASS CONTAMINANT LOAD CALCULATIONS

DOWN-GRADIENT BORES

B2, B3, C1, C2, C2DS, G2S, Xs1

Aquifer Thickness x Depth (W x D)

Aquifer Front Area = Thickness x Depth		Thickness (m)		
		13	15	17
Width (m)	350	4,550	5,250	5,950
	450	5,850	6,750	7,650
	550	7,150	8,250	9,350

Hydraulic Conductivity (K)

2.77E-05 m/s = 2.39 m/day Assume range from 0.5 to 2m/day

2 2.5 3 Based on field data collected July 2012

Hydraulic Gradient (i)

Assume = 0.01

Concentration of Analytes in g/m3 (=C from B2, B3, C1, C2, C2DS, G2S and Xs1) - **excluding background**

	NH4 - N	Boron	Chloride	Sodium	Nitrate - N	DRP
Average of max. values last 5 years	82.154	1.431	240.524	133.667	17.403	-0.097
Average of median values last 5 years	54.012	1.008	113.833	94.367	3.854	-0.108

Discharge Volume (Q = W x D x K X i) in m3/day

W x D ↓ / K→		2	2.5	3
4550		91.0	113.8	136.5
6750		135.0	168.8	202.5
9350		187.0	233.8	280.5

Mass Load (Q x C) in kg/day

	W x D	C				
NH4-N	4550	82.15		7.48	9.35	11.21
		54.01		4.92	6.14	7.37
	6750	82.15		11.09	13.86	16.64
		54.01		7.29	9.11	10.94
	9350	82.15		15.36	19.20	23.04
		54.01		10.10	12.63	15.15
Boron	4550	1.431		0.130	0.163	0.195
		1.008		0.092	0.115	0.138
	6750	1.431		0.193	0.242	0.290
		1.008		0.136	0.170	0.204
	9350	1.431		0.268	0.335	0.402
		1.008		0.188	0.236	0.283
Chloride	4550	240.5		21.89	27.36	32.83
		113.8		10.36	12.95	15.54
	6750	240.5		32.47	40.59	48.71
		113.8		15.37	19.21	23.05
	9350	240.5		44.98	56.22	67.47
		113.8		21.29	26.61	31.93
Sodium	4550	133.7		12.16	15.20	18.25
		94.4		8.59	10.73	12.88
	6750	133.7		18.05	22.56	27.07
		94.4		12.74	15.92	19.11
	9350	133.7		25.00	31.24	37.49
		94.4		17.65	22.06	26.47
Nitrate N	4550	17.4033		1.58	1.98	2.38
		3.8538		0.3507	0.4384	0.5260
	6750	17.4033		2.35	2.94	3.52
		3.8538		0.5203	0.6503	0.7804
	9350	17.4033		3.25	4.07	4.88
		3.85381		0.721	0.901	1.081
DRP	4550	-0.097		-0.0088	-0.0110	-0.0132
		-0.108		-0.0098	-0.0123	-0.0148
	6750	-0.097		-0.0131	-0.0164	-0.0196
		-0.108		-0.0146	-0.0183	-0.0219
	9350	-0.097		-0.0181	-0.0227	-0.0272
		-0.108		-0.0202	-0.0253	-0.0304

DOWN-GRADIENT BORES
B2, B3, C1, C2, C2DS, G2S and Xs1
Excludes background

SURFACE WATER (HOKIO STREAM) **Without Background**
HS1 and HS3

From Results data spreadsheet
Average of HS1A and HS1 (values in g/m3)

	NH4 - N	Boron	Chloride	Sodium	Nitrate N	DRP
max. values last 5 years	0.775	0.080	37.800	25.350	2.550	0.378
median values last 5 years	0.050	0.060	23.400	19.950	0.415	0.037

HS3 (values in g/m3)

	NH4 - N	Boron	Chloride	Sodium	Nitrate N	DRP
max. values last 5 years	0.730	0.090	30.100	27.300	2.520	0.321
median values last 5 years	0.120	0.060	24.700	20.650	0.385	0.040

Hokio Stream Characteristics

Minimum flow = **q** =	176	L/s	=	15206	m3/day
	Conc (u/s)	**q** x **C** (u/s)			
NH4-N	0.05	0.76			
Boron	0.06	0.91			
Chloride	23.4	355.83			
Sodium	19.95	303.37			
Nitrate N	0.415	6.31			
DRP	0.0365	0.56			

Q + q = Combined Flow

K→

W x D ↓		2	2.5	3
4550		15297.4	15320.2	15342.9
6750		15341.4	15375.2	15408.9
9350		15393.4	15440.2	15486.9

Calculated Concentration Downstream, in Hokio Stream
Without background

NH4-N	1500	82.15		0.54	0.66	0.78
		54.01		0.37	0.45	0.53
	4000	82.15		0.77	0.95	1.13
		54.01		0.52	0.64	0.76
	7500	82.15		1.05	1.29	1.54
		54.01		0.71	0.87	1.03
Boron	1500	1.431		0.07	0.07	0.07
		1.008		0.07	0.07	0.07
	4000	1.431		0.07	0.08	0.08
		1.008		0.07	0.07	0.07
	7500	1.431		0.08	0.08	0.08
		1.007857		0.07	0.07	0.08
Chloride	1500	240.5		24.69	25.01	25.33
		113.8		23.94	24.07	24.20
	4000	240.5		25.31	25.78	26.25
		113.8		24.20	24.39	24.59
	7500	240.5		26.04	26.69	27.33
		113.8		24.50	24.77	25.04
Sodium	1500	133.7		20.63	20.79	20.96
		94.4		20.39	20.50	20.61
	4000	133.7		20.95	21.20	21.44
		94.4		20.60	20.77	20.93
	7500	133.7		21.33	21.67	22.01
		94.4		20.85	21.08	21.30
Nitrate N	1500	17.4033		0.52	0.54	0.57
		3.8538		0.44	0.44	0.45
	4000	17.4033		0.56	0.60	0.64
		3.8538		0.45	0.45	0.46
	7500	17.4033		0.62	0.67	0.72
		3.8538		0.46	0.47	0.48
DRP	1500	-0.097		0.036	0.036	0.035
		-0.108		0.036	0.035	0.035
	4000	-0.097		0.035	0.035	0.035
		-0.108		0.035	0.035	0.035
	7500	-0.097		0.035	0.034	0.034
		-0.108		0.035	0.034	0.034

	NH4-N	Boron	Chloride	Sodium	Nitrate N	DRP
Min	0.37	0.07	23.94	20.39	0.44	0.034
Max	1.54	0.08	27.33	22.01	0.72	0.036

PIK/L10009-5/mw

11 July 2024

The Solid Waste Manager
Horowhenua District Council
126 Oxford Street
Private Bag 4002
Levin 5510

Attention: Mr David McMillan
Davidm@horowhenua.govt.nz

Dear David

RE: HŌKIO STREAM WATER QUALITY PREDICTIONS FOR PROPOSED BEST PRACTICAL OPTION 3 - GROUNDWATER INTERCEPT DRAIN REMEDIAL WORKS, LEVIN LANDFILL

1. Background

Groundwater monitoring has encountered a groundwater contaminant plume down gradient of the Old Landfill Area 1 of the Levin Landfill (Earthtech, 2023 and 2024a). The proposed Best Practical Option (BPO) 3 remedial works consists of a 200*m* long groundwater intercept drain. Plume mobility with and without the intercept drain has been modelled by Earthtech (2024b) for ammoniacal-N, which is a landfill leachate indicator and also a critical parameter for environmental effects. The Earthtech groundwater modelling provided predictions of ammoniacal-N entering the Hōkio Stream.

To provide an assessment of landfill derived ammoniacal-N on the Hōkio Stream, stream flow gauging has been carried out by NIWA at four surface water monitoring locations (presented in Figure 1):

- Hōkio Stream at HS1A,
- Hōkio Stream at HS2,
- Hōkio Stream at HS3,
- Northern Farm Drain Outlet at SW4.

The flow gauging measurements were carried out on 26 March 2024 and 5 April 2024, during low-flow conditions. The NIWA (2024) report is presented in Appendix A.

This letter provides a summary of the NIWA monitoring, and assessment of the ammoniacal-N concentrations in the Hōkio Stream at HS3 with and without the BPO3 (groundwater intercept drain) installation. HS3 represents the Hōkio Stream monitoring point of compliance with consented (Table C1 Environment Court Order) ammoniacal-nitrogen trigger value concentrations of 2.1*mg/l* maximum and 0.4*mg/l* average.

2. Flow Gauging Observations

The NIWA flow gauging methodology and results are presented in Appendix A, and included stream level monitoring.

As requested by Earthtech, NIWA carried out the gaugings during Hōkio Stream low-flow conditions, which are indicated by the water levels at the Punahau (Lake Horowhenua) weir outlet (monitoring location known as "Punahau at Weir") being below the 1,050*mm* staff level, as shown on the Horizons Council online data platform[1]. At the time of the gaugings on 26 March 2024 and 5 April 2024, the staff levels were 1,025*mm* and 1,050*mm* respectively which comply with the low-flow requirement. The gaugings were also carried out at mid-tide on the falling limb of the tide, to capture stream outflow related to tidal influence.

Hōkio Stream levels at HS1A, HS2 and HS3 were monitored for an 18-day period to check for potential tidal influences. This data is presented in Appendix A, and shows that there is a weak correlation between tidal effects and stream water levels. Stream levels appear to be more strongly influenced by the Punahau (Lake Horowhenua) weir outlet, as level trends at HS1A, HS2 and HS3 are similar to level trends at the weir monitoring site.

The results of the two flow-gauging rounds are presented in Table 1, and on Figure 1.

Table 1: Flow gauging results at Hōkio Stream at HS1A, HS2 and HS3, and at the Northern Farm Drain Outlet at SW4

Date	Total flow (L/s)			
	HS1A	HS2	HS3	SW4
26 March 2024	176	175	194	-13
5 April 2024	567	523	571	2

Comments and interpretation of the gauging observations are as follows:

- Flows measured on 5 April were elevated compared to the 26 March gauging. This is due to 23*mm* of rainfall which occurred in the two days prior to the 5 April gauging. Whereas there was no rainfall over the week prior to the 26 March gauging. Therefore, data from the gauging carried out on 26 March 2024 has been adopted for this surface water quality assessment, as this represents the lowest measured flow conditions. Adopting low-flow conditions maximises the groundwater 'baseflow' contribution to total flow, and minimises the effects of surface water 'quick flow' from rainfall events.
- The Northern Farm Drain outlet SW4 is reported to have a negative flow on 26 March 2024, suggesting flow away from the Hōkio Stream. This flow direction has not been observed during any of the Earthtech site visits, and is not expected on the basis of hydraulic gradients. NIWA reports a high 45.3% measuring uncertainty at this location. Therefore, the SW4 flow has not been specifically assessed. Northern Farm Drain Flows are however captured by the overall gain in baseflows between HS1A and HS3.
- During site visits it was observed that flows at HS1A and HS2 are similar, with a significant increase in flow between HS2 and HS3. This is supported by the gauging results.

[1] Horizons online environmental data - Horizons Environmental Data

- The gauging results suggest that following rainfall the Hōkio Stream may be locally losing to groundwater (flow at HS2 less than HS1A on 5 April 2024). Photographs (Appendix A) indicate difficult conditions for flow gauging due to stream vegetation, and it is also possible that flows between HS1A and HS2 are influenced by local stream bank effects. For these reasons, the gaugings at HS2 may be less reliable so have not been included in the surface water assessment.

On the basis of the above, this surface water quality assessment relies on flows at HS1A and HS3 recorded on 26 March 2024. Commentary is provided on HS2, but this has not been used in the water quality forward analyses.

3. Ammoniacal-N Monitoring Records

The average ammoniacal-N concentrations measured between June 2023 to May 2024 at HS1A, HS2 and HS3 are shown on Table 2. Average concentrations for sampling rounds carried out during low-flow conditions only (when the Punahau weir monitoring level was below the 1,050*mm* staff level) are also shown in Table 2, as these relate to time period and flow conditions of the NIWA gaugings.

Table 2: Average Ammoniacal-N Concentrations,
12mths from June 2023 to May 2024 (time period relating to NIWA gaugings)

Flow conditions	Ammoniacal-N concentration (mg/L)		
	HS1A	HS2	HS3
Average of samples collected during low-flow conditions only[1]	0.04	0.04	0.07
12*mth* average, all flow conditions	0.07[2]	0.41[3]	0.17[4]

[1] Sampling rounds carried out during low-flow conditions in Feb., Apr. and May 2024.
[2] Maximum 12*mth* average of 0.10*mg/l* measured between Nov. 2022 to Oct. 2023.
[3] Maximum 12*mth* average of 0.74*mg/l* measured between Nov. 2022 to Oct. 2023.
[4] Maximum 12*mth* average of 0.20*mg/l* measured between Nov. 2022 to Oct. 2023.

Table 2 shows the influence of the Northern Farm Drain, which provides a direct line for higher ammoniacal-N concentrations (sourced from the swampy area to the north of the unlined landfill) to enter the Hōkio Stream when the drain flows. The drain flow results in a higher 12*mth* average ammoniacal-N concentration at HS2 compared to the low-flow only average. This is supported by the NIWA gaugings which show that Northern Farm Drain does not flow into the Hōkio Stream under low-flow conditions during dry weather.

Monitoring records for ammoniacal-N in the Hōkio Stream date back to 1994. Maximum values associated with concentration spikes are up to 1.40*mg/l* in HS3 (Feb. 1994). Concentration spikes in excess of 1*mg/l* at HS3 have been measured twice since records began, with all remaining concentration spikes being ≤ 0.73*mg/l*. The maximum concentration has also been considered by this assessment as described in the following sections.

4. Surface Water Quality Assessment

4.1 Verification against Current Ammoniacal-N Concentrations

Verification of the surface water quality assessment methodology was first carried out against currently measured (Table 2) ammoniacal-N concentrations.

There are various sources of ammoniacal-N within and entering the Hōkio Stream. These include upstream concentrations, background groundwater concentrations, and the leachate plume. These sources are conceptually shown on Figure A.

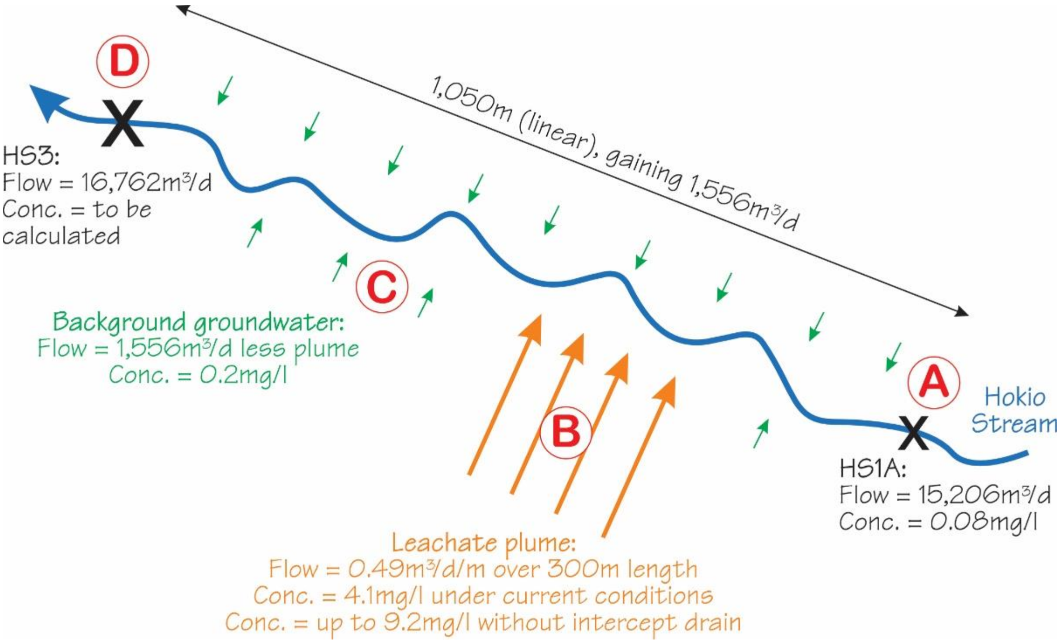


Figure A: Ammoniacal-N sources in surface water quality assessment

The groundwater modelling presented in Earthtech (2024b) provides predictions of both flows and concentrations entering the Hōkio Stream under current conditions, which have been used as inputs to the surface water assessment in conjunction with the flow gauging from 26 March 2024. Earthtech (2024b) shows that the ammoniacal-N concentration entering the Hōkio Stream through groundwater is currently estimated at 4.1*mg/l*. Note that this 4.1*mg/l* is representative of the 300*m* leachate plume width down-gradient of the landfill, and the maximum concentration is not used as this only occurs at one location so does not represent the full plume.

Ammoniacal-N entering the Hōkio Stream from the Northern Farm Drain has not been included, as the NIWA gauging carried out on 26 March 2024 shows that this drain does not flow into the Hōkio Stream under low-flow conditions in the absence of rainfall.

Ammoniacal-N concentrations of 0.2*mg/l* have been measured in up-gradient monitoring bores, and have been used to represent the natural background ammoniacal-N groundwater concentration.

Verification of the ammoniacal-N low-flow concentration predictions under current conditions (NIWA March 2024 low-flow gaugings, corresponding to the Feb. to May 2024 average low-flow ammoniacal-N concentrations, and current estimated plume discharge) is as follows:

i. Upstream Hōkio at HS1A (Source A): 176*l/s* = 15,206m^3/d at 0.04*mg/l*
ii. Hōkio Stream at HS3 (Location D) = 194*l/s* = 16,762m^3/d
iii. Gain between HS1A and HS3 = 1,556m^3/d over a linear length of 1,050*m*.
iv. FEFLOW model inflow into Hōkio Stream, = 0.94$m^3/d/m$ × 1,050*m* = 987m^3/d from both sides of stream, which is less than measured inflow of 1,556m^3/d.

v. Therefore, factor up FEFLOW predicted flows by 1,556 / 987 = 1.58 to match conditions on 26 March 2024.

vi. FEFLOW model predicted ammoniacal-N plume entering Hōkio Stream (Source B) is currently 4.1*mg/l* over a 300*m* length at 0.31$m^3/d/m$ × 1.58 factor = 0.49$m^3/d/m$.

vii. Background groundwater concentration entering Hōkio Stream (Source C) = 0.2*mg/l* outside of leachate plume.

The mass balance to calculate the HS3 low-flow concentration is shown in Table 3.

Table 3: Predicted ammoniacal-N concentration at HS3, verification against current low-flow conditions

Source	Location	Flow	Concentration [1]	Mass
		m^3/d	g/m^3	g/d
A	Upstream Hōkio at HS1A	15,206 from gauging	0.04	608
B	Leachate Plume	0.49$m^3/d/m$ × 300*m* = 147 from FEFLOW	4.1	603
C	Background groundwater	1,556 – 147 = 1,409 difference	0.2	282
D	HS3 monitoring location	16,762 from gauging	By calculation: = 1,493 / 16,762 = 0.09 Comparable to Table 2 average of 0.07.	Sum of the above = 1,493

[1] Note that 1*mg/l* = 1g/m^3.

Table 3 shows that under current low-flow conditions, concentrations at HS3 are expected to average at 0.09*mg/l*. This is comparable to the average concentration measured at HS3 during 2024 low-flow conditions shown in Table 2, which verifies the surface water assessment method.

4.2 Without Groundwater Intercept Drain

Without the groundwater intercept drain, Figure H of Earthtech (2024b) shows that in 2045 the ammoniacal-N concentration is predicted to be 9.2*mg/l* over the 300*m* plume width down-gradient of the landfill.

Without the groundwater intercept drain installation, the low-flow ammoniacal-N concentration at the HS3 monitoring location is calculated as follows:

i. Points i. to v. and vii. as in Section 4.1 above.

vi. FEFLOW model predicted ammoniacal-N plume entering Hōkio Stream (Source B) at 9.2*mg/l* over a 300*m* length at 0.31$m^3/d/m$ × 1.58 factor = 0.49$m^3/d/m$.

The mass balance to calculate the HS3 low-flow concentration is shown in Table 4.

Table 4: Predicted ammoniacal-N concentration at HS3,
without intercept drain during low-flow conditions in year 2045

Source	Location	Flow	Concentration	Mass
		m^3/d	g/m^3	g/d
A	Upstream Hōkio at HS1A	15,206 from gauging	0.04	608
B	Leachate Plume	$0.49m^3/d/m \times 300m$ = 147 from FEFLOW	9.2	1,352
C	Background groundwater	1,556 – 147 = 1,409 difference	0.2	282
D	HS3 monitoring location	16,762 from gauging	By calculation: = 2,242 / 16,762 = 0.13	Sum of the above = 2,242

Consented ammoniacal-N limits at HS3 are an average concentration no higher than 0.4*mg/l*, and a maximum concentration of 2.1*mg/l*.

Table 4 shows future ammoniacal-N concentrations under low-flow conditions, and this prediction needs to be factored to consider the 12*mth* average and peak concentrations.

i. Factor for 12*mth* average concentration:

Section 3 shows that the highest 12*mth* average concentration measured at HS3 is 0.20*mg/l*, which is a factor of 2.9 greater than the 2024 low-flow concentration. Applying the factor of 2.9 to the predicted future low-flow concentration of 0.13*mg/l* provides a future 12*mth* average concentration of 0.38*mg/l*. This is just below the consented average concentration limit of 0.4*mg/l*.

ii. Factor for peak concentration:

Section 3 shows that concentrations at HS3 have been measured to spike up to 1.40*mg/l*, which is a factor of 20 larger than the 2024 low-flow concentration. Spikes in concentration can occur due to a number of factors, but are principally considered to be due to rainfall events triggering flow with high ammoniacal-N concentrations through the Northern Farm Drain outlet. Applying the factor of 20 to the predicted future low-flow concentration of 0.13*mg/l*, provides a future maximum concentration of 2.6*mg/l*. This is above the consented maximum concentration limit of 2.1*mg/l*.

Without the groundwater intercept drain, future ammoniacal-N concentrations at HS3 are predicted to be a 12*mth* average of 0.38*mg/l* and a maximum of 2.6*mg/l*. This exceeds the Environment Court consented limit for maximum concentrations, and almost exceeds the consented limit for average concentrations. Given the high variability in ammoniacal-N concentrations dependant on Northern Farm Drain flow and other external factors, it is possible that the consented limit for average concentrations could also be exceeded.

4.3 <u>With Groundwater Intercept Drain</u>

With the groundwater intercept drain, Figure H of Earthtech (2024b) shows that the ammoniacal-N concentration is predicted to be 4.1*mg/l* over the 300*m* plume width down-gradient of the landfill. The worst-case 4.1*mg/l* is also the current situation, as once the intercept drain is installed concentrations are predicted to reduce with time.

With the groundwater intercept drain, Sections 3 and 4.1 show that the ammoniacal-N concentration is expected to average at 0.07 to 0.09*mg/l* at HS3 under low-flow conditions. The available monitoring data also provides a 12*mth* average concentration of 0.20*mg/l*, and a maximum concentration of 1.4*mg/l*. These are below the consented limits, and concentrations are predicted to reduce following intercept drain installation.

5. Conditions at HS2

Although HS3 is the Environment Court designated monitoring location to which the ammoniacal-N consented limits of 0.4*mg/l* average and 2.1*mg/l* maximum apply, Section 3 shows that these limits are already being exceeded at the HS2 location. For example, a 12*mth* average concentration of 0.74*mg/l* was measured at HS2 between Nov. 2022 to Oct. 2023, and a maximum concentration of 2.71*mg/l* was measured in Sep. 2023.

Furthermore, ammoniacal-N concentrations entering the Hōkio Stream from groundwater above HS2 at the leachate plume are predicted to be 9.2*mg/l* across the 300*m* plume width, and up to 18*mg/l* through the peak of the plume (Figure E of Earthtech, 2024b).

On the basis of the currently measured ammoniacal-N concentrations at HS2, and the future predicted consent limit exceedance at HS3, we recommend that the groundwater intercept drain is installed to meet the conditions of Discharge Permit 6010 to "*cease, or if cessation is not feasible, materially reduce the discharge of leachate to the Tatana Drain and Hōkio Stream*".

6. Summary and Conclusions

NIWA have carried out flow gaugings at the Hōkio Stream during low-flow conditions. This data has been used to carry out a surface water quality assessment to predict ammoniacal-N concentrations at the HS3 monitoring location, with and without the proposed groundwater intercept drain remedial works.

The surface water assessment methodology has been verified and achieves good agreement between the current ammoniacal-N concentrations entering the Hōkio Stream and recent low-flow chemistry data from HS3.

With the groundwater intercept drain, ammoniacal-N concentrations at HS3 are expected to reduce below current values, and remain below the consented average and maximum limits.

Without the groundwater intercept drain, future ammoniacal-N concentrations at HS3 are predicted to be a 12*mth* average of 0.38*mg/l* and a maximum of 2.6*mg/l*. This exceeds the Environment Court consented limit for maximum concentrations, and almost exceeds the consented limit for average concentrations. Given the high variability in ammoniacal-N concentrations dependant on Northern Farm Drain flow and other external factors, it is possible that the consented limit for average concentrations could also be exceeded.

Although the consented limits apply to HS3, ammoniacal-N concentrations greater than the consented limits are already being experienced at HS2. Above HS2 ammoniacal-N concentrations entering the Hōkio Stream from groundwater are predicted to be 9.2*mg/l* over the 300*m* plume width, and up to 18*mg/l* through the peak of the plume.

On the basis of the currently measured ammoniacal-N concentrations at HS2, and the future predicted consent limit exceedance at HS3, we recommend that the groundwater intercept drain is installed to meet the conditions of Discharge Permit 6010 to "*cease, or if cessation is not feasible, materially reduce the discharge of leachate to the Tatana Drain and Hōkio Stream*".

Should you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully

Michelle Willis

M L WILLIS
Senior Groundwater Engineer, CPEng
EARTHTECH CONSULTING LTD

P I KELSEY
Principal Hydrogeologist
EARTHTECH CONSULTING LTD

Encls:

Figure 1	Flow Gauging Measurements
Appendix A	NIWA Flow Gauging Report

References:

Earthtech (2023) *Assessment of Groundwater Pollution Plume Mobility and Remediation Plan - Levin Landfill, Hōkio Beach Road, Levin*. Report prepared by Earthtech Consulting Limited, R10009-1, Rev. A, dated 31 May 2023.

Earthtech (2024a) *Conceptual Groundwater Model Report, Levin Landfill, Hōkio Beach Road, Levin*. Report prepared by Earthtech Consulting Limited, R10009-2, Rev. B, dated 16 February 2024.

Earthtech (2024b) *Numerical Groundwater Modelling Report and BPO Engineering Design, Levin Landfill, Hōkio Beach Road, Levin*. Report prepared by Earthtech Consulting Limited, R10009-3, Rev. A, dated 16 February 2024.

FOR INFORMATION

Note: All drawings are to be approved (initialled) before final issue.

EARTHTECH

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LEVIN LANDFILL
HOKIO BEACH ROAD, LEVIN
Horowhenua District Council

Flow Gauging Results - NIWA 2024

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	11-07-24	ISSUE FOR L10009-5	M.F	P.K	S.SW	[signature]

DRAWING NO.: FIG. 1
REF: 10009-L5
SCALE: 1:2500
CRS: NZTM
DATUM:

Appendix A

NIWA Flow Gauging Report

Hokio Stream data report

Short-term level and flow monitoring

Prepared for EarthTech Consulting Ltd

June 2024

Prepared by:
M. Flanagan

For any information regarding this report please contact:

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NIWA CLIENT REPORT No: 2024158EI
Report date: June 2024
NIWA Project: HWD24901

Revision	Description	Date
Version 1.0	Final version sent to client	14 June 2024

Quality Assurance Statement		
	Reviewed by:	Graham Elley
	Formatting checked by:	Nic McNeil
	Approved for release by:	Charles Pearson

Contents

Figures

1 Introduction

Earthtech Ltd requested a proposal (2024024pEI) from NIWA, to undertake a period of hydrological data collection within a specified reach of Hokio Stream, approximately 2-3 km downstream of the Lake Horowhenua outlet. The reach location is approximately 2 km upstream from Hokio Beach.

Earthtech's monitoring requirements included:

- Continuous stream level monitoring over a minimum five-day period at three monitoring locations within Hokio Stream (namely HS1A, HS2 and HS3), as shown in Figure 1-1.
- Stream flow gaugings on two separate occasions at approximate mid-tidal influence at four monitoring locations (namely HS1A, HS2, HS3 and SW4-Northern Farm Drain outlet), during summer low-flow conditions. Gauging measurements scheduled to target the falling mid-tidal period.
- Flow monitoring to take place during Hokio stream low-flow conditions, referenced as below 1.050 m stage level at Punahau at Weir (Lake Horowhenua outlet).
- Collected level data do not require referencing to any local datum or correlation between the specified level monitoring locations.

NIWA defined a field monitoring programme and a logger installation was completed by NIWA's Wellington-based Field Team, with data collection occurring from 18 March to 5 April 2024.

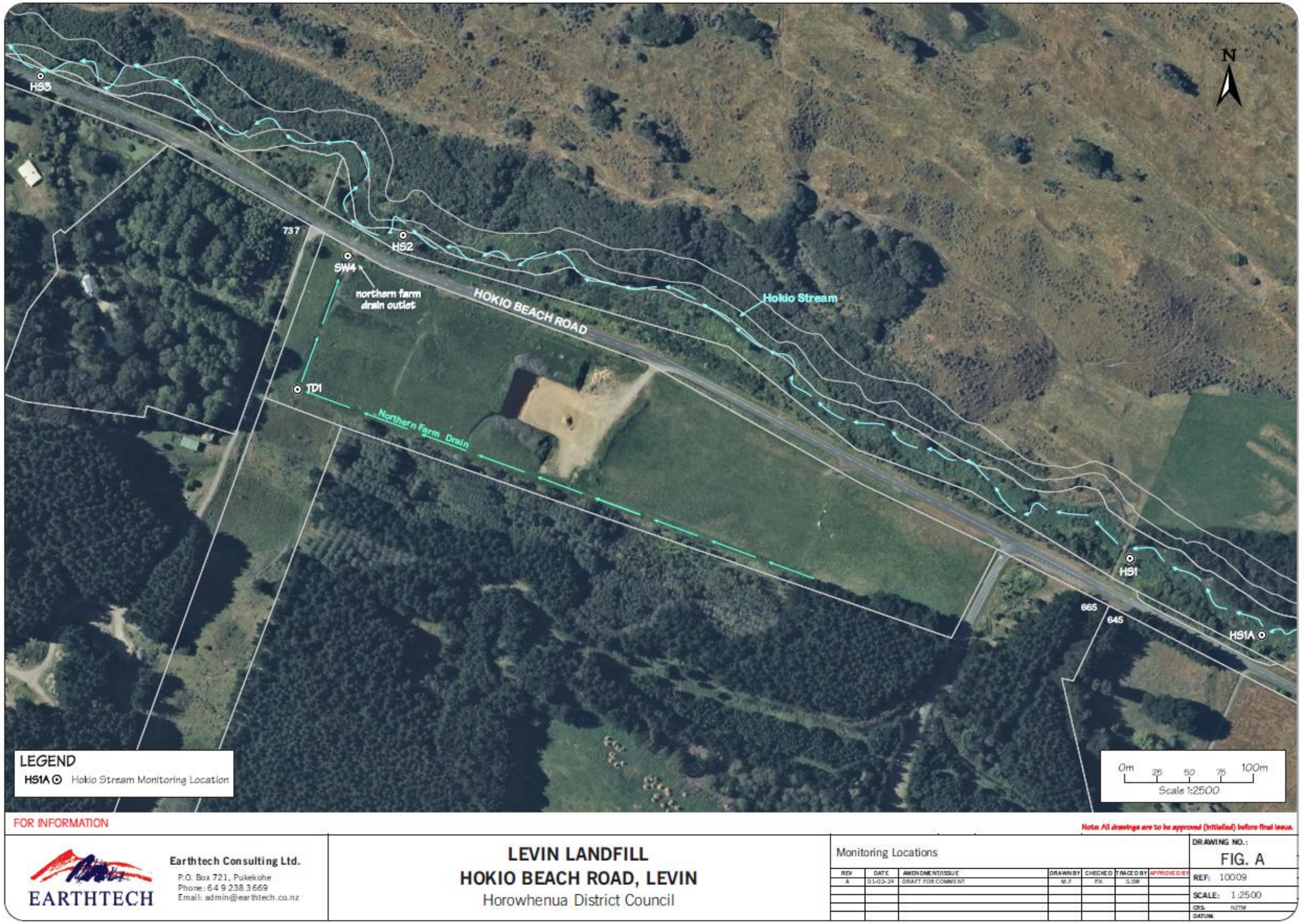


Figure 1-1: Hokio Stream monitoring locations.

2 Monitoring method

Water level monitoring equipment included the installation of in-situ Hobo waterlevel Data loggers, fixed to temporary mounts at each of the three level locations.

Each Hobo logger recorded 5-minute water-level, with manual data download at the completion of the monitoring period. A reference barometric pressure Hobo logger was also installed for post-processing data correction and barometric pressure compensation.

Flow gaugings were conducted at the four specified locations on two separate 'Gauging Runs'. The gauging occasions were scheduled for periods when:

- Coastal tidal influence is at a falling mid-tide range.
- Lake Horowhenua level was less than 1.050 m stage at the Punahau weir.
- All four flow locations to be measured during the same 'Gauging run'.

Flow gauging measurements were conducted using either Flowtracker Wading gaugings or the deployed ADCP (acoustic Doppler current profiler) remote boat method, depending on the flow range and depth condition observed at each location.

3 Data collection

During the site installation visit, the Hokio stream locations were found to be very over-grown with significant instream macrophytes. This presented a challenge to identify suitable stream reaches to install the waterlevel monitoring equipment and for stream gaugings. Some sections of the stream channel required standing macrophytes to be manually removed to clear a suitable cross-section where flow gauging measurements could be attempted.

It was observed that some sections of the stream were a deep, low-gradient channel with soft sediment bottom and 'sluggish' water flow due to the thick macrophyte growth in places, and/or low gradient.

Site photos (Figure 3-1 to 3-4) provide an indication of the in-stream conditions encountered.

Figure 3-1: Hokio Stream monitoring site HS1A.

Figure 3-2: Hokio Stream monitoring site HS2.

Figure 3-3: Hokio Stream monitoring site HS3.

Figure 3-4: Hokio Stream monitoring site SW4.

All water level logger instrumentation was deployed and collected from the various locations on the same days, representing a 19-day data collection period.

Gauging Runs were completed on two separate occasions (26 March and 5 April), when flow ranges were expected to be different, based on the Lake Horowhenua at weir stage level.

4 Result summary

All field data were post-processed and reviewed using standard NIWA hydrometric data collection practice. No statistical analysis or detailed interpretation of the results has been made by NIWA. The measured results are processed field observations only.

4.1 Flow gauging summary

The flow gaugings at three locations (HS1A, HS2, HS3) were completed by ADCP section by section method. Gaugings at these locations had uncertainty estimate results of between 5 – 10%, typically due to the stream channel condition presenting multiple obstacles and flow disturbance which affect measurement accuracy. Gauging results on the two separate events show a similar flow relationship between the three locations, as would be expected.

Location SW4 was gauged by the alternative FlowTracker section method due to the shallow and slow flow conditions in this farm drain. Gauging measurement estimated uncertainty results in this location was high (16 – 45%) due to the very low flow conditions observed on the two occasions measurements were completed.

Gauging measurement results are summarised in Figure 4-1.

Gauging date: 26/3/2024					
Location	**Units**	**HS1A**	**HS2**	**HS3**	**SW4**
Mean time	NZST (h)	11:40	12:41	14:42	13:40
Total_Q Flow	m3/s	0.176	0.175	0.194	-0.013
Est_Uncertainty	%	10.4	5.7	8.5	45.3
Meas_Width	m	4.450	4.200	4.800	2.900
Meas_Area	m2	3.054	2.22	1.974	0.306
Mean_Vel (Total_Q / Meas_Area)	m/s	0.058	0.079	0.098	-0.041
Water temp	deg C	17.9	18.5	18.6	22.7

Gauging date: 5/4/2024					
Location	**Units**	**HS1A**	**HS2**	**HS3**	**SW4**
Mean time	NZST (h)	9:35	10:25	11:05	11:55
Total_Q Flow	m3/s	0.567	0.523	0.571	0.002
Est_Uncertainty	%	4.7	5.0	6.0	16.3
Meas_Width	m	4.650	4.550	5.700	5.600
Meas_Area	m2	5.298	4.495	5.105	2.359
Mean_Vel (Total_Q / Meas_Area)	m/s	0.107	0.116	0.112	0.001
Water temp	deg C	16.6	16.8	16.6	14.5

Figure 4-1: Gauging measurement summary.

4.2 Water level monitoring summary

The Hobo level logger data was post-corrected with barometric pressure correction and offset to an assumed independent level for plot comparison (Figure 4-2).

The true relative level between the locations was not determined.

Comparison of data sets, shows all three Hokio Stream measured locations displayed a similar trend of water level response and magnitude over the monitoring period.

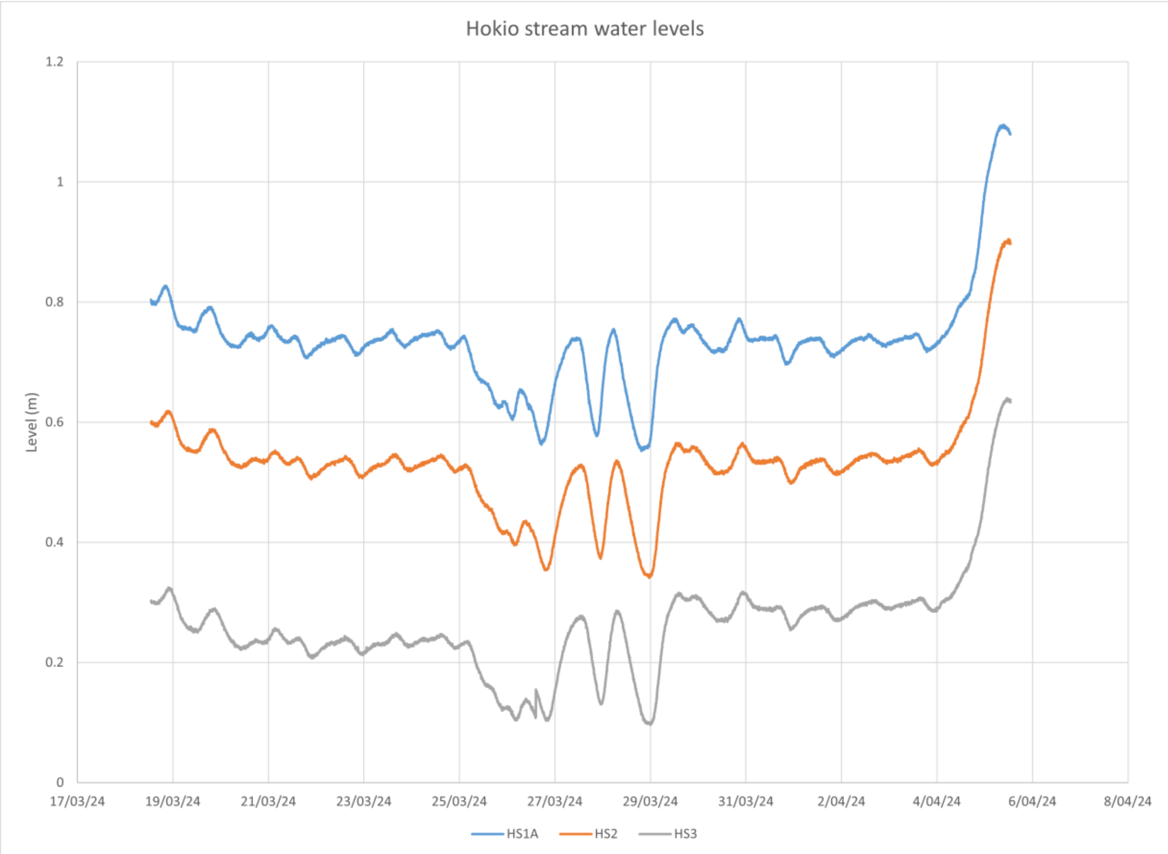


Figure 4-2: Hokio Stream recorded level at specified locations.

Comparison of the level data against the Lake Horowhenua at Weir (Horizons Regional Council monitoring station) indicates a close correlation between outflow from the lake and the Hokio Stream locations (Figure 4-3).

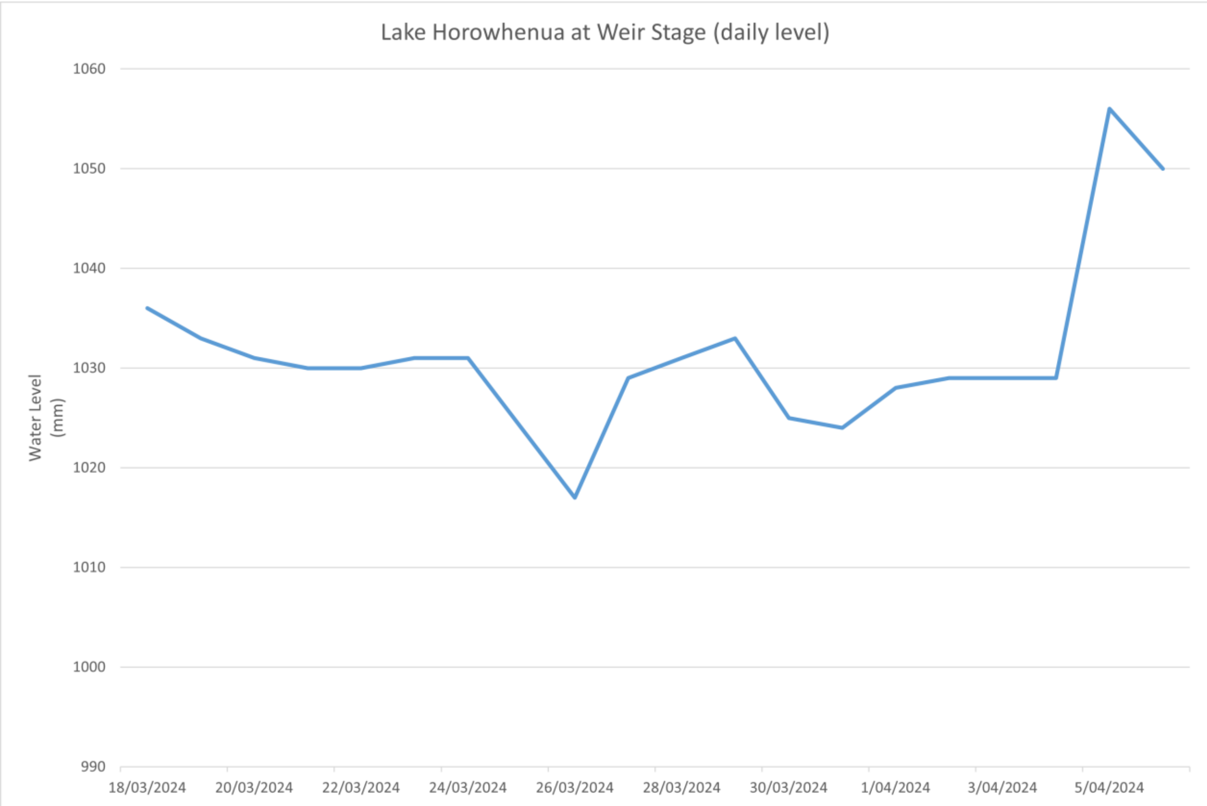


Figure 4-3: Lake Horowhenua at Weir (Horizons Regional Council monitoring station).

As a summary of the stream characteristics where data were obtained, based on our observations, we describe them as:

- low gradient channels, heavily impacted by seasonal macrophyte growth resulting in sluggish drainage.
- the three Hobo level monitored locations responded similarly both temporally and in magnitude.
- Monitored Levels appear to be closely related to Lake Horowhenua at Weir water level.
- The SW4 location had very low flow observed during both gauging measurements.

5 Tidal comparison

Although no detailed analysis of tidal effect was undertaken by NIWA, comparison with data from the NIWA Tide Forecaster (https://tides.niwa.co.nz) at a coastal location off Hokio Beach can be obtained freely from the NIWA service web page (Figure 5-1). This provides an approximate indication of tidal heights and cycles for the chosen location (note: tide height data used are given as metres from the lowest astronomical tide level, not a survey or chart datum).

Overplotting this forecast tide data compared to the recorded Hokio Stream level data (Figure 5-2), visually suggests there may be a weak correlation between tidal effect and Hokio stream water level at these measured locations. This effect may become more pronounced during low stream flow periods that coincide with high tidal phases, as noticed in Hokio Stream level data between 25 – 29 March 2024.

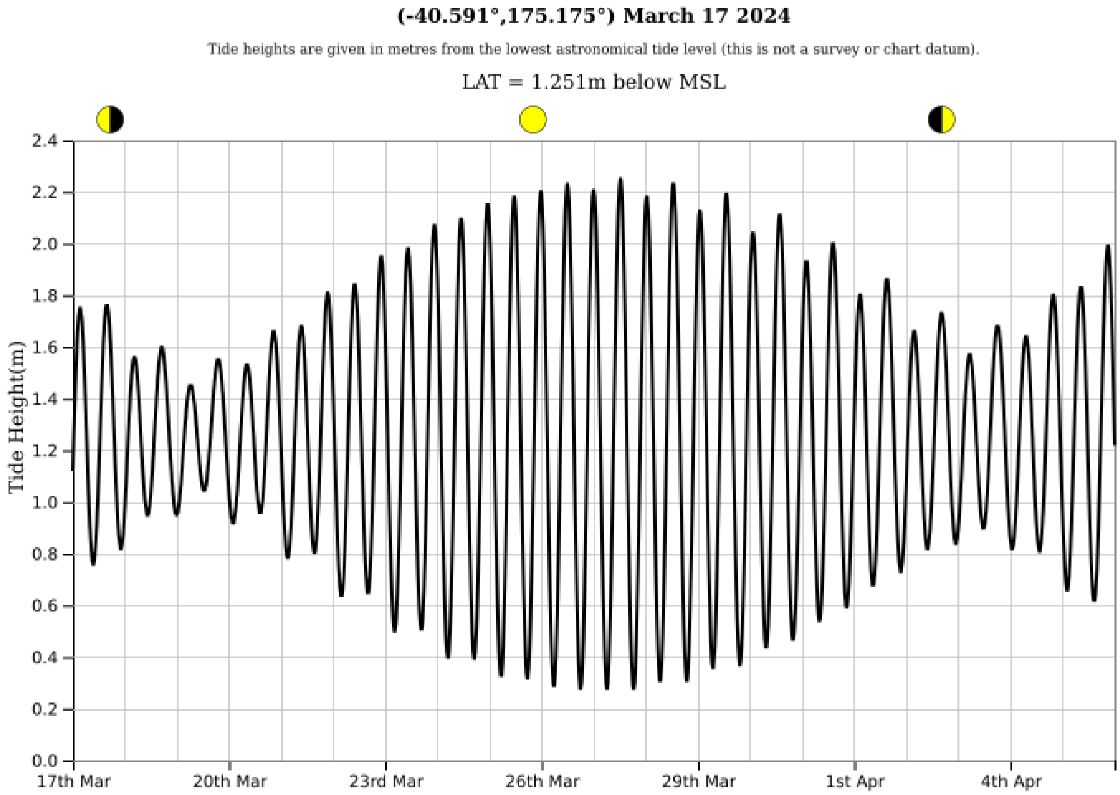


Figure 5-1: NIWA Tide Forecaster output – Hokio Beach (https://tides.niwa.co.nz/map).

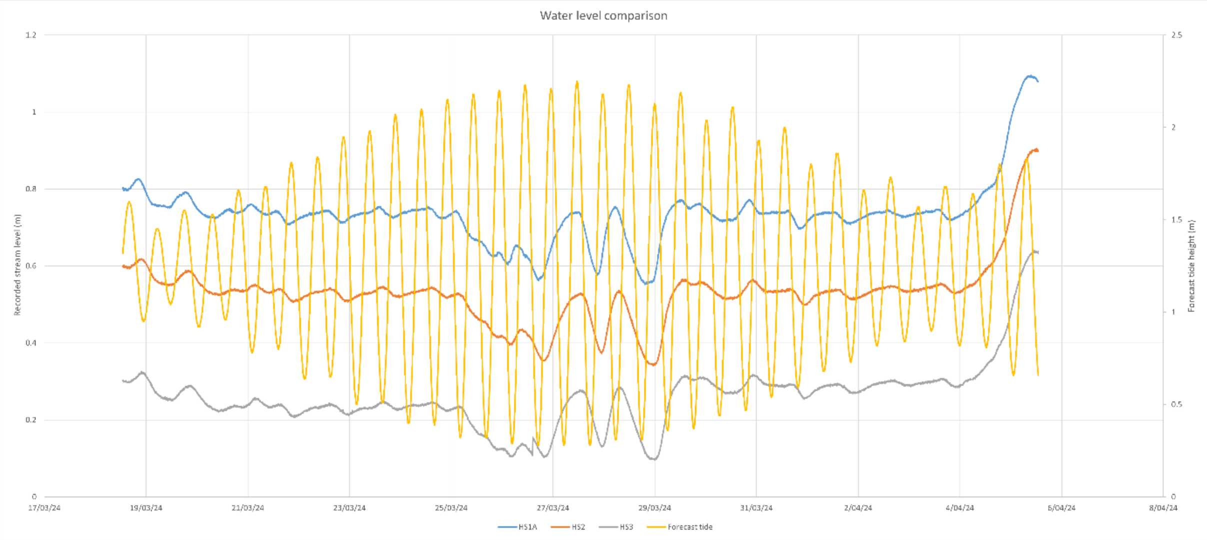


Figure 5-2: Overplot NIWA Tide Forecaster data with Hokio Stream level data.

6 Acknowledgements

Thanks to Horowhenua District Council, particularly Scott Wardlaw, for providing initial on-site assistance, and NIWA field team members Mark Corkery and Sam Dickson for managing the field data collection and measurements.

Appendix H Summary of odour monitoring and borehole gas sampling results

ODOUR ASSESSMENT UNDERTAKEN AT THE BIOFILTER

Entry Date	Assessor	Reason for Investigation	Wind Direction	Wind Speed	Cloud Cover	Temp.	Odour Detection	Odour Intensity	Odour Character	General Hedonic Tone	Apparent Source of Odour	Conclusion	Action Undertaken	Problem Status	Assessed by (name)	Time When Finished
1/11/2023	S. Wardlaw	Proactive	SE	3 - Gentle breeze; 3. - 5.4 m/s	4 - Half the sky is cloudy	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	Bio filter not active	I did not detect any odour	Bio filter not active	Not applicable	S. Wardlaw	11.30
1/12/2023	S. Wardlaw	Proactive	NW	5 - Fresh breeze; 8 - 10.7 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	2 - Pleasant	None	I did not detect any odour	None	Not applicable	S. Wardlaw	11.52
1/01/2024	S. Wardlaw	Proactive	SW	3 - Gentle breeze; 3. - 5.4 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.30
1/02/2024	S. Wardlaw	Complaint	W	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.00
1/03/2024	S. Wardlaw	Proactive	NW	1 - Light air; 0.5 - 1.5 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	No comment
1/04/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	11.00
1/05/2024	S. Wardlaw	Proactive	NNE	1 - Light air; 0.5 - 1.5 m/s	6 - Mostly cloudy	3 - Cool	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	No comment

ODOUR ASSESSMENT UNDERTAKEN AT THE LANDFILL GAS FLARE

6/07/2023	D. McMillan	Proactive	None	0 - Calm; < 0.5 m/s	0 - Clear sky	3 - Cool	No	0 - No odour	No comment	0 - Neutral	No odour	I did not detect any odour	None	Not applicable	D. McMillan	
13/07/2023	D. McMillan	Proactive	SW	4 - Moderate breeze; 5.5 - 7.9 m/s	6 - Mostly cloudy	3 - Cool	No	0 - No odour	No comment	0 - Neutral	No odour	I did not detect any odour	None	Not applicable	D. McMillan	15.21
21/07/2023	D. McMillan	Proactive	SW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	4 - Cold	No	0 - No odour	No comment	0 - Neutral	None	I did not detect any odour	None	Not applicable	D. McMillan	13.53
26/07/2023	D. McMillan	Proactive	SW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	3 - Cool	No	1 - Very weak	19 - Landfill gas	-1 - A bit unpleasant	Landfill	I did detect odour and consider it would not be objectionable at any location for any duration or frequency	None	Resolved	D. McMillan	14.58
17/08/2023	D. McMillan	Proactive	SE	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	3 - Cool	No	0 - No odour	No comment	0 - Neutral	None	I did not detect any odour	None	Not applicable	D. McMillan	8.50
25/08/2023	D. McMillan	Proactive	SE	0 - Calm; < 0.5 m/s	2 - Mostly sunny	2 - Mild	No	1 - Very weak	19 - Landfill gas	-1 - A bit unpleasant	Landfill	I did detect odour and consider it would not be objectionable at any location for any duration or frequency	None	Not applicable	D. McMillan and S. Wardlaw	14.46
1/11/2023	S. Wardlaw	Proactive	SE	3 - Gentle breeze; 3. - 5.4 m/s	4 - Half the sky is cloudy	1 - Warm	No	0 - No odour	19 - Landfill gas	1 - A bit pleasant	Flare	I did detect odour and consider it would not be objectionable at any location for any duration or frequency	None required	Not applicable	S. Wardlaw	11.30
1/12/2023	S. Wardlaw	Proactive	NW	5 - Fresh breeze; 8 - 10.7 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	2 - Pleasant	None	I did not detect any odour	None	Not applicable	S. Wardlaw	11.52
1/01/2024	S. Wardlaw	Proactive	SW	3 - Gentle breeze; 3. - 5.4 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did detect odour and consider it would not be objectionable at any location for any duration or frequency	No comment	Not applicable	S. Wardlaw	12.30
1/02/2024	S. Wardlaw	Proactive	W	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.00
1/03/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	13.46
1/04/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	11.00
1/05/2024	S. Wardlaw	Proactive	NNE	1 - Light air; 0.5 - 1.5 m/s	6 - Mostly cloudy	3 - Cool	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	No comment

ODOUR ASSESSMENT UNDERTAKEN AT THE LANDFILL GATE

1/11/2023	S. Wardlaw	Proactive	SE	3 - Gentle breeze; 3. - 5.4 m/s	4 - Half the sky is cloudy	1 - Warm	No	0 - No odour	19 - Landfill gas	0 - Neutral	Flare	I did not detect any odour	None required	Not applicable	S. Wardlaw	11.30
1/12/2023	S. Wardlaw	Proactive	NW	5 - Fresh breeze; 8 - 10.7 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	2 - Pleasant	None	I did not detect any odour	None	Not applicable	S. Wardlaw	11.52
1/01/2024	S. Wardlaw	Proactive	SW	3 - Gentle breeze; 3. - 5.4 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.30
1/02/2024	S. Wardlaw	Proactive	W	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.00
1/03/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	13.56
1/04/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	11.00
1/05/2024	S. Wardlaw	Proactive	NNE	1 - Light air; 0.5 - 1.5 m/s	6 - Mostly cloudy	3 - Cool	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	No comment

ODOUR ASSESSMENT UNDERTAKEN AT THE LANDFILL LEACHATE POND

1/11/2023	S. Wardlaw	Proactive	SE	3 - Gentle breeze; 3. - 5.4 m/s	4 - Half the sky is cloudy	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	None	I did not detect any odour	None required	Not applicable	S. Wardlaw	11.30
1/12/2023	S. Wardlaw	Proactive	NW	5 - Fresh breeze; 8 - 10.7 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	2 - Pleasant	None	I did not detect any odour	N/A	Not applicable	S. Wardlaw	11.52
1/01/2024	S. Wardlaw	Proactive	SW	3 - Gentle breeze; 3. - 5.4 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	12.30
1/02/2024	S. Wardlaw	Proactive	W	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.00
1/03/2024	S. Wardlaw	Proactive	NW	1 - Light air; 0.5 - 1.5 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	No comment
1/04/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	11.00
1/05/2024	S. Wardlaw	Proactive	NNW	1 - Light air; 0.5 - 1.5 m/s	6 - Mostly cloudy	3 - Cool	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	No comment

ODOUR ASSESSMENT UNDERTAKEN AT THE LANDFILL OFFICE

1/11/2023	S. Wardlaw	Proactive	SE	3 - Gentle breeze; 3. - 5.4 m/s	4 - Half the sky is cloudy	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	N/A	I did not detect any odour	No comment	Not applicable	S. Wardlaw	11.30
1/12/2023	S. Wardlaw	Proactive	NW	4 - Moderate breeze; 5.5 - 7.9 m/	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	None	I did not detect any odour	None	Not applicable	S. Wardlaw	11.52
1/01/2024	S. Wardlaw	Proactive	SW	3 - Gentle breeze; 3. - 5.4 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.30
1/02/2024	S. Wardlaw	Proactive	W	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	None	Not applicable	S. Wardlaw	12.00
1/03/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	13.46
1/04/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	11.00
1/05/2024	S. Wardlaw	Proactive	NNW	1 - Light air; 0.5 - 1.5 m/s	6 - Mostly cloudy	3 - Cool	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	No comment

ODOUR ASSESSMENT UNDERTAKEN AT THE LANDFILL PROPOSED LOCATION

1/11/2023	S. Wardlaw	Proactive	C - From SW	3 - Gentle breeze; 3. - 5.4 m/s	4 - Half the sky is cloudy	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	None	I did not detect any odour	N/A	Not applicable	S. Wardlaw	11.30
1/12/2023	S. Wardlaw	Proactive	E - From NW	4 - Moderate breeze; 5.5 - 7.9 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	None	I did not detect any odour	None	Not applicable	S. Wardlaw	11.52
1/01/2024	S. Wardlaw	Proactive	C - From SW	3 - Gentle breeze; 3. - 5.4 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.30
1/02/2024	S. Wardlaw	Proactive	D - From W	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.00
1/03/2024	S. Wardlaw	Proactive	E - From NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	13.46
1/04/2024	S. Wardlaw	Proactive	E - From NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	11.00
1/05/2024	S. Wardlaw	Proactive	G - From NE	2 - Light breeze; 1.6 - 3.3 m/s	4 - Half the sky is cloudy	3 - Cool	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	No comment

ODOUR ASSESSMENT UNDERTAKEN AT THE TOP OF THE LANDFILL

1/11/2023	S. Wardlaw	Proactive	SE	3 - Gentle breeze; 3. - 5.4 m/s	4 - Half the sky is cloudy	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	None	I did not detect any odour	None	Not applicable	S. Wardlaw	11.30
1/12/2023	S. Wardlaw	Proactive	NW	4 - Moderate breeze; 5.5 - 7.9 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	None	I did not detect any odour	None	Not applicable	S. Wardlaw	11.52
1/01/2024	S. Wardlaw	Proactive	SW	3 - Gentle breeze; 3. - 5.4 m/s	2 - Mostly sunny	1 - Warm	No	1 - Very weak	19 - Landfill gas	-1 - A bit unpleasant	No comment	I did detect odour and consider it would not be objectionable at any location for any duration or frequency	No comment	Not applicable	S. Wardlaw	12.30
1/02/2024	S. Wardlaw	Proactive	W	2 - Light breeze; 1.6 - 3.3 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	12.00
1/03/2024	S. Wardlaw	Proactive	NW	3 - Gentle breeze; 3. - 5.4 m/s	1 - Sunny	1 - Warm	No	0 - No odour	1 - Fragrant	0 - Neutral	No comment	I did not detect any odour	No comment	Not applicable	S. Wardlaw	13.49
1/04/2024	S. Wardlaw	Proactive	NW	2 - Light breeze; 1.6 - 3.3 m/s	2 - Mostly sunny	1 - Warm	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	11.00
1/05/2024	S. Wardlaw	Proactive	NNE	1 - Light air; 0.5 - 1.5 m/s	6 - Mostly cloudy	3 - Cool	No	0 - No odour	No comment	No comment	No comment	I did not detect any odour	No comment	No comment	S. Wardlaw	No comment

Appendix I Surface emissions reports

LEVIN LANDFILL GAS MONITORING

JULY 2023

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of July, 2023 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedances require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** ***Note:** *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a

new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the standard Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 22nd July 2023 from 9.00 a.m. to 3.00 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty three gas wells in different stages of the landfill were monitored by using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Three monitoring sessions were conducted during the month of July, being undertaken every two weeks.

4. Weather condition

The weather data monitoring was carried out according to the following website which was retrieved on 05/08/2023 for the reporting purposes.
https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2023-07-22/2023-06-22/weekly

https://www.wunderground.com/dashboard/pws/ILEVIN22/graph/2023-07-22/2023-07-22/weekly

The last rainfall recorded by a Levin weather station prior to the survey was 1.27mm on 20/07/2023 at 4.25 a.m., 52 hours prior to the survey commence. The pressure fluctuated prior to the survey date in between 997.29 mbar to 999.32 mbar. See appendix 3.0 for full detail of weather condition prior to the survey date.

During the survey the pressure was 999.32 mbar and declined up to 985.43 mbar during the survey. The wind speed was fluctuating between 0 km/h to 4.5 km/h within the survey time. There was no rainfall during the survey and the data retrieved on 05/08/2023. See Appendix 4.0 for full detail of weather condition on survey date

5. Survey Results

There were 2 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using Bentonite and water. The identified high emission locations include; cracked and eroded areas of the final and intermediate cover.

Gas well monitoring was conducted according to the prescheduled dates within the month and from 33 wells the average CH_4 level was 55.67% with the highest of 68.4% in LVNW2004 and the lowest of 1.2% in LVNW3001. The average CO_2 level was 36.69% with the highest of 44.8% in LVNW0005 and the lowest of 2.3% in LVNW3001. The average O_2 level was 1.37% with the highest of 19.5% in LVNW3001 and the lowest of 0% in 14 wells.

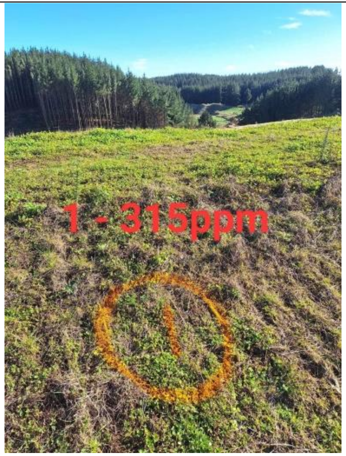
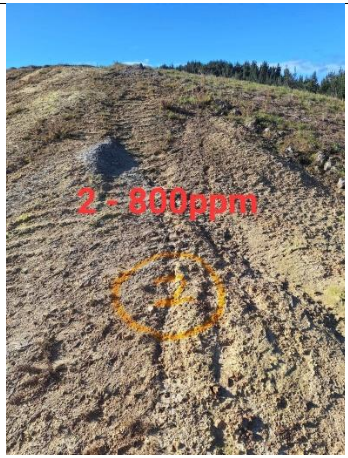
Some of the well heads sampling ports in stage 1 and stage 2 were damaged and needed repair to conduct the gas monitoring for those wells.

6. Recommendations

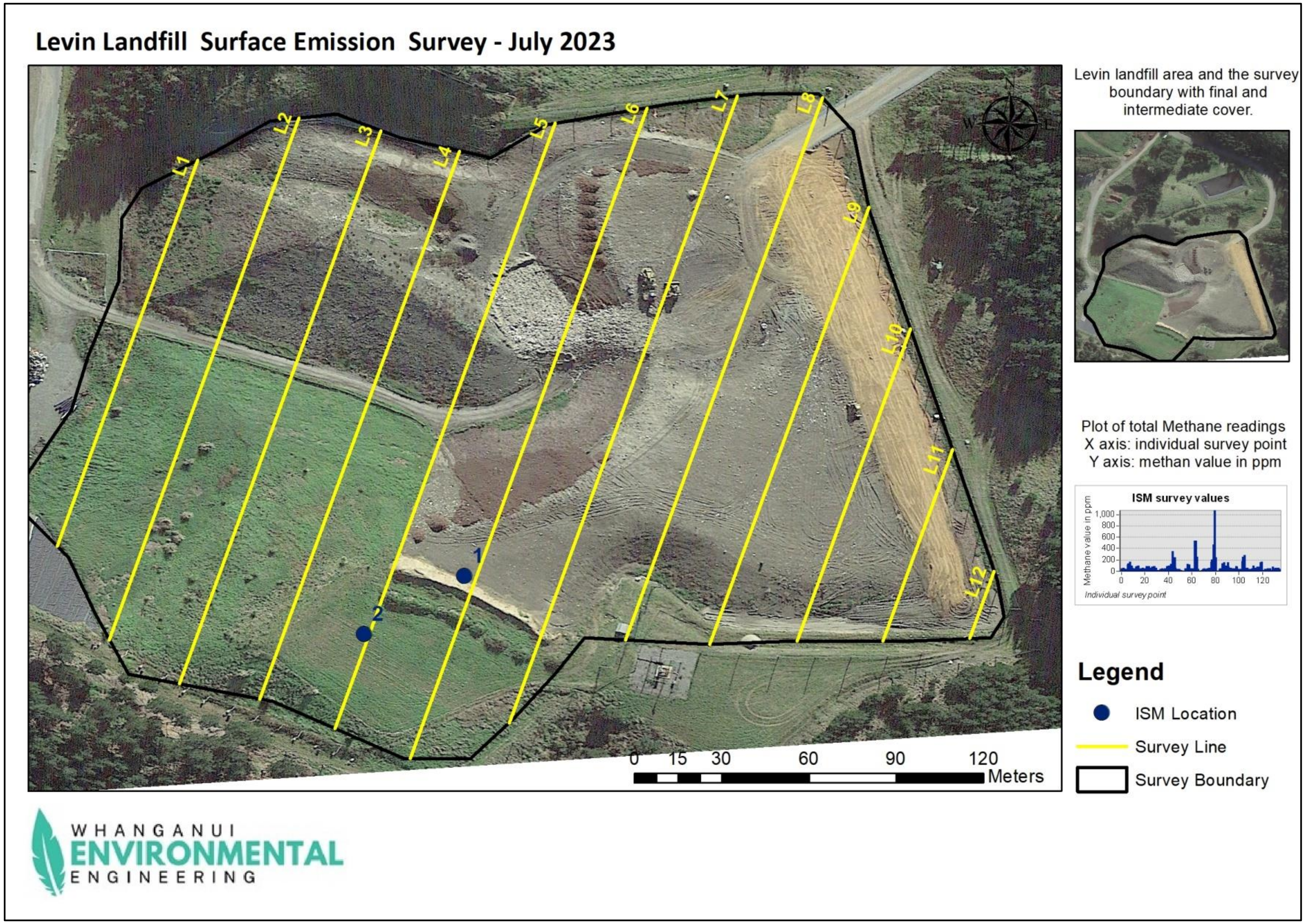
The gas wells are tuned and balanced according to the draw, and amongst other aspects, in addition to, the gas parameters present in the wells. In ideal circumstances, the draw from flare should reflect the behaviour of the gas well field. It is recommended that changes to the flare draw and destruction be communicated to the gas well sampling team so that the wells can be adjusted accordingly.

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills. Many sites undertake weekly gas well field monitoring and balancing, but the Levin landfill and flare is responding sufficiently well to fortnightly rounds. If surface monitoring indicates a frequently high number of, or a significant increase in, surface leaks, then increasing well monitoring rounds and optimizing the capture and destruction will likely help address this.

Appendix 1.Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	315ppm		in South Western face, in L5	Bentonite and water	No captured image of remediation due to a technical error	0ppm
2	800ppm		Upper south western face , in L6	Bentonite and water		0 ppm

Appendix 2.Surface emission map



Appendix 3.Weather conditions preceding the survey

revious Weekly Mode | July | 23 | 2023 | View Next

ummary

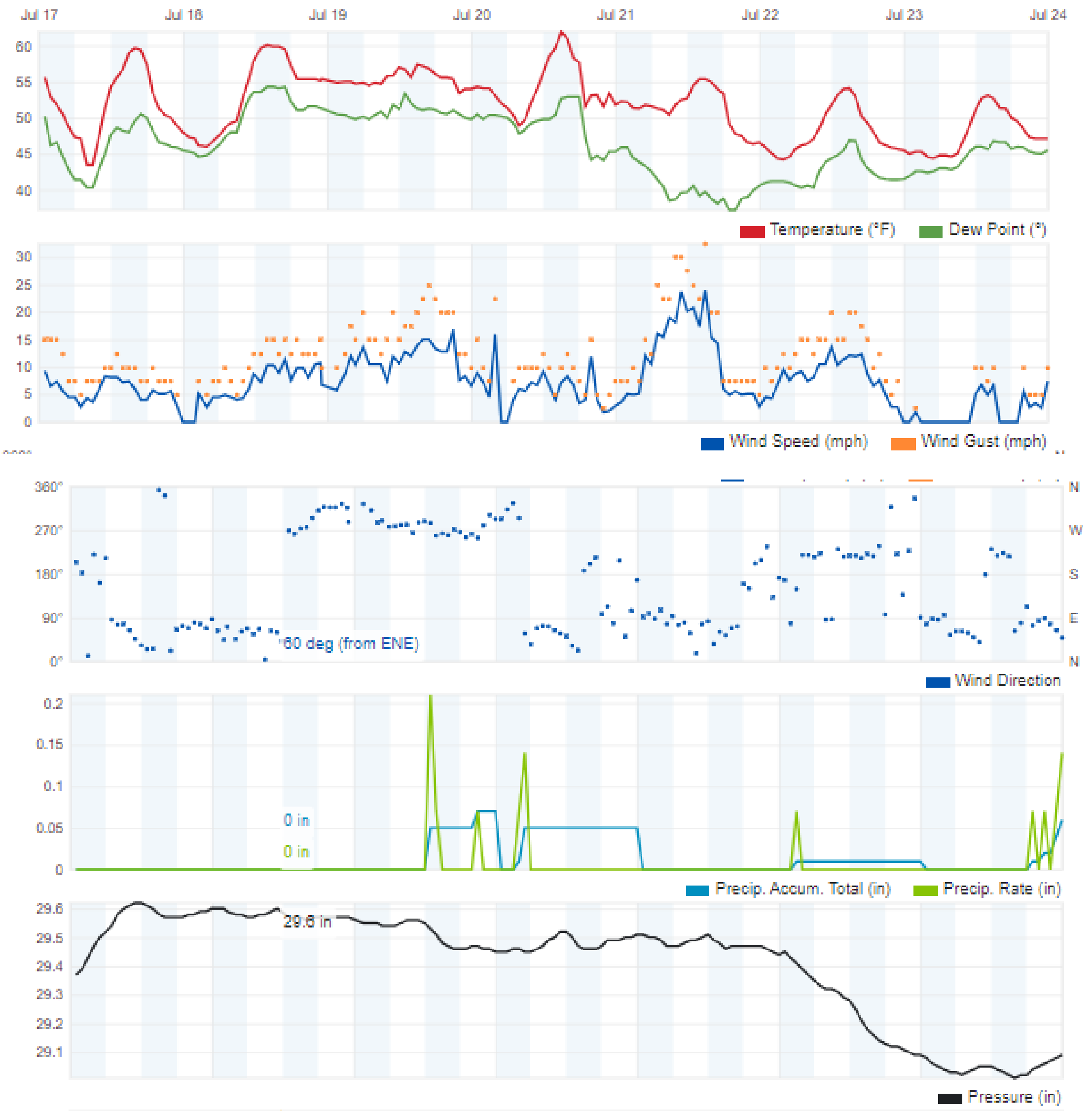
uly 17, 2023 - July 23, 2023

	High	Low	Average
Temperature	61.9 °F	42.8 °F	51.2 °F
Dew Point	54.3 °F	31.8 °F	45.5 °F
Humidity	96 %	42 %	82 %
Precipitation	0.19 in	--	--

	High	Low	Average
Wind Speed	23.9 mph	0.0 mph	2.3 mph
Wind Gust	32.4 mph	--	4.0 mph
Wind Direction	--	--	South
Pressure	29.62 in	29.00 in	--

Graph | Table

July 17, 2023 - July 23, 2023



Appendix 4. Weather conditions during the day of survey

Previous | Daily Mode | July | 22 | 2023 | View | Next

Summary

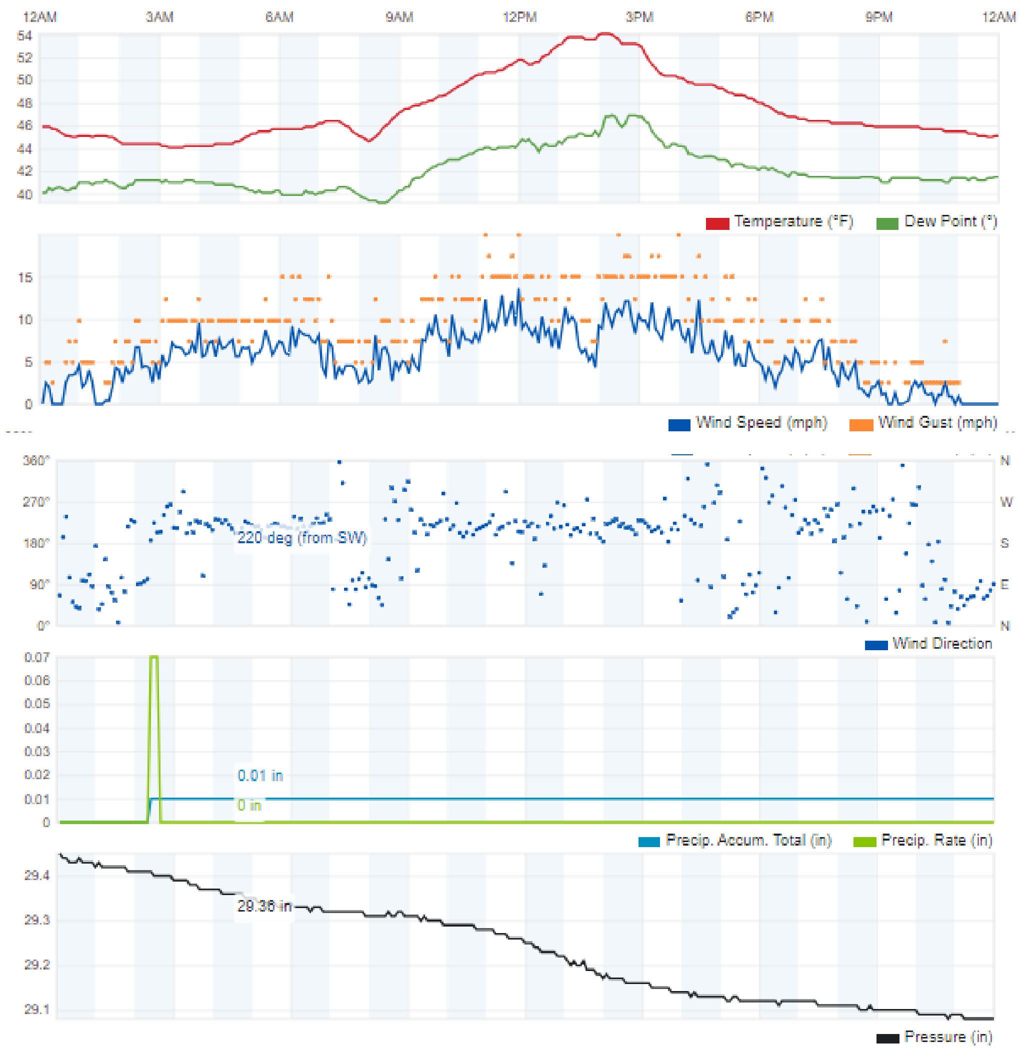
July 22, 2023

	High	Low	Average
Temperature	54.1 °F	44.1 °F	47.5 °F
Dew Point	46.9 °F	38.8 °F	41.9 °F
Humidity	89 %	70 %	81 %
Precipitation	0.01 in	--	--

	High	Low	Average
Wind Speed	13.6 mph	0.0 mph	2.8 mph
Wind Gust	19.9 mph	--	5.3 mph
Wind Direction	--	--	SSW
Pressure	29.45 in	29.07 in	--

Graph | Table

July 22, 2023



Appendix 5.Gas monitoring results

ID	DATE	CH4	CO2	O2	BALANCE	PEAKCH4	PEAKCO2	MIN O2	BARO
LVNBNH01	16/07/2023	58.1	38.8	0.4	2.7	58.9	39	0.3	1011
LVNBNH02	16/07/2023	60.2	39.3	0.2	0.3	60.2	39.3	0.2	1011
LVNFLARE	16/07/2023	58.2	38.3	0.7	2.8	58.2	38.3	0.7	1010
LVNW0001	16/07/2023	49.2	36.6	2.3	11.9	49.2	36.6	2.3	1009
LVNW0004	16/07/2023	58	43.1	0	0	58	43.2	0	1010
LVNW0005	16/07/2023	56.8	44.8	0	0	56.8	44.8	0	1009
LVNW0006	16/07/2023	60.3	40.4	0	0	60.3	40.4	0	1010
LVNW0007	16/07/2023	54	36.9	1.5	7.6	55.8	37.3	1.4	1010
LVNW0008	16/07/2023	58.8	44.2	0	0	58.8	44.2	0	1010
LVNW0009	16/07/2023	60.5	41.4	0	0	60.5	41.4	0	1011
LVNW0010	16/07/2023	59.4	41.6	0	0	59.4	41.6	0	1011
LVNW1002	16/07/2023	62.2	33.6	1	3.2	62.2	33.6	1	1011
LVNW1004	16/07/2023	56.7	33.9	1.5	7.9	61.4	36.2	0.3	1011
LVNW1005	16/07/2023	55.1	30.5	2.9	11.5	61.2	32.7	1.3	1011
LVNW1006	16/07/2023	61.4	38.3	0.1	0.2	61.4	38.3	0.1	1011
LVNW1007	16/07/2023	57.9	35	0.4	6.7	58	35.1	0.4	1011
LVNW1008	16/07/2023	61.5	38.3	0.1	0.1	61.5	38.3	0.1	1011
LVNW1009	16/07/2023	66.3	33.2	0	0.5	66.3	33.2	0	1011
LVNW1010	16/07/2023	55.3	37.1	1.4	6.2	56.2	37.7	0.9	1011
LVNW2001	16/07/2023	66.2	35.2	0	0	73.9	44.6	0	1012
LVNW2002	16/07/2023	65.2	38.4	0.1	0	65.2	38.4	0.1	1012
LVNW2004	16/07/2023	68.4	33	0	0	68.4	33	0	1012
LVNW2006	16/07/2023	64.4	36.6	0	0	64.4	36.6	0	1012
LVNW2008	16/07/2023	62.6	35.8	0.4	1.2	62.6	35.8	0.4	1012
LVNW2009	16/07/2023	67.5	34.5	0	0	67.5	35.6	0	1009
LVNW2010	16/07/2023	65.4	35.6	0.1	0	0.1	0.1	20.2	1010
LVNW3001	16/07/2023	1.2	2.3	19.5	77	2.4	4.3	18.4	1011
LVNW3002	16/07/2023	57.7	43.4	0	0	57.8	43.4	0	1011
LVNW3003	16/07/2023	7.6	33.8	5	53.6	7.6	33.8	5	1011
LVNW3004	16/07/2023	57.8	43.4	0	0	57.8	43.4	0	1010
LVNW3005	16/07/2023	56.9	44.4	0	0	56.9	44.5	0	1010
LVNW3006	16/07/2023	44	34.4	3.5	18.1	44.1	34.4	3.5	1011
LVNW3007	16/07/2023	42.4	34.8	4.4	18.4	42.6	34.8	4.4	1010

WHANGANUI ENVIRONMENTAL ENGINEERING

LEVIN LANDFILL GAS MONITORING

AUGUST 2023

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of August, 2023 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedances require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** ***Note:** *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a

new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the standard Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 12th August 2023 from 9.00 a.m. to 3.15 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty three gas wells in different stages of the landfill were monitored by using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Two monitoring sessions were conducted per month in between two weeks period.

4. Weather conditions

The weather data monitoring was carried out according to the following website which was retrieved on 05/08/2023 for the reporting purposes.
https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2023-08-12/2023-08-12/daily

https://www.wunderground.com/dashboard/pws/ILEVIN22/graph/2023-08-12/2023-08-12/weekly

The last rainfall recorded by a Levin weather station prior to the survey was 1.28mm on 10/08/2023 at 08.04 p.m., 36 hours prior to the survey commencing. The pressure fluctuated prior to the survey date in between 995.93 mbar to 1000.67mbar. See appendix 3.0 for full detail of weather condition prior to the survey date.

During the survey the pressure was 999.66 mbar and declined up to 997.29 mbar during the survey. The wind speed was fluctuating between 0 km/h to 2.5 km/h within the survey time. There was no rainfall during the survey and the data retrieved on 16/09/2023. See Appendix 4.0 for full detail of weather condition on survey date

5. Survey Results

There were 4 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using Bentonite and water. The identified high emission locations include cracked and eroded areas of the final and intermediate cover.

Gas well monitoring was conducted according to the pre scheduled dates within the month and from 33 wells the average CH_4 level was 57.53% with the highest of 71% in LVNW1009 and the lowest of 7.2% in LVNW3003. The average CO_2 level was 36.60% with the highest of 44.4% in LVNW0005 and the lowest of 29.5% in LVNW2003. The average O_2 level was 1.26% with the highest of 21.2% in LVNW1005 and the lowest of 0% in 23 wells.

Some of the well heads sampling ports in stage 1 and stage 2 were damaged and needed repair to conduct the gas monitoring for those wells.

6. Recommendations

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills. Many sites undertake weekly gas well field monitoring and balancing, but the Levin landfill and flare is responding sufficiently well to fortnightly rounds. If surface monitoring indicates a frequently high number of, or a significant increase in, surface leaks, then increasing well monitoring rounds and optimizing the capture and destruction will likely help address this.

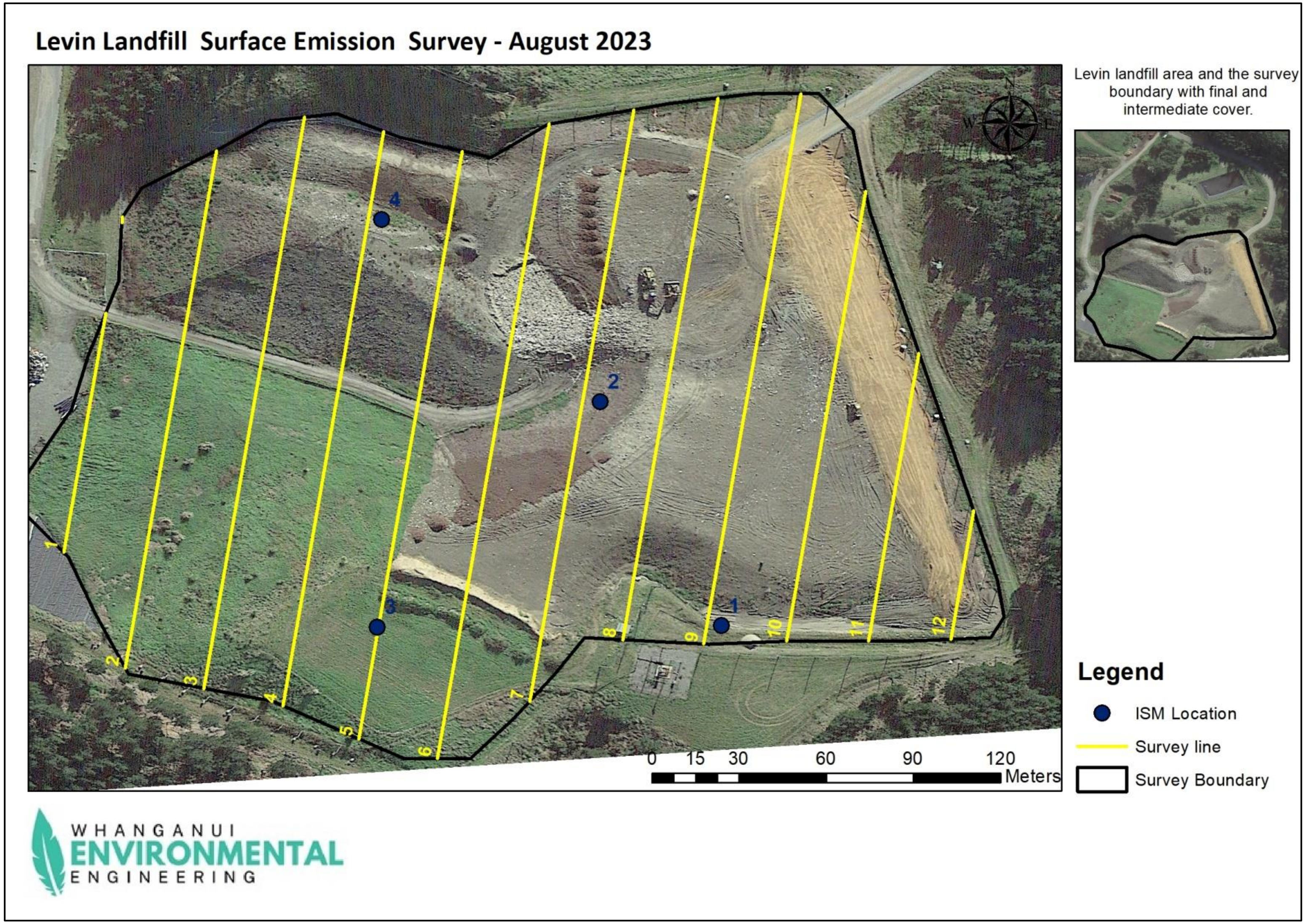
Weather conditions and technical issues in the flare system, and gas line repair have historically been the main limitations for the monitoring.

Appendix 1.Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	750ppm		Bottom edge of cap in south face, crack in clay cover	Bentonite and water		20ppm
2	1000ppm		Upper western face, middle of the landfill, next to the access road, closer to previous remediation	Bentonite and water		0 ppm

3	700ppm		Interface in south western face, grass covered and clay fractured area	Bentonite and water		30ppm
4	380ppm		Northern face closer to middle, in bare soil cover	Bentonite and water		20ppm

Appendix 2.Surface emission map



Appendix 3. Weather conditions preceding the survey

Previous | Weekly Mode | August | 13 | 2023 | View | Next

Summary

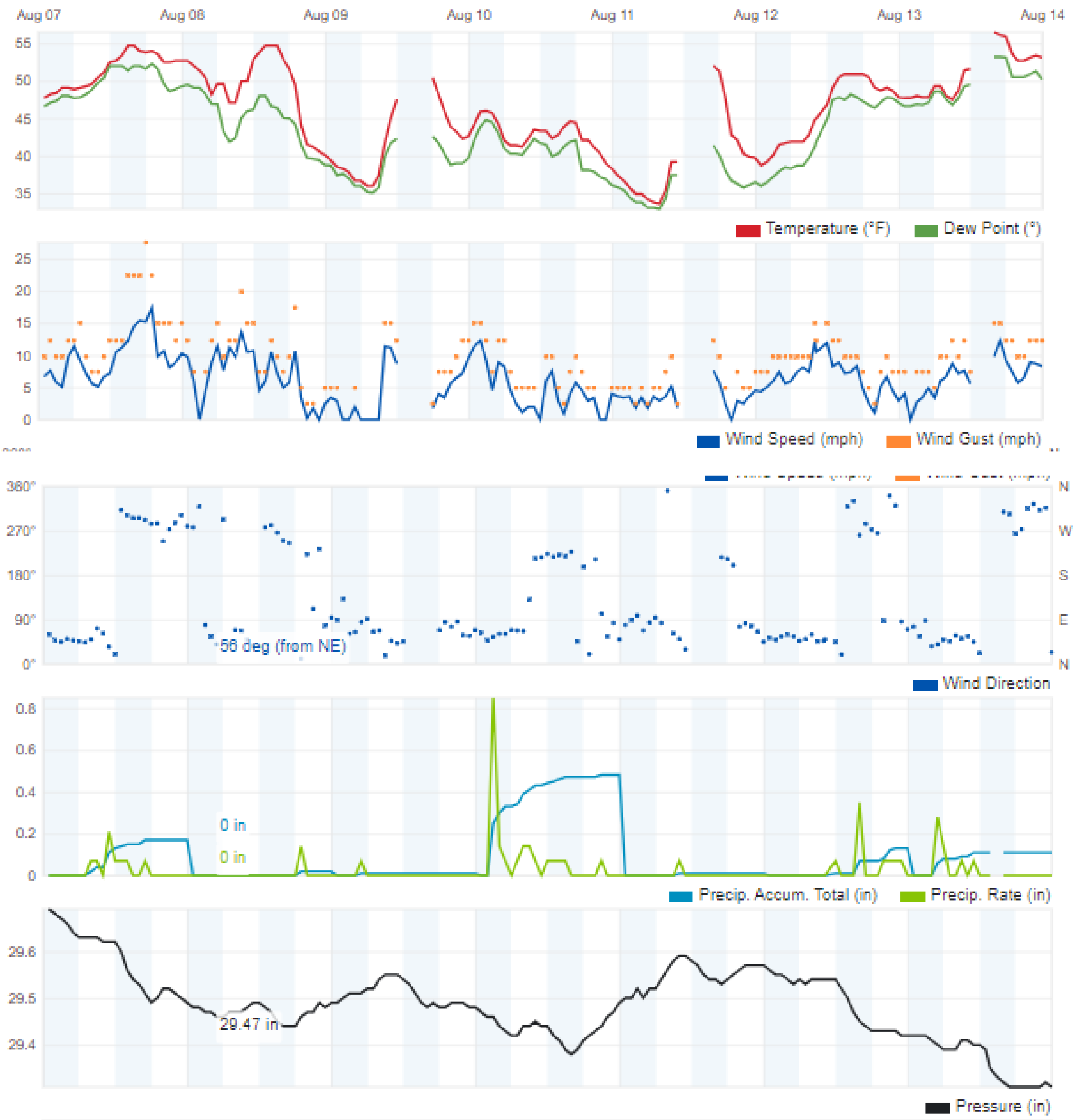
August 7, 2023 - August 13, 2023

	High	Low	Average
Temperature	56.5 °F	32.7 °F	45.2 °F
Dew Point	53.2 °F	32.0 °F	42.5 °F
Humidity	98 %	60 %	90 %
Precipitation	0.93 in	--	--

	High	Low	Average
Wind Speed	17.4 mph	0.0 mph	2.1 mph
Wind Gust	27.5 mph	--	3.4 mph
Wind Direction	--	--	East
Pressure	29.69 in	29.29 in	--

Graph | Table

August 7, 2023 - August 13, 2023



Appendix 4.Weather conditions during the day of survey

Daily Mode | August | 12 | 2023 | View

Previous | Next

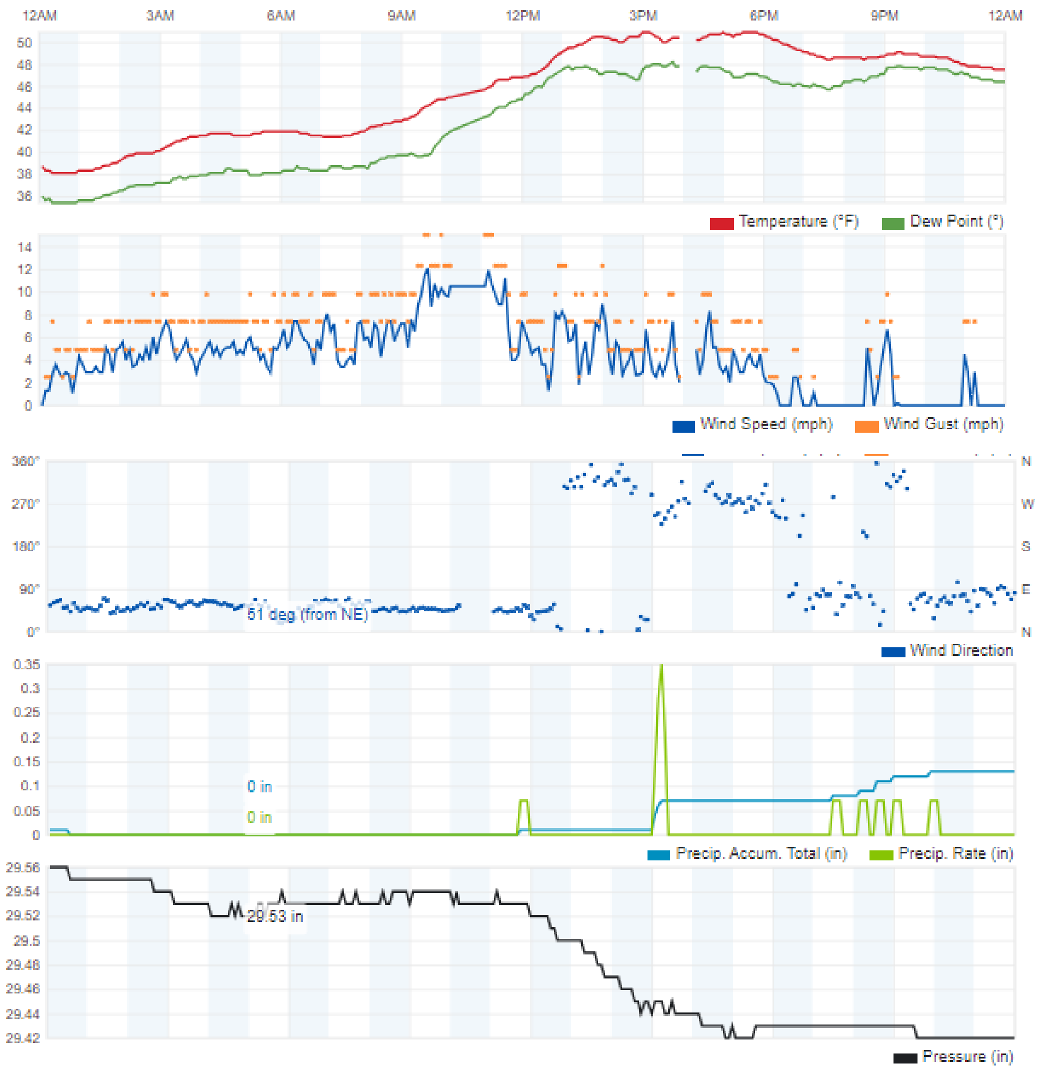
Summary
August 12, 2023

	High	Low	Average
Temperature	50.9 °F	37.9 °F	45.5 °F
Dew Point	48.2 °F	35.2 °F	42.8 °F
Humidity	97 %	83 %	90 %
Precipitation	0.13 in	--	--

	High	Low	Average
Wind Speed	12.1 mph	0.0 mph	2.5 mph
Wind Gust	15.0 mph	--	3.9 mph
Wind Direction	--	--	NE
Pressure	29.56 in	29.41 in	--

Graph | Table

August 12, 2023



Appendix 5.Gas monitoring results

ID	DATE	CH4 %	CO2 %	O2 %	BARO mb	CO ppm	H2S ppm	Res Nitrogen %
LVNW2001	12/08/2023	67	34.7	0	1018	2	77	0
LVNW2002	12/08/2023	66.3	36	0	1018	9	25	0
LVNW2003	12/08/2023	52.7	29.5	4.5	1018	40	48	0
LVNW2004	12/08/2023	68.7	32.9	0	1017	36	12	0
LVNW2006	12/08/2023	65.5	35.6	0	1018	28	202	0
LVNW2007	12/08/2023	60.3	34.6	1.3	1017	9	221	0
LVNW2008	12/08/2023	65.2	36.3	0	1018	8	398	0
LVNW2009	12/08/2023	66.9	34.8	0	1018	8	259	0
LVNW2010	12/08/2023	64.6	36.2	0	1018	8	272	0
LVNW0008	12/08/2023	58.2	43.7	0	1016	13	>>>>	0
LVNW0007	12/08/2023	55	37.8	1.2	1016	14	10	1.46
LVNW0006	12/08/2023	60.6	41.1	0	1017	11	331	0
LVNW0010	12/08/2023	58.5	43	0	1017	11	453	0
LVNW0005	12/08/2023	57.7	44.4	0	1016	14	>>>>	0
LVNW0004	12/08/2023	59	43	0	1017	13	>>>>	0
LVNW3007	12/08/2023	49.4	39.9	2	1016	13	18	1.14
LVNW3005	12/08/2023	57.7	44.2	0	1017	11	>>>>	0
LVNW3004	12/08/2023	58	44.1	0	1017	12	882	0
LVNW3003	12/08/2023	7.2	32.5	6	1018	55	16	31.62
LVNW3002	12/08/2023	54.5	40.2	1.2	1017	10	244	0
LVNW3006	12/08/2023	43.1	34.2	3.8	1017	30	9	4.54
LVNW0009	12/08/2023	61.8	41.1	0	1017	12	>>>>	0
LVNW1010	12/08/2023	63.1	37.9	0	1017	9	35	0
LVNW1009	12/08/2023	71	30.8	0	1017	7	11	0
LVNW1008	12/08/2023	64.1	37.4	0	1017	7	55	0
LVNW1007	12/08/2023	65.9	33.8	0	1017	7	93	0.3
LVNW1006	12/08/2023	63.5	38	0	1017	7	101	0
LVNW1005	12/08/2023	0	0.1	21.2	1017	4	6	0
LVNW1004	12/08/2023	64.3	36.7	0	1017	7	42	0
LVNW1002	12/08/2023	65.4	35.8	0	1017	6	87	0
LVNBNH01	12/08/2023	61.3	37.9	0.3	1017	8	353	0
LVNBNH02	12/08/2023	61	40.4	0	1017	9	392	0
LVNFLARE	12/08/2023	61.1	39.4	0.1	1017	8	372	0

WHANGANUI ENVIRONMENTAL ENGINEERING

LEVIN LANDFILL GAS MONITORING

SEPTEMBER 2023

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of September, 2023 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedances require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** *****Note: *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating Procedure For All Landfills. The survey was conducted on 23rd September 2023 from 8.45 a.m. to 3.00 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty three gas wells in different stages of the landfill were monitored using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Two monitoring sessions were conducted per month in between two weeks period.

4. Weather conditions

The weather data monitoring was carried out according to the following website which was retrieved on 01/10/2023 for reporting purposes.

https://www.metservice.com/towns-cities/locations/levin/past-weather

https://www.wunderground.com/dashboard/pws/ILEVIN22/graph/2023-09-23/2023-09-23/weekly

The last rainfall recorded by a Levin weather station prior to the survey was 1.60mm on 20/09/2023 at 07.09 p.m., 73 hours prior to the survey commence. The pressure declined prior to the survey date from 1012.53 mbar to 1003.7mbar. The ambient temperature at the start of the survey was 14°C. See appendix 3.0 for full detail of weather condition prior to the survey date.

During the survey the pressure was fluctuated between 1003.7 mbar to 994.24 mbar as during the survey with available data. The wind speed was fluctuating between 0 km/h to 6.43 km/h within the survey day with available data. There was no rainfall during the survey and the data was retrieved on 01/10/2023. See Appendix 4.0 for full detail of weather condition on survey date

5. Survey Results

There were 3 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using Bentonite and water. The identified high emission locations include; in bare soil cover and in grass covered areas on final and intermediate cover.

Gas well monitoring was conducted according to the pre scheduled dates within the month and from 31 wells the average CH_4 level was 44.76 % with the highest of 68.7% in LVNW2004 and the lowest of 1.9% in LVNW3001. The average CO_2 level was 31.88% with the highest of 43.6% in LVNW0005 and the lowest of 4.1% in LVNW3001. The average O_2 level was 2.65% with the highest of 18.0% in LVNW3001 and the lowest of 0% in 12 wells. A Slight drop in the average gas well methane level has been observed when compared to the previous survey, as well as a slight increase in the oxygen level.

Some of the well heads sampling ports in Stage 1 and Stage 2 were damaged and needed repair to conduct the gas monitoring for those wells.

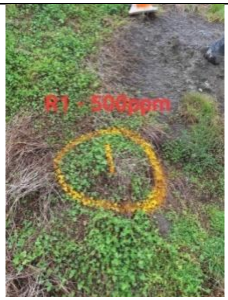
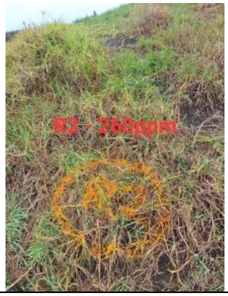
6. Recommendations

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills. The reduction in methane when compared to previous surveys will need to be monitored for future surveys. Changes to the flare and gas reticulation system may be necessary to appropriately manage the changing gas compositions should the trend continue.

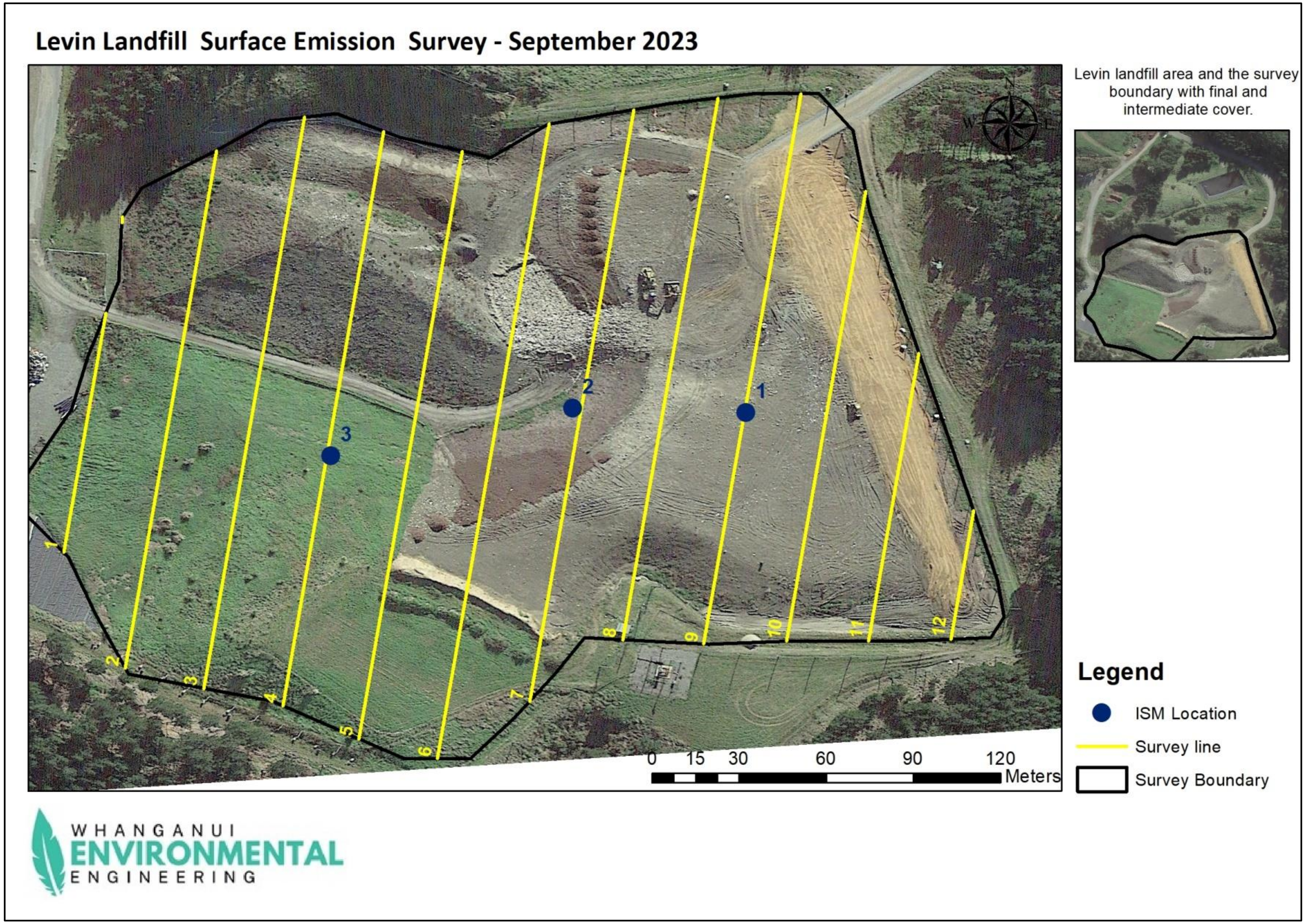
Many sites undertake weekly gas well field monitoring and balancing, but the Levin landfill and flare is responding sufficiently well to fortnightly rounds. If surface monitoring indicates a frequently high number of, or a significant increase in, surface leaks, then increasing well monitoring rounds and optimizing the capture and destruction will likely help address this.

Weather conditions and technical issues in the flare system, as well gas reticulation repairs have historically been the main limitations for the monitoring.

Appendix 1.Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	500ppm		North Eastern face, in grass covered area closer to gas well	Bentonite and water		30ppm
2	260ppm		Upper western face, next to the access road, in a grass covered area	Bentonite and water		0 ppm
3	600ppm		In the western face, in bare soil cover and part in a dead grass patch	Bentonite and water		0ppm

Appendix 2.Surface emission map



Appendix 3.Weather conditions preceding the survey

Previous

Weekly Mode | September | 24 | 2023 | View

Next

Summary

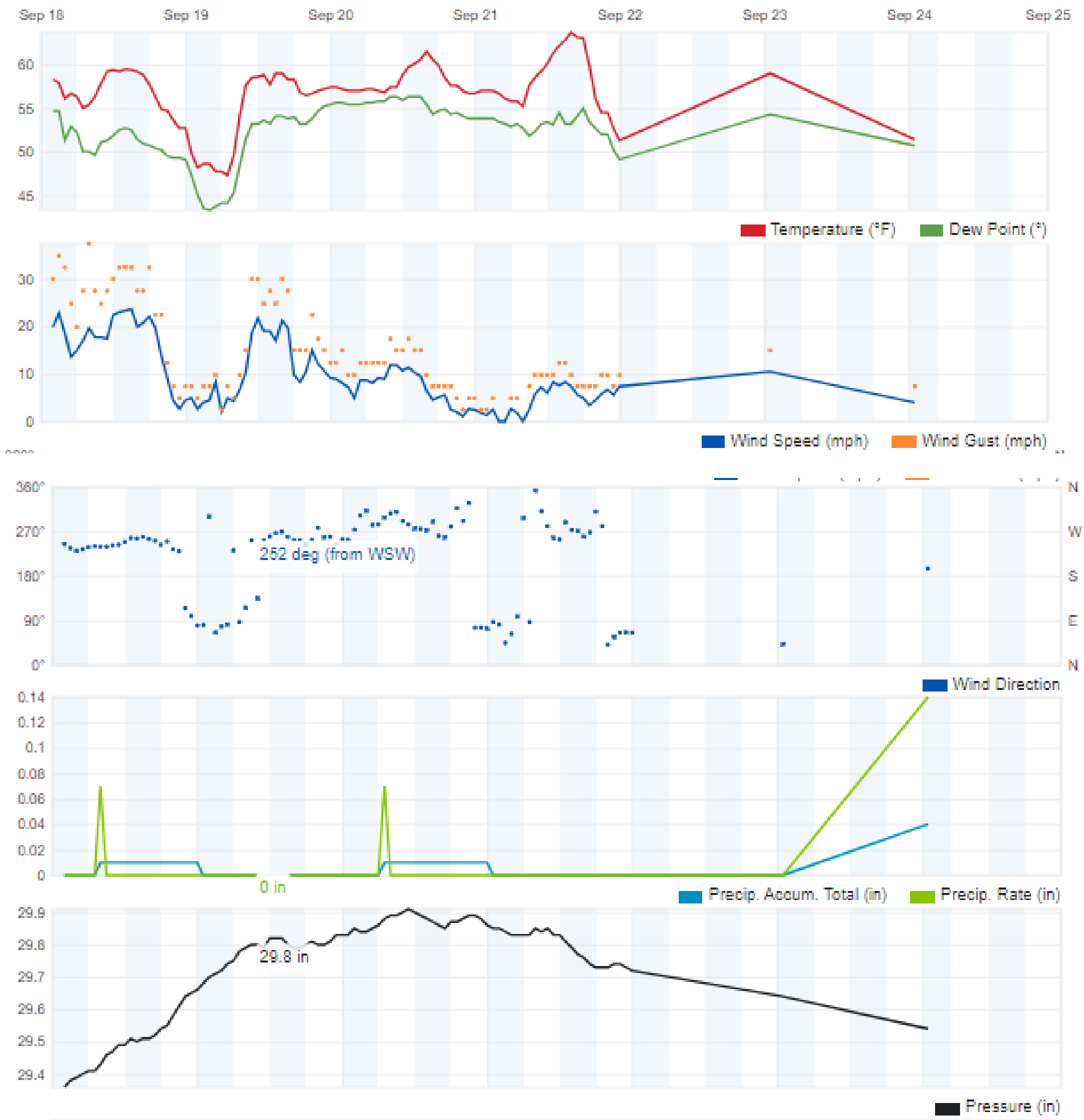
September 18, 2023 - September 24, 2023

	High	Low	Average
Temperature	63.7 °F	46.4 °F	56.2 °F
Dew Point	57.6 °F	42.4 °F	51.8 °F
Humidity	99 %	62 %	86 %
Precipitation	0.41 in	--	--

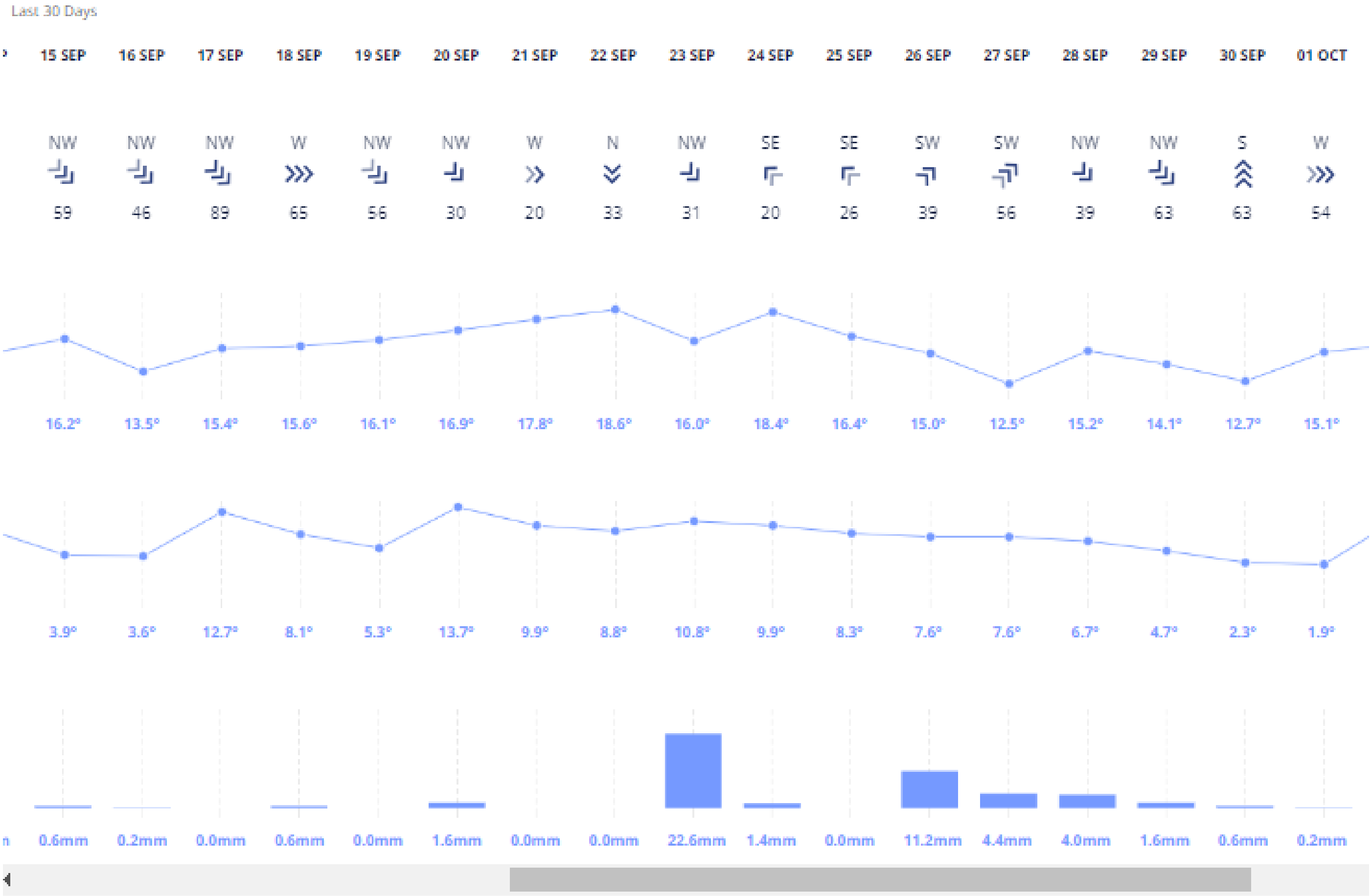
	High	Low	Average
Wind Speed	23.7 mph	0.0 mph	3.7 mph
Wind Gust	37.4 mph	--	5.7 mph
Wind Direction	--	--	South
Pressure	29.91 in	29.34 in	--

Graph | Table

September 18, 2023 - September 24, 2023



Appendix 4.Weather conditions during the day of survey



Peak wind gust The direction and speed of the highest gust that was recorded on the calendar day.
Temperature The highest and lowest temperatures that were recorded on the calendar day.
Rainfall The total rainfall that fell during the calendar day.
Observations recorded at Levin (AWS-93410)

Appendix 5.Gas monitoring results

ID	DATE	CH4	CO2	O2	BALANCE	BARO	REL.PRESSURE
LVNW2010	9/09/2023	66.3	35.1	0.3	0	1036	-2.75
LVNW2009	9/09/2023	67.4	34	0.4	0	1037	-2.94
LVNW2008	9/09/2023	50.3	32.5	0.1	17.1	1037	-2.47
LVNW2006	9/09/2023	31.9	27.5	0.2	40.4	1037	-2.32
LVNW2004	9/09/2023	68.7	32.7	0	0	1037	0.36
LVNW2003	9/09/2023	51.9	35	0.8	12.3	1036	-2.32
LVNW2002	9/09/2023	59.1	37	0.1	3.8	1037	-2.59
LVNW2001	9/09/2023	47.5	30.6	0	21.9	1037	-2.42
LVNBNH02	9/09/2023	57.8	39.8	0	2.4	1037	-2.19
LVNBNH01	9/09/2023	40.9	33	0.5	25.6	1037	0.03
LVNW1002	9/09/2023	18.2	11	13.9	56.9	1038	-1.07
LVNW1004	9/09/2023	62.3	36	0.1	1.6	1037	-0.48
LVNW1006	9/09/2023	56.4	36.9	0.1	6.6	1038	-0.02
LVNW1007	9/09/2023	28.4	30.7	0.1	40.8	1038	-1.95
LVNW1008	9/09/2023	27.9	29.9	0	42.2	1038	-1.5
LVNW1009	9/09/2023	48.7	27.4	0	23.9	1037	-0.03
LVNW1010	9/09/2023	18.9	27.2	0.4	53.5	1038	-0.78
LVNW0004	9/09/2023	58.8	42	0	0	1036	0.12
LVNW0005	9/09/2023	57.4	43.6	0	0	1036	-2.13
LVNW0006	9/09/2023	61	39.7	0	0	1036	0.1
LVNW0007	9/09/2023	46.4	32.4	3.6	17.6	1036	-2.06
LVNW0008	9/09/2023	58	43.2	0	0	1036	-2.38
LVNWELL2	9/09/2023	17.8	13.4	13.6	55.2	1036	-7.65
LVNW3007	9/09/2023	49.9	40.1	1.8	8.2	1036	-6.5
LVNW3005	9/09/2023	10.9	8.3	16.4	64.4	1036	-2.26
LVNW3004	9/09/2023	58.1	42.6	0	0	1037	3.52
LVNW3003	9/09/2023	6.5	31.4	6.3	55.8	1037	2.06
LVNW3002	9/09/2023	56.8	37.9	1	4.3	1036	-2.37
LVNW3001	9/09/2023	1.9	4.1	18	76	1036	
LVNW3006	9/09/2023	41.2	33.1	4	21.7	1036	
LVNW3009	9/09/2023	60.5	40.4	0	0	1036	

LEVIN LANDFILL GAS MONITORING

OCTOBER 2023

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of October, 2023 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedances require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** ***Note:** *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a

new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 22nd October 2023 from 9.45 a.m. to 2.00 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty three gas wells in different stages of the landfill were monitored by using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Two monitoring sessions were conducted per month in between two weeks period.

4. Weather conditions

The weather data is based on according to the Levin landfill on site weather station data for this reporting.

The last rainfall recorded by a Levin weather station prior to the survey was 7.2 mm on 17/10/2023. The pressure slightly fluctuate prior to the survey date from 1010 hpa to 1018 hpa. See appendix 3.0 for full detail of weather condition prior to the survey date.

During the survey day the pressure 1013 hpa and cannot observe much fluctuation from the weather data. The average wind speed was 0.8m/sec within the survey day. There was no rainfall during the survey and the data baswd on levin weather station data. See Appendix 4.0 for full detail of weather condition on survey date

5. Survey Results

There were 3 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using Bentonite and water. The identified high emission locations include; in bare soil cover and in grass covered areas on final and intermediate cover.

Gas well monitoring was conducted according to the prescheduled dates within the month and from 20 wells the average CH_4 level was 51.81 % with the highest of 65 % in LVNW2009 and the lowest of 1.6% in LVNW3001. This is a slight increase from the previous survey. The average CO_2 level was 36.00% with the highest of 43.6% in LVNW005 and the lowest of 4.0% in LVNW3001. The average O_2 level was 2.1% with the highest of 18.8% in LVNW3001 and the lowest of 0% in 2 wells. The individual gas value and total average values can fluctuate due to many reason such as draw of the well, and number of monitoring wells. Additionally, the number of monitoring gas wells can vary each month depending on the well head condition or the landfill activity.

Some of the well heads sampling ports in stage 1 and stage 2 were damaged and needed repair to conduct the gas monitoring for those wells.

6. Recommendations

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

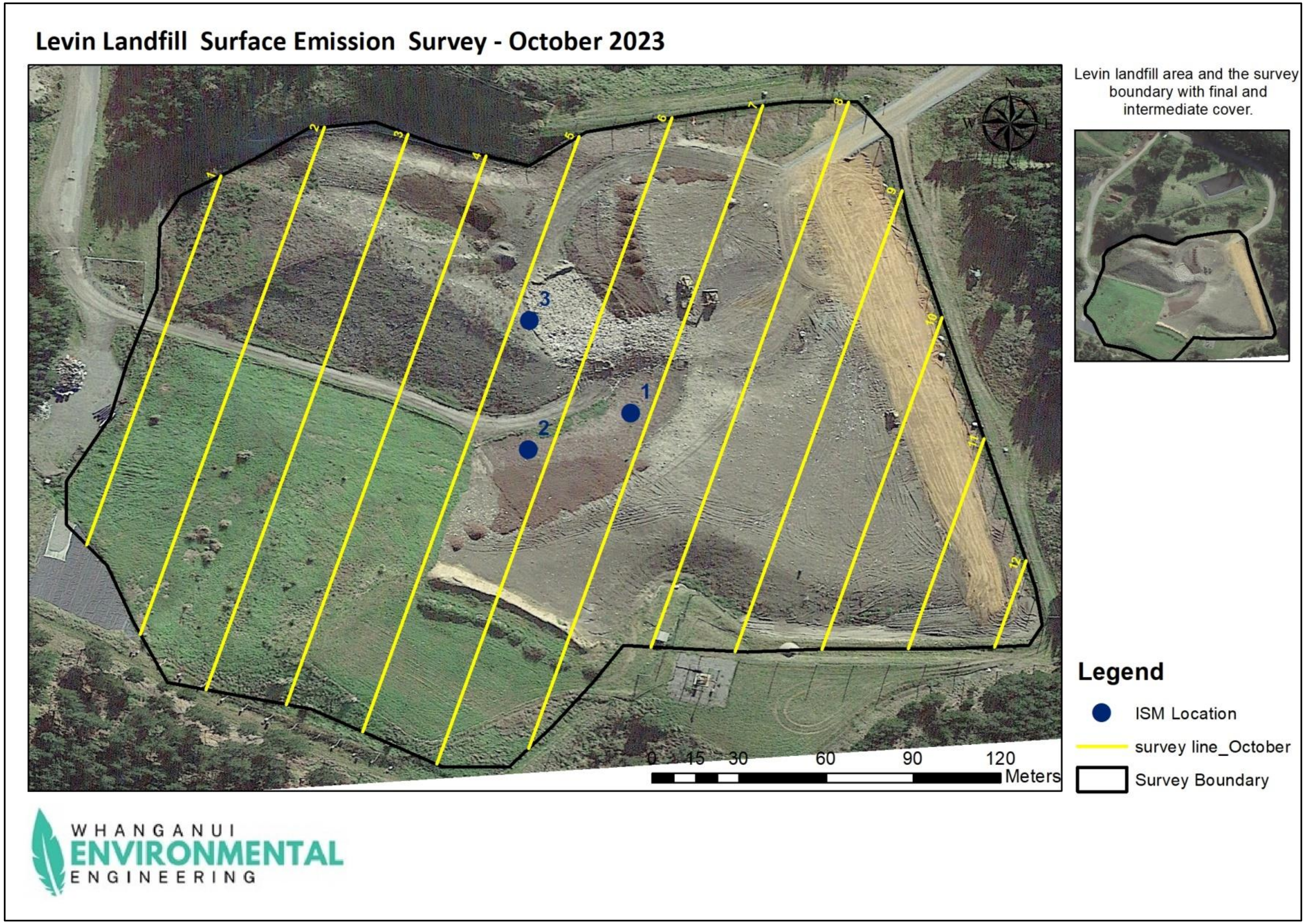
Many sites undertake weekly gas well field monitoring and balancing, but the Levin landfill and flare is responding sufficiently well to fortnightly rounds. The methane content has increased from the September round, correcting the previous trend we were observing. Changes made to the flare system may have helped correct this. If surface monitoring indicates a frequently high number of, or a significant increase in, surface leaks, then increasing well monitoring rounds and optimizing the capture and destruction will likely help address this.

Weather conditions and technical issues in the flare system, and gas line repair have historically been the main limitations for the monitoring.

Appendix 1.Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	160ppm		Middle of the landfill, upper western face closer to access road, in a bare soil cover	Bentonite and water		47ppm
2	375ppm		Middle of the landfill, upper western face closer to access road, in a grass patch	Bentonite and water		5ppm
3	290ppm		Middle of the landfill, upper Northern face, in bare soil cover	Bentonite and water		0ppm

Appendix 2.Surface emission map



Appendix 3.Weather conditions preceding the survey

Statistics for AAF-748:1 Wind Speed (m per sec)

Daily	First	Last	Diff	Average	Samples	Min	Max
Tue, Oct 17	0.4	0.4	0.0	1.4	1441	0.4	5.5
Wed, Oct 18	0.4	0.4	0.0	0.9	1440	0.4	3.5
Thu, Oct 19	0.4	0.4	0.0	0.9	1441	0.4	3.5
Fri, Oct 20	0.4	0.4	0.0	0.8	1441	0.4	4.2
Sat, Oct 21	0.4	1.2	0.8	0.9	1441	0.4	3.2
Sun, Oct 22	1.2	0.4	-0.8	0.8	1440	0.4	3.4

Statistics for AAF-748:2 Wind Direction (Degrees)

Daily	First	Last	Diff	Average	Samples	Min	Max
Tue, Oct 17	8.6	123.3	114.7	227.3	1441	0.0	355.0
Wed, Oct 18	123.3	68.0	-55.4	190.0	1440	0.0	354.2
Thu, Oct 19	68.0	35.7	-32.3	175.8	1441	0.1	353.4
Fri, Oct 20	35.7	41.7	6.0	195.0	1441	0.0	355.3
Sat, Oct 21	41.7	260.1	218.5	184.4	1441	0.0	355.2
Sun, Oct 22	260.1	355.3	95.1	161.4	1440	12.0	355.3

Statistics for AAF-748:3 Air Temperature (C)

Daily	First	Last	Diff	Average	Samples	Min	Max
Tue, Oct 17	14.1	12.1	-2.0	14.5	1441	11.7	15.9
Wed, Oct 18	12.1	14.5	2.4	14.5	1440	11.3	18.6
Thu, Oct 19	14.5	10.0	-4.5	14.8	1441	9.8	19.8
Fri, Oct 20	10.0	13.9	3.9	13.7	1441	8.9	18.6
Sat, Oct 21	13.9	14.1	0.2	14.3	1441	10.8	18.9
Sun, Oct 22	14.1	10.7	-3.4	14.2	1440	10.3	18.6

Statistics for AAF-748:4 Humidity (Percent RH)

Daily	First	Last	Diff	Average	Samples	Min	Max
Tue, Oct 17	11.1	11.1	0.0	11.4	1441	10.7	47.5
Wed, Oct 18	11.1	11.1	0.0	11.6	1440	6.8	67.5
Thu, Oct 19	11.1	10.9	-0.1	11.1	1441	9.0	11.4
Fri, Oct 20	10.9	11.2	0.2	11.2	1441	10.9	11.4
Sat, Oct 21	11.2	11.1	-0.1	11.1	1441	10.9	11.4
Sun, Oct 22	11.1	11.0	-0.1	11.1	1440	10.9	11.4

Input statistics summary - continued

Statistics for AAF-748:5 Barometric Pressure (hpa)

Daily	First	Last	Diff	Average	Samples	Min	Max
Tue, Oct 17	1013	1019	6	1014	1441	1011	1019
Wed, Oct 18	1019	1020	1	1019	1440	1018	1020
Thu, Oct 19	1020	1017	-3	1018	1441	1016	1020
Fri, Oct 20	1017	1013	-4	1015	1441	1013	1017
Sat, Oct 21	1013	1010	-3	1010	1441	1008	1013
Sun, Oct 22	1010	1018	8	1013	1440	1010	1018

Statistics for AAF-748:6 Rain Gauge (mm per Hour)

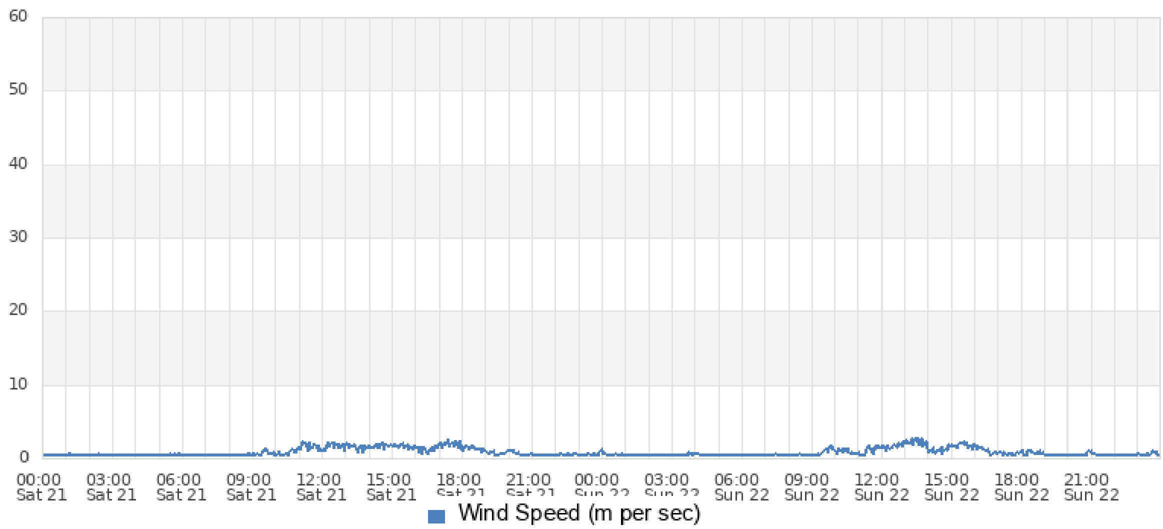
Daily	First	Last	Diff	Average	Samples	Min	Max
Tue, Oct 17	0.0	0.0	0.0	0.4	1441	0.0	7.2
Wed, Oct 18	0.0	0.0	0.0	0.0	1440	0.0	0.0
Thu, Oct 19	0.0	0.0	0.0	0.0	1441	0.0	0.0
Fri, Oct 20	0.0	0.0	0.0	0.0	1441	0.0	0.0
Sat, Oct 21	0.0	0.0	0.0	0.0	1441	0.0	0.0
Sun, Oct 22	0.0	0.0	0.0	0.1	1440	0.0	3.6

Appendix 4.Weather conditions during the day of survey

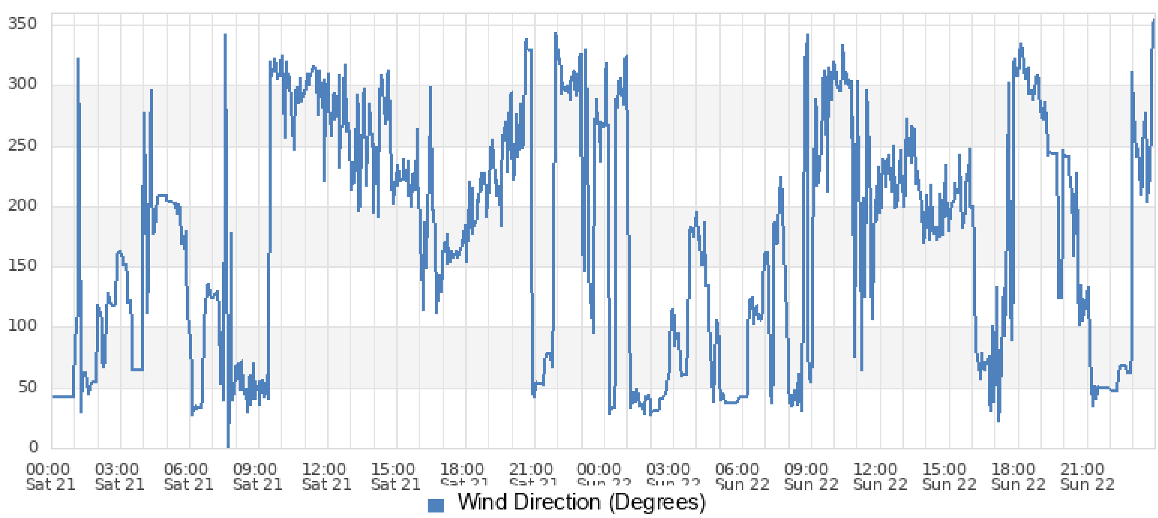
This report includes data up to Oct 23 2023 at 00:00 (UTC+13:00)

Daily weather report

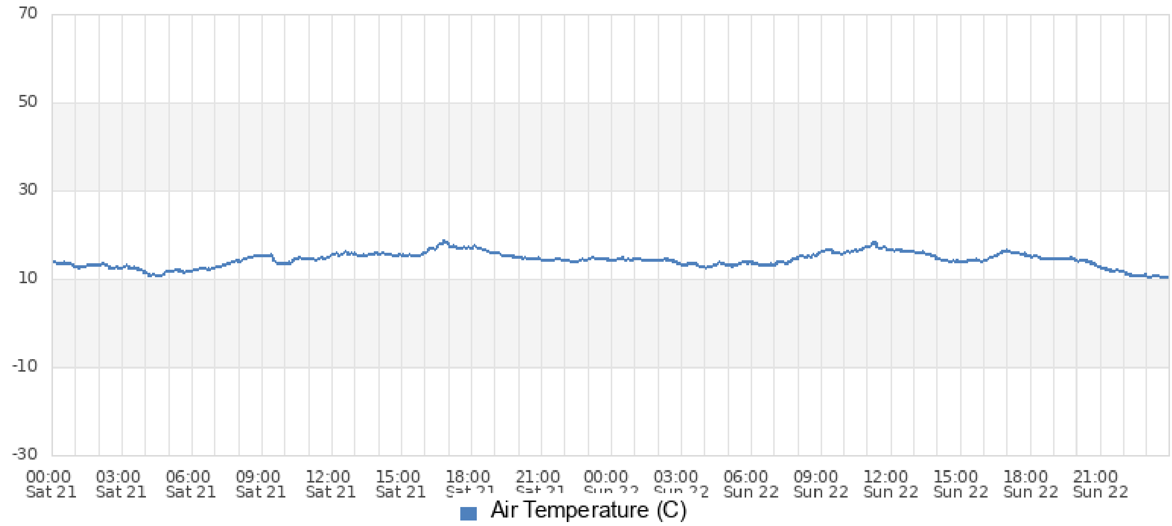
Oct 21 through Oct 22.



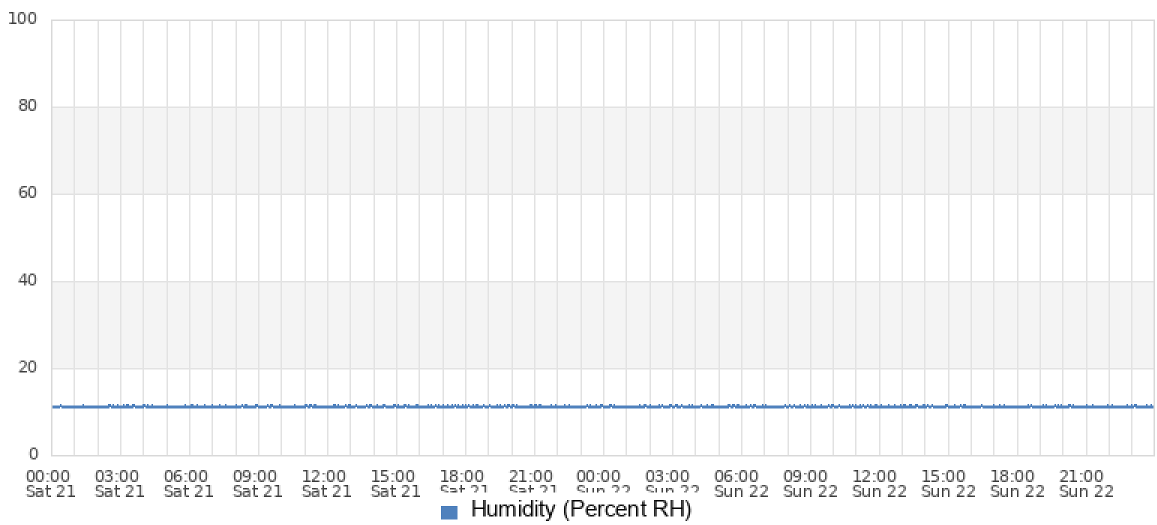
Oct 21 through Oct 22.



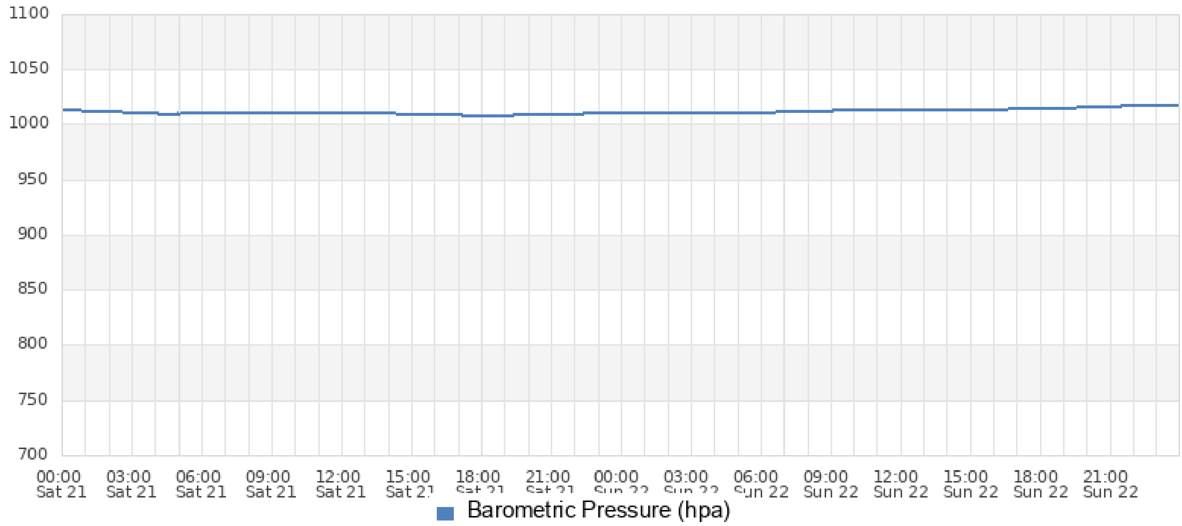
Oct 21 through Oct 22.



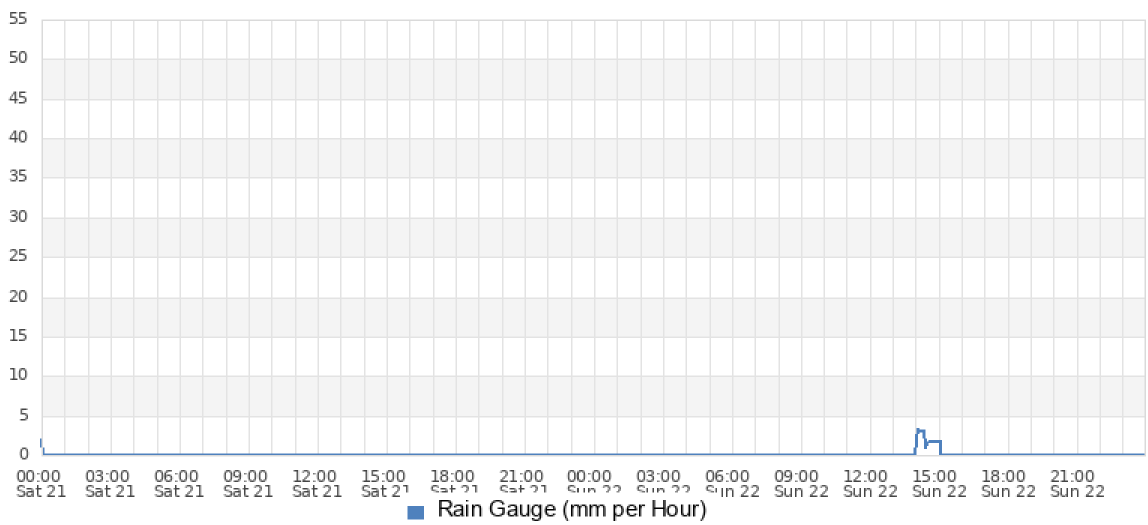
Oct 21 through Oct 22.



Oct 21 through Oct 22.



Oct 21 through Oct 22.



Appendix 5.Gas monitoring results

ID	DATE	CH4 %	CO2 %	O2 %	BALAN %	BARO mb	REL.PRE mb
LVNW008_	22/10/2023	58.7	42.9	0.2	0	1017	-2.52
LVNW007_	22/10/2023	47.8	32.2	3.4	16.6	1017	10.26
LVNW006_	22/10/2023	62	39.4	0.1	0	1018	0
LVNW010_	22/10/2023	60.6	40.6	0	0	1018	-0.62
LVNW005_	22/10/2023	57.4	43.6	0.1	0	1018	-1.97
LVNW004_	22/10/2023	59.1	41.9	0.1	0	1018	-0.02
LVNW307_	22/10/2023	50.2	39.7	1.8	8.3	1018	0.07
LVNW3005	22/10/2023	57.3	42.9	0.3	0	1019	26.07
LVNW3006	22/10/2023	39.2	31.8	4.4	24.6	1019	0.57
LVNW3004	22/10/2023	58.1	42.3	0.1	0	1019	
LVNW3004	22/10/2023	57.5	42.1	0.3	0.1	1019	3.23
LVNW3002	22/10/2023	57.1	37.8	1.1	4	1019	0.05
LVNW3003	22/10/2023	6.4	31.6	6.9	55.1	1020	-0.22
LVNW3001	22/10/2023	1.6	4	18.8	75.6	1019	-0.03
LVNW0009	22/10/2023	60.4	40.3	0.2	0	1019	0.12
LVNW2010	22/10/2023	63.8	33.4	5.5	0	1020	-2.47
LVNW2009	22/10/2023	65	33.4	0.3	1.3	1020	-2.16
LVNW2008	22/10/2023	58.2	34.3	0	7.5	1020	-2.19
LVNW2006	22/10/2023	63.7	36	0.1	0.2	1020	12.7
LVNW2002	22/10/2023	57.7	35.7	0.5	6.1	1020	-2.25
LVNW2001	22/10/2023	46.3	30.3	0.2	23.2	1017	-2.4

WHANGANUI ENVIRONMENTAL ENGINEERING

LEVIN LANDFILL GAS MONITORING

NOVEMBER 2023

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of November, 2023 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedances require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The monitoring mandated by Discharge Permit 6011 consists of two main components: gas well monitoring and surface emission monitoring. Gas well monitoring is an ongoing process that measures the gas flow and pressure in specific gas well heads. This process is minimally affected by weather conditions, especially atmospheric pressure. The surface emission survey is a periodic process that detects and quantifies the gas leaks from the landfill cover. This process requires optimal weather conditions to ensure the reliability and validity of the survey results. Table 1 below specifies the ideal weather parameters for the survey between the resource consent conditions and the Whanganui Environmental Engineering Standard Operating Procedure (SOP) suidelines.

Table 1: Criteria for undertaking a Surface Emission Survey

Criteria	**Resource consent requirements None** ***Note:** *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the survey

3.1 Site Description

Levin landfill occupies approximately 4 Ha of land at 665 Hokio Beach Road, Levin within a 71.5 Ha property. The site contains two landfills: an older, unlined and inactive landfill and a newer, lined and recently closed landfill. The new landfill was constructed in phases and it is the target area for the gas and surface emission monitoring.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector was employed to detect and quantify the methane emission levels. The instantaneous surface emission monitoring was performed following the Standard Operating Procedure for all Landfills. The survey took place on 19th November 2023 from 10.00 a.m. to 2.10 p.m. Pre-planned survey lines directing 20°NE in 25m intervals were used as the primary survey lines along the landfill surface. The survey lines are shifted every month by a pre-determined distance to enable continuation of procedures and reporting from previous surveys. This helps to ensure adequate coverage of the site across the year. Moreover, additional locations with potential high surface emissions such as areas with dead grass, cracked or open clay cover, and eroded slopes were also examined and inspected.

3.3 Gas Well Monitoring

Thirty three gas wells in different stages of the landfill were monitored using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. In certain circumstances other dedicated specialist equipment may be used to help better determine pressure, differential pressure, and flow rates with improved accuracy or to confirm recorded readings. The monitoring is performed once per fortnight.

4. Weather Conditions

The weather data monitoring was based on the following website, which was accessed on 25/12/2023 for the reporting purposes.

https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2023-11-19/2023-11-19/weekly

https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2023-11-19/2023-11-19/daily

The most recent rainfall event recorded by a Levin weather station prior to the survey was 5.8 mm on 18/11/2023. The pressure varied slightly before the survey date from 990.85 hpa to 998.98 hpa. Appendix 3.0 details the complete weather condition before the survey date. On the survey day, the pressure ranged from 997.96 hpa to 1001.35 hpa. The average wind speed was 0.58 m/sec during the survey day. There was no rainfall during the survey. Appendix 4.0 presents the full weather condition on the survey date.

5. Survey Results

The methane surface emission survey on the final cover detected three locations with emissions levels that exceeded those required by the resource consent conditions, and consequently were remediated with bentonite and water to acceptable levels. These locations were found in both bare soil cover and in grass covered areas on the final cover.

Gas well monitoring was conducted according to the pre-arranged dates within the month and 20 wells were monitored. The average CH_4 level was 49.59 % with a maximum of 63 % in LVNW1004 and a minimum of 1.5% in LVNW3001. The average CO_2 level was 33.47% with a maximum of 43.1% in LVNW005 and a minimum of 3.7% in LVNW3001. The average O_2 level was 3.1% with a maximum of 19.1% in LVNW3001 and a minimum of 0% in LVNW006 well. The individual gas values and the total average values may vary due to several factors such as well draw, minor leaks in the line, and the number of active monitoring wells. The number of active monitoring gas wells may vary each month depending on the well head condition or the landfill activity.

Some of the well head sampling ports in stage 1 and stage 2 were damaged and some temporarily fixed gas line leaks required permanent repair to enable gas monitoring for the respective wells.

6. Recommendations

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

Many sites undertake weekly gas well field monitoring and balancing, but the Levin landfill and flare is responding sufficiently well to fortnightly rounds. If surface monitoring indicates a frequently high number of, or a significant increase in, surface leaks, then increasing well monitoring rounds and optimizing the capture and destruction will likely help address this.

Weather conditions and technical issues in the flare system, and gas line repair have been the main limitations for the monitoring. Lack of historic data in continuous monitoring of landfill gas has been another limitation for gas well adjustments and survey planning. All of these can be due to project handover.

Continuous monitoring is essential to track gas well trends and landfill behaviour. The flare influences the gas well performance and the surface emissions significantly. Regular well monitoring and tuning is the key measure for ensuring continuous flare operation, and minimizing surface emissions, and thus is the most critical aspect of gas management in closed and active landfills.

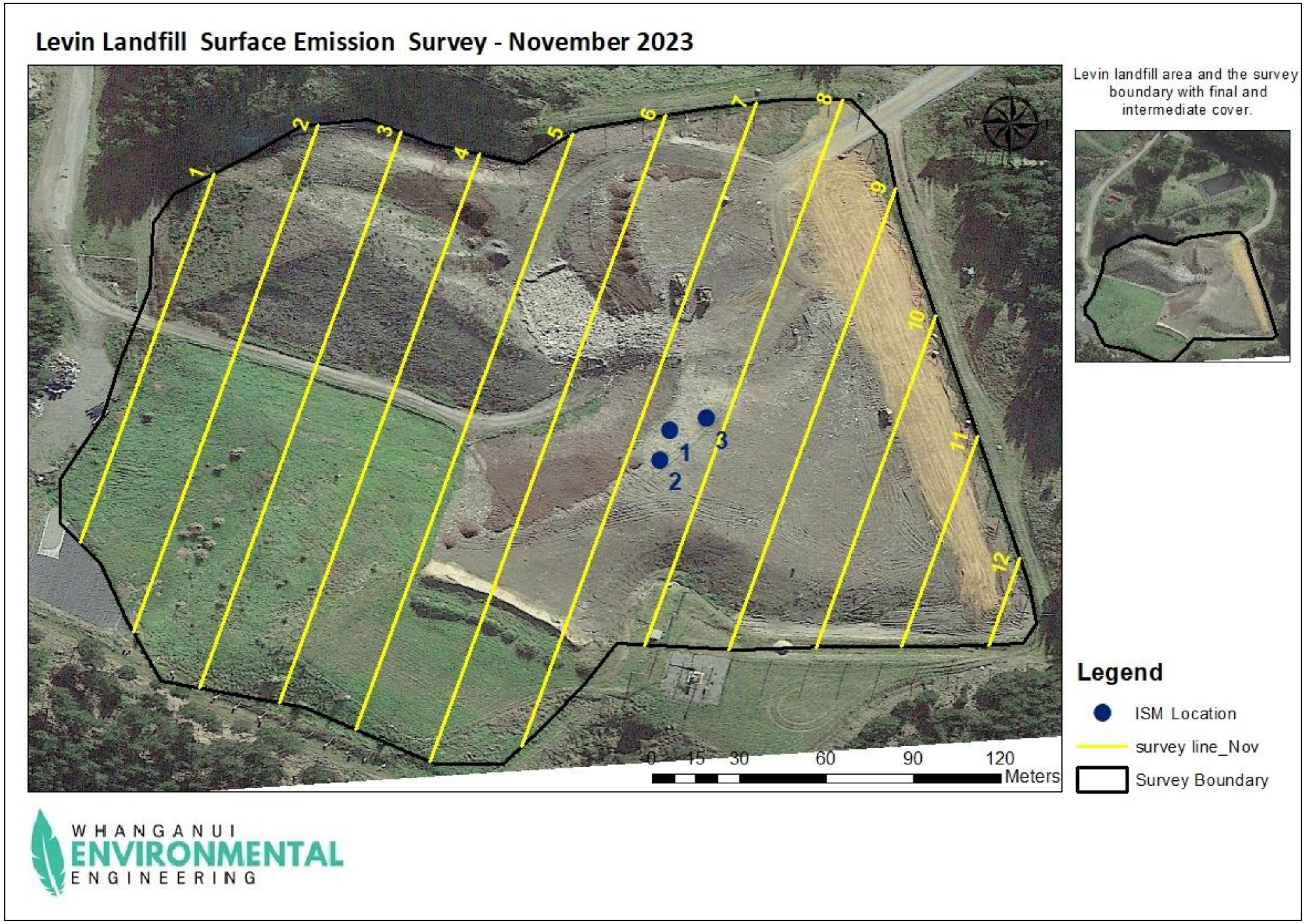
Many sites conduct weekly gas well field monitoring and balancing, but the Levin landfill and flare is adequately responsive to fortnightly rounds. If surface monitoring indicates an increased frequency in the number of, or a substantial increase of in emission readings of surface leaks, then more frequent well monitoring rounds and improved capture and destruction will likely mitigate this issue.

Weather conditions, technical constraints with the flare, and repairs needed in the gas reticulation system have historically been the main limitations for monitoring.

Appendix 1.Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	330ppm		Upper western face in bare soil cover, soil crack	Bentonite and water		15ppm
2	175ppm		Upper western face in bare soil cover,	Bentonite and water		0ppm
3	173ppm		Upper western face in the edge of a previous Bentonite cover and part of the bare soil cover	Bentonite and water		10ppm

Appendix 2.Surface emission map



Appendix 3.Weather conditions preceding the survey

Previous | Weekly Mode | November | 19 | 2023 | View | Next

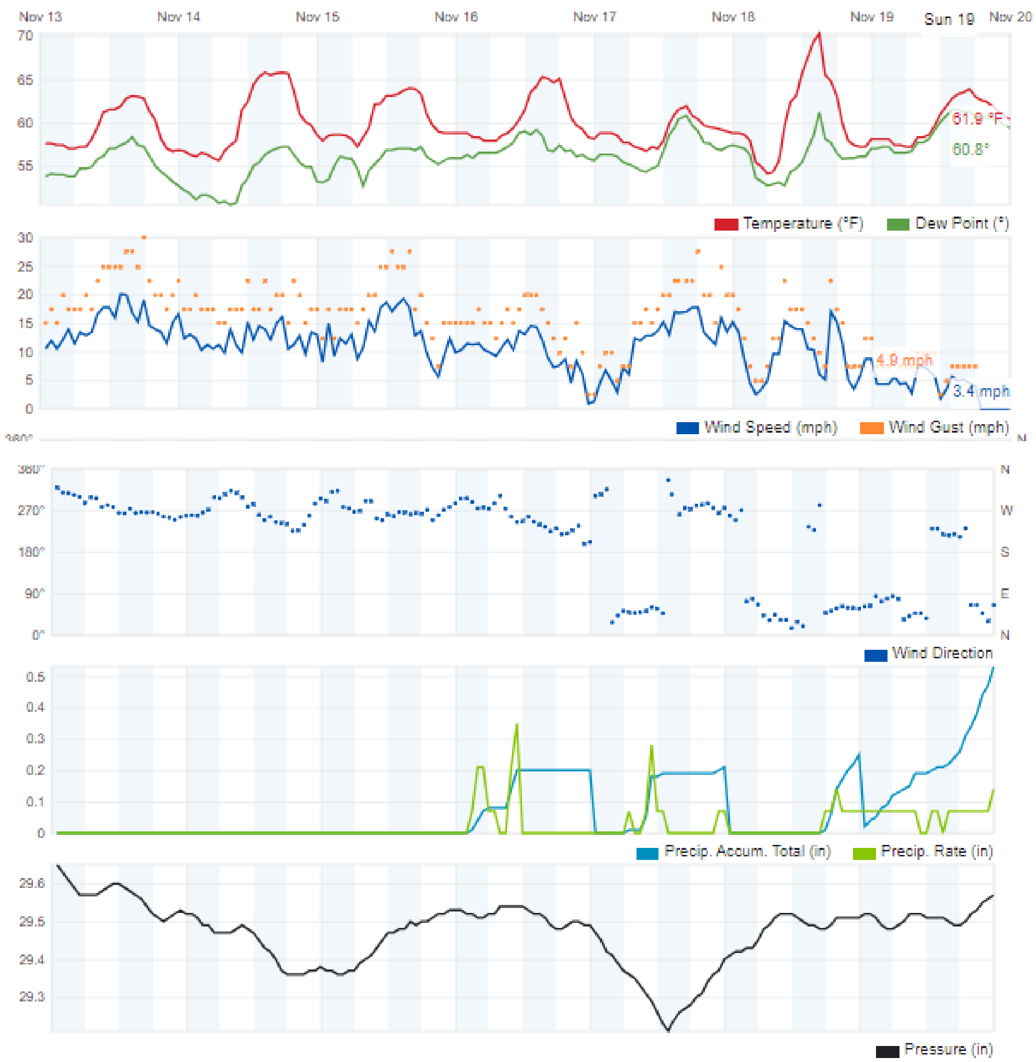
Summary
November 13, 2023 - November 19, 2023

	High	Low	Average
Temperature	70.3 °F	53.4 °F	59.6 °F
Dew Point	61.5 °F	49.6 °F	55.7 °F
Humidity	98 %	59 %	87 %
Precipitation	1.19 in	--	--

	High	Low	Average
Wind Speed	20.1 mph	0.0 mph	4.7 mph
Wind Gust	30.0 mph	--	7.2 mph
Wind Direction	--	--	SSW
Pressure	29.65 in	29.20 in	--

Graph | Table

November 13, 2023 - November 19, 2023



Appendix 4.Weather conditions during the day of survey

Previous | Daily Mode | November | 19 | 2023 | View | Next

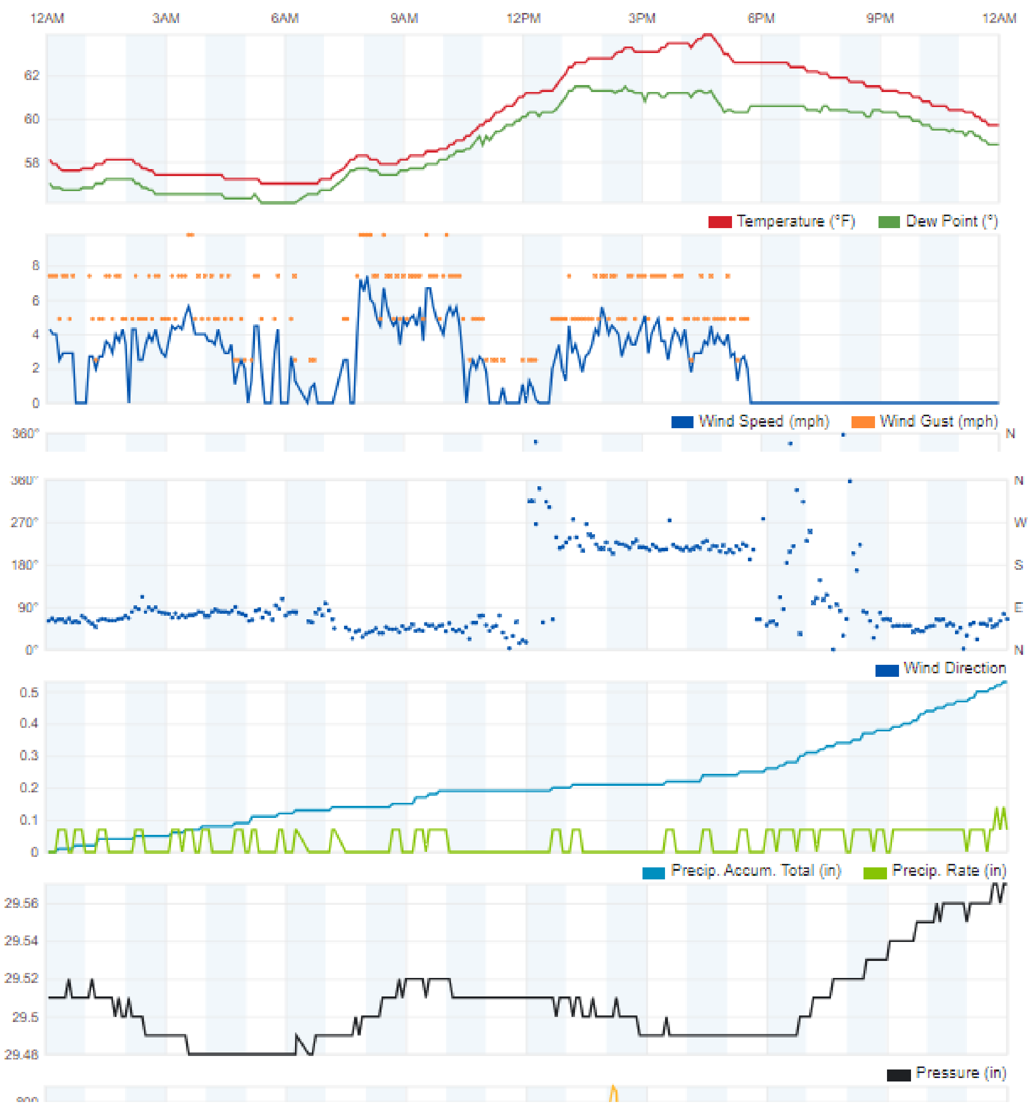
Summary
November 19, 2023

	High	Low	Average
Temperature	63.9 °F	57.0 °F	60.0 °F
Dew Point	61.5 °F	56.1 °F	58.8 °F
Humidity	98 %	91 %	96 %
Precipitation	0.53 in	--	--

	High	Low	Average
Wind Speed	7.4 mph	0.0 mph	1.3 mph
Wind Gust	9.8 mph	--	2.3 mph
Wind Direction	--	--	ENE
Pressure	29.57 in	29.47 in	--

Graph | Table

November 19, 2023



Appendix 5.Gas monitoring results

ID	DATE	CH4 %	CO2 %	O2 %	CO ppm	H2S pp	BARO mb	REL.PRE mb
LVNW1002	19/11/23	57.9	32.3	2.1	3	26	1019	-0.09
LVNW1004	19/11/23	63	35.7	0.2	4	48	1019	0.41
LVNW1006	19/11/23	61.1	36.9	0.2	4	8	1020	0.54
LVNW1007	19/11/23	7.9	5.2	16.6	3	0	1019	1.04
LVNW1008	19/11/23	58.3	37.9	0.8	4	177	1019	0.64
LVNW1009	19/11/23	40.5	23	0.6	3	2	1019	-0.02
LVNW1010	19/11/23	60.2	39.4	0.1	5	242	1019	0.45
LVNW0001	19/11/23	60.1	40.9	0.1	6	328	1018	0.05
LVNW0006	19/11/23	60.9	40.1	0	6	287	1018	3.52
LVNW0007	19/11/23	56.6	35.8	1.6	18	5	1018	0.07
LVNW0008	19/11/23	58	43.1	0.1	10	N/A	1018	0.09
LVNW0005	19/11/23	57.5	43.1	0.3	9	N/A	1018	0.05
LVNW0004	19/11/23	58.5	42.1	0.2	9	N/A	1019	0.35
LVNW3007	19/11/23	15.3	11.1	15.6	5	22	1019	-0.02
LVNW3005	19/11/23	57.6	43.1	0.1	8	898	1019	0.05
LVNW3004	19/11/23	58.3	42.7	0.1	8	886	1019	2.02
LVNW3002	19/11/23	60	40.5	0.3	7	294	1019	0.03
LVNW3001	19/11/23	1.5	3.7	19.1	3	17	1018	-6.53
LVNW3006	19/11/23	38.7	31.5	4.7	36	14	1020	-0.24
LVNW0009	19/11/23	60	41.4	0.1	10	N/A	1020	1.94

LEVIN LANDFILL GAS MONITORING

DECEMBER 2023

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Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of December, 2023 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

The Levin Landfill monthly methane monitoring consent requirements are outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedances require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The monitoring mandated by Discharge Permit 6011 consists of two main components: gas well monitoring and surface emission monitoring. Gas well monitoring is an ongoing process that measures the gas flow and pressure in specific gas well heads. This process is marginally affected by weather conditions, particularly atmospheric pressure. The surface emission survey is a periodic process that detects and quantifies the gas leaks from the landfill cover. This process requires optimal weather conditions to ensure the reliability and validity of the survey results. Table 1 below specifies the ideal weather parameters for the survey between the resource consent conditions and the Whanganui Environmental Engineering Standard Operating Procedure (SOP) guidelines.

Table 1: Criteria for undertaking an Instantaneous Surface Emission Survey

Criteria	**Resource consent requirements None** *****Note: *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Details of the survey

3.1 Site description

Levin landfill occupies approximately 4 Ha of land at 665 Hokio Beach Road, Levin within a 71.5 Ha property. The site contains two landfills: an older, unlined and inactive landfill and a newer, lined and recently closed landfill. The new landfill was constructed in phases and it is the target area for the gas and surface emission monitoring.

3.2 Instantaneous surface emission survey

A Bascom-Turner Gas-Rover detector was employed to detect and quantify the methane emission levels. The instantaneous surface emission monitoring was performed following the Standard Operating Procedure for all Landfills. The survey took place on 31st December 2023 from 09.00 a.m. to 1.30 p.m. Pre-planned survey lines directing 20°NE in 25m intervals were used as the primary survey lines along the landfill surface. The survey lines are shifted every month by a pre-determined distance and direction to enable continuation of procedures and reporting from previous surveys. This helps to ensure adequate coverage of the site across the year. Moreover, additional locations with potentially high surface emissions such as areas with dead grass, cracked or open clay cover, and eroded slopes were also examined and inspected.

3.3 Gas well monitoring

Thirty three gas wells in different stages of the landfill were monitored using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined by the gas content and quality in the well. In certain circumstances, other dedicated specialist equipment may be used to help better determine pressure, differential pressure, and flow rates with improved accuracy or to confirm recorded readings. The monitoring is performed once per fortnight.

4.0 Weather conditions

The weather data monitoring was conducted using the Levin landfill on-site weather station. Prior to the survey commencement, a rainfall event was recorded on 29/12/2023, 4.8 mm rainfall. The pressure within 72 hours before the survey date varied from 1004 hPa to 1020 hPa. On the survey day, the pressure fluctuated between 1005 hPa and 1008 hPa. The average wind speed during the survey day was 1.5 m/s. There was no rainfall during the survey. Appendix 3.0 presents the full weather condition on the survey date.

5.0 Survey results

5.1 Monthly gas monitoring

The methane surface emission survey on the final cover detected two locations with emissions levels that exceeded those required by the resource consent conditions, and consequently were remediated with bentonite and water to acceptable levels. These locations were found in bare soil cover and around the base of a well on the final cover.

Gas well monitoring was conducted on pre-arranged dates within the month, and 30 wells were monitored. The average CH4 level was 39.74 % with a maximum of 68 % in LVNW2005 and a minimum of 0.4% in LVNW2004. The average CO2 level was 29.86% with a maximum of 44.5% in LVNW3005 and a minimum of 0.4% in LVNW2004. The average O2 level was 3.62% with a maximum of 20.5% in LVNW2004 and a minimum of 0% in 15 wells. The individual gas values and the total average values may vary due to several factors such as well draw, minor leaks in the line, and the number of active monitoring wells. The number of active monitoring gas wells may vary each month depending on the well head condition or the landfill activity.

Some of the well head sampling ports in stage 1 and stage 2 were damaged and some temporarily fixed gas line leaks required permanent repair to enable gas monitoring for the respective wells.

5.2 Summary of overall gas monitoring

5.2.1 Gas well monitoring

The average methane percentage was stable at 55% - 56% for the first three months and then dropped slightly to 45% in September before rising to 51% in October. From October to December, the methane percentage decreased gradually to 39%. The general fluctuation of methane percentage is largely dependent on the draw from, and the run-time of, the flare. The number of wells with more than 45% methane in each monitoring round varies depending on the activity around the landfill, and has been decreasing in recent months. This trend has also been observed at several other landfills across New Zealand and is likely to be representative of seasonal weather patterns.

The majority of monitored wells are consistantly over 45% methane, and Table 2 shows the number of wells with more than 45% of methane from the total monitored wells in each month.

Table 2: The number of wells with more than 45% Methane each monitoring round.

Month	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Total monitored wells	30	30	29	27	20	20	29
Number of wells with over 45% Methane	27	26	25	18	17	15	15

The average Carbon Dioxide percentage was fairly consistent for the first three months with around 38% - 36%, and from August to December a gradual drop of average CO_2 percentage from 36% to 28% was observed. Table 3 represents the total number of wells with over 30% CO_2 each month.

Table 3: The number of wells with more than 30% Carbon Dioxide each monitoring round.

Month	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Total monitored wells	30	30	29	27	20	20	29
Number of wells with over 30% CO2	28	29	27	20	19	16	18

Table 4 below represents the change in gas quality, flow rate, pressure, and temperature observed at the flare before and after gas well tuning.

Table 4: Parameters observed at the flare before and after gas well tuning.

Parameter	**Before Gas Well Tuning**	**After Gas Well Tuning**
Oxygen (%)	0.42	0.19
Methane (%)	43	59
Flow Rate (m^3/hour)	64	71
Inlet Pressure (mb)	-2.8	-2.8
Temperature (° Celsius)	471	567

Landfill gas is typically composed of methane (45-60%), carbon dioxide (40% to 60%), with smaller amounts of nitrogen (2% to 5%), oxygen (0.1% to 1%) and other trace gases such as ammonia, sulfides, hydrogen, carbon monoxide, and nonmethane organic compounds. The average gas percentages from the well monitoring data indicate CH4 at 50.43%, CO2 at 34.49% and O2 at 2.44%. These values suggest that most of the waste in the landfill has transitioned from Phase 2 to Phase 3 of bacterial decomposition.

Landfill gas is produced by three processes: bacterial decomposition, which accounts for most of the landfill gas generation; volatilization, the conversion of liquid or solid wastes into vapour; and chemical reactions, such as oxidation, hydrolysis and pyrolysis.

Bacterial decomposition occurs in four phases: Phase I aerobic decomposition, where aerobic bacteria use oxygen to break down organic matter into carbon dioxide and water; Phase II anaerobic acidogenesis, where anaerobic bacteria produce organic acids, hydrogen and carbon dioxide in the absence of oxygen; Phase III anaerobic methanogenesis, where methanogenic bacteria convert organic acids into methane and carbon dioxide; and Phase IV steady state, where the composition and production rates of landfill gas are relatively constant. Phase V occurs when the organic matter is depleted, and oxygen re-enters the landfill.

The following graphs represent the gas quality across selected wells with consistent monitoring results for last six months survey period from each stage of the landfill.

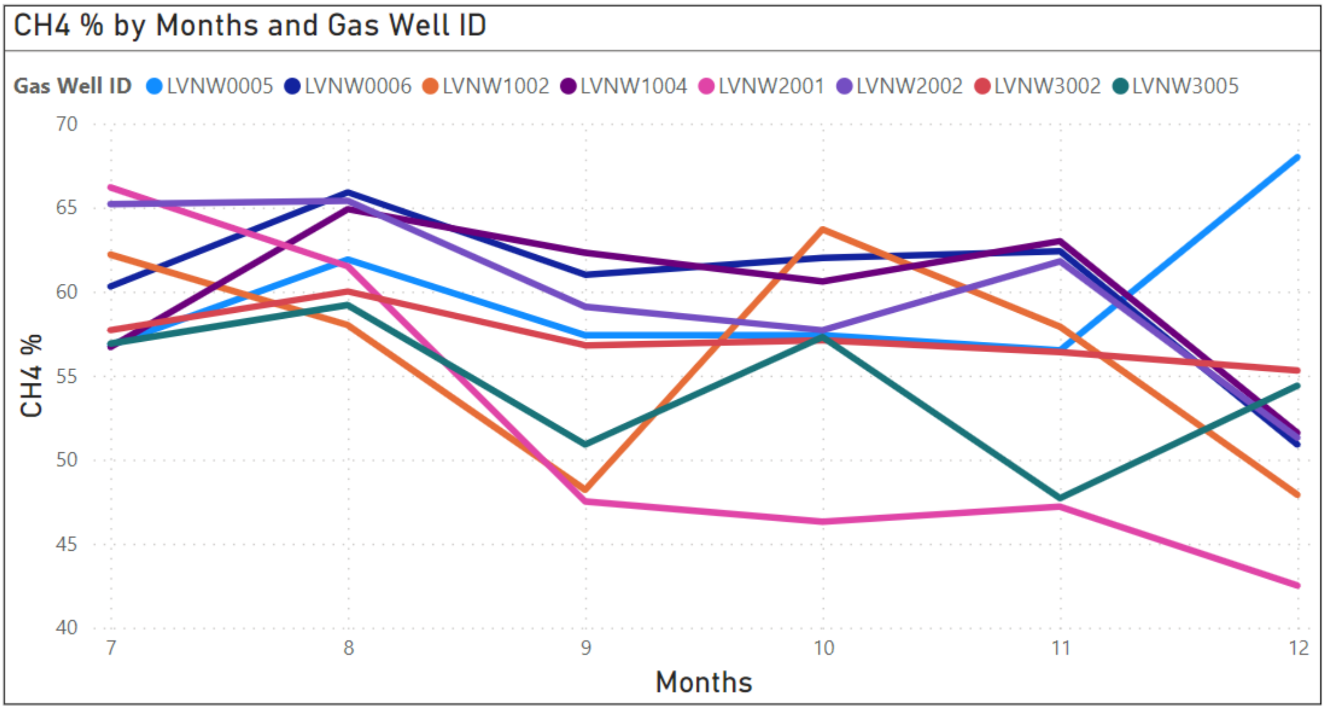


Figure 1: Monthly methane variation by gas well at Levin Landfill during the period of July-December 2023

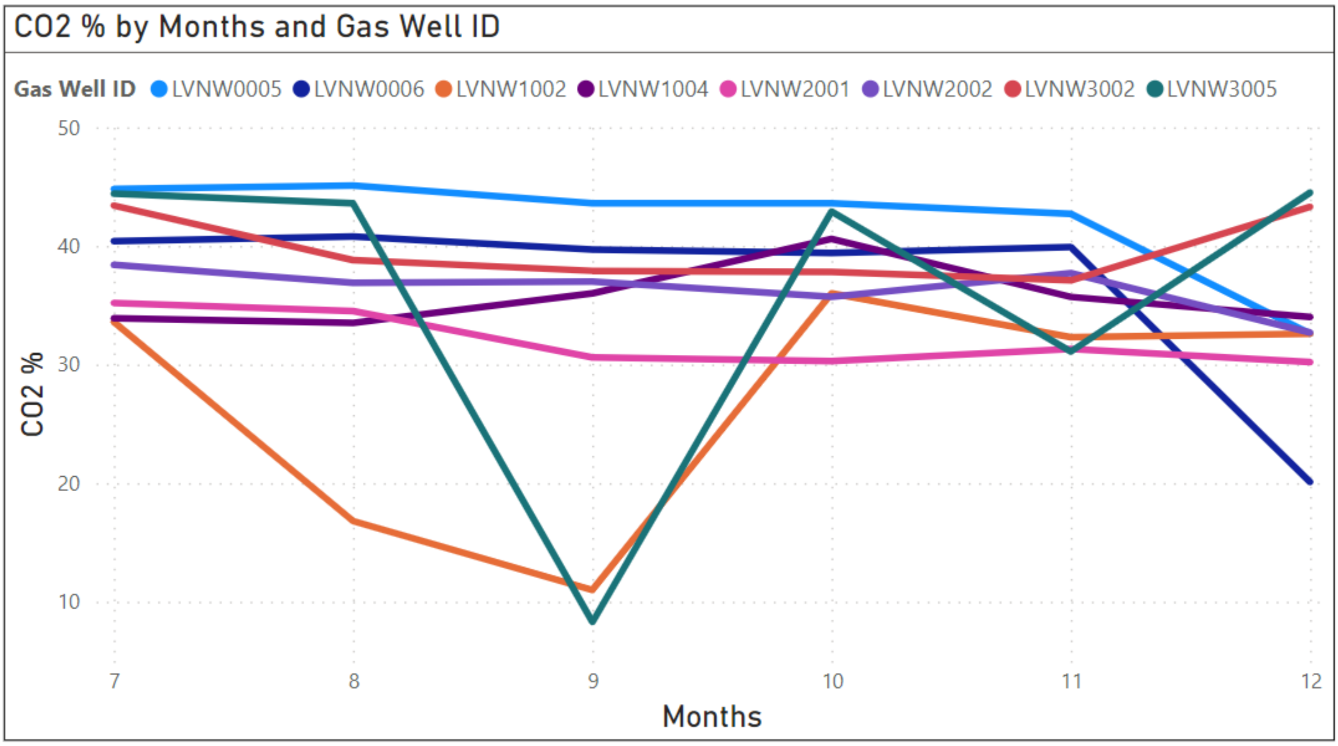


Figure 2: Monthly Carbon Dioxide variation by gas well at Levin Landfill during the period of July-December 2023

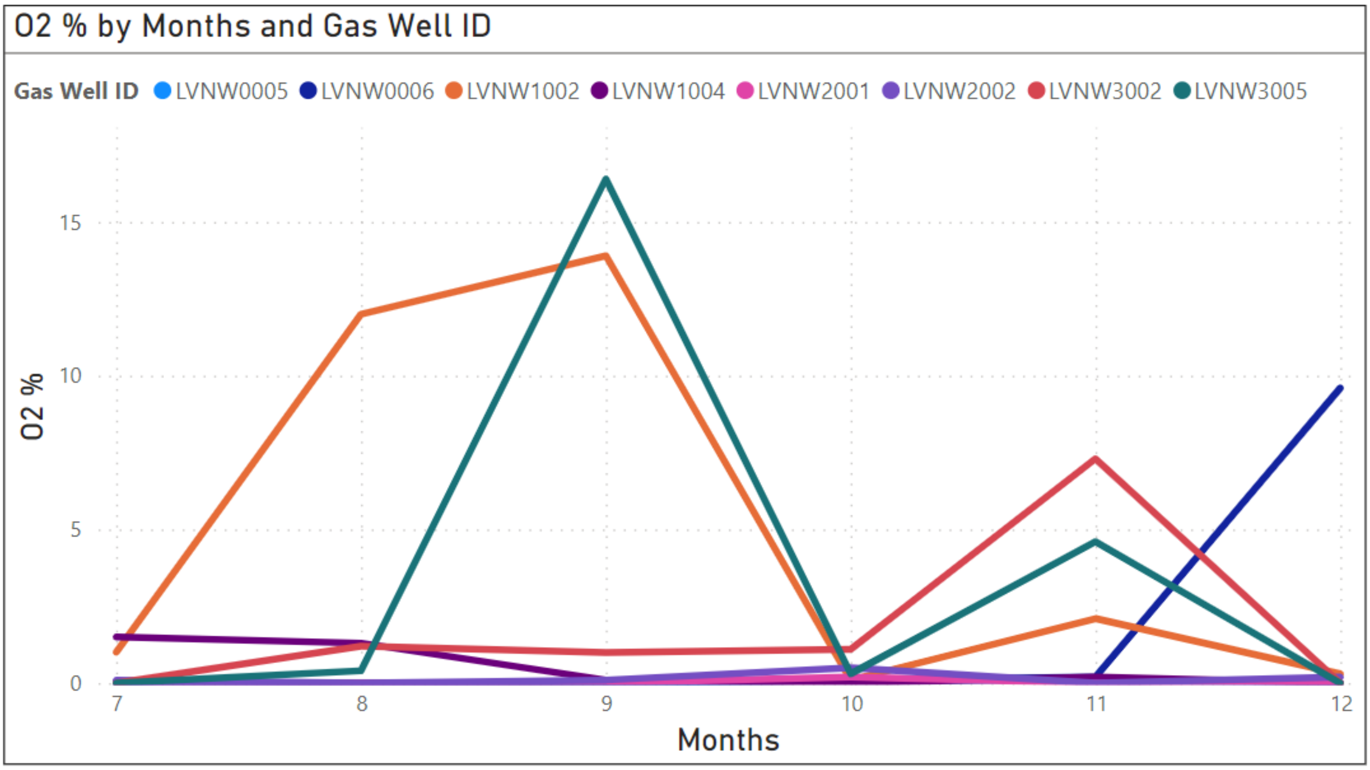


Figure 3: Monthly Oxygen variation by gas well at Levin Landfill during the period of July-December 2023

Oxygen percentage can vary depending on gas line condition, well design, well base condition, and landfill cover. Poor conditions of any of these factors may cause oxygen to be drawn into the gas reticulation system. Therefore, some wells may show highly fluctuating oxygen percentages, while others may show consistent values over the monitoring period.

5.2.2 Instantaneous surface monitoring

During the period from May 2023 to December 2023, 41 ISM locations were identified and remediated. The first survey identified a considerable number of locations due to required improvements in well management and reticulation maintenance prior to the initial ISM survey. This resulted in reduced gas draw from the flare, and considerably high methane emittance through the final and intermediate cover. By monitoring and managing the gas emissions carefully and continuously, and by applying remediation and appropriate gas extraction, the landfill cover has shown a lower amount of gas emissions and fewer locations with high emissions.

Table 5: The number of identified and remediated ISM exceedances each month.

Month	**Identified locations**	**Remediated locations**
May	18	18
June	6	6
July	2	2
August	4	4
September	3	3
October	3	3
November	3	3
December	2	2

6.0 Recommendations and Summary

A decrease in methane production in the gas wells has been observed for the month of December. This decrease has occurred at many landfills across New Zealand and is likely to be reflective of the seasonal weather conditions, namely reduced rainfall events.

The instantaneous surface monitoring survey identified two locations that had exceedances for methane which were remediated with bentonite within 24 hours, in line with the resource consent requirements.

Regular monitoring is essential to maintain high-quality landfill gas wells and an effective gas draw system. The biological activity inside the landfill is sensitive to temperature, the surrounding environment, and the management of gas extraction. To maintain favourable bacteriological activity, it is important to maintain a reliable draw from gas wells and maintain consistency in the environment of the landfill. The current landfill gas monitoring and management processes have been effective at mitigating the environmental impacts of the closed Levin Landfill and it is recommended that these processes continue to be implemented.

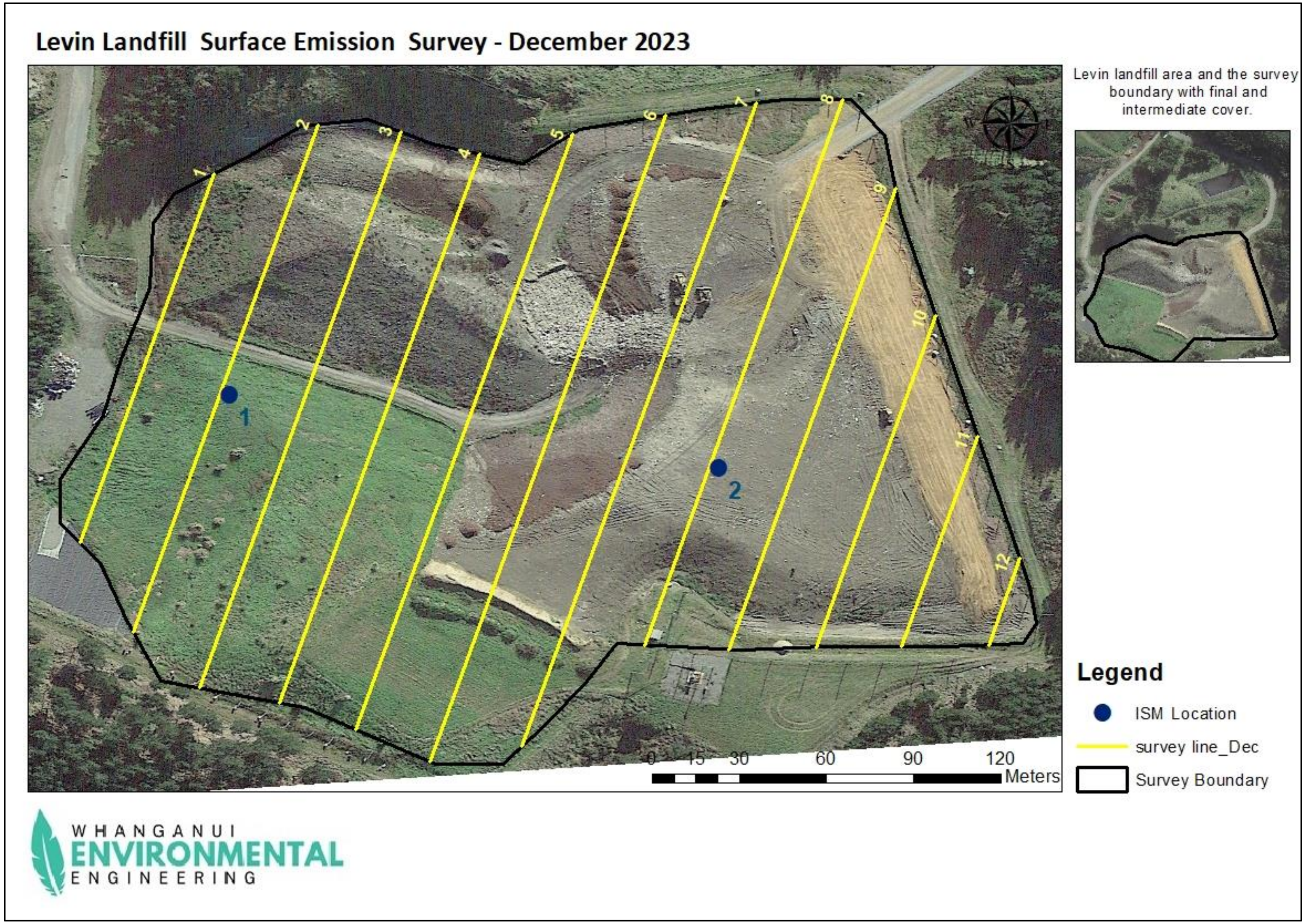
Appropriate maintenance on the gas reticulation network is crucial to conduct continuous and effective draw from the landfill. Repairs and improvements to the gas network system, and cover, are ongoing. Landfill gas inherently presents significant risks such as asphyxiation, poisoning, and explosion. Any unsupervised work to the gas reticulation network, flare, or gas wells should be avoided.

In summary, the Horowhenua District Council has been effective in its management of the environmental impacts of the Levin Landfill and its compliance with the resource consent requirements.

Appendix 1: Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	380ppm		Well base in previous remediated area	Bentonite and water		20ppm
2	210ppm		Upper western face in bare soil cover,	Bentonite and water		15ppm

Appendix 2: Surface emission map



Appendix 3: Weather conditions during the day of survey and preceding the survey

Source:	AAF-748	1	Wind Speed	m /sec			
Daily	First	Last	Diff	Average	Samples	Min	Max
Sun, Dec 31	0.4	2.4	2	1.5	1441	0.4	4.9
Sat, Dec 30	1.4	0.4	-1	2.5	1441	0.4	6.3
Fri, Dec 29	0.4	1.4	1	1.5	1441	0.4	5.1
Thu, Dec 28	0.4	0.4	0	1	1441	0.4	3.8
Wed, Dec 27	1.9	0.4	-1.4	1.4	1441	0.4	4.3
Tue, Dec 26	0.4	1.9	1.5	1.2	1441	0.4	3.7

Source:	AAF-748	2	Wind Direction	Degrees			
Daily	First	Last	Diff	Average	Samples	Min	Max
Sun, Dec 31	238.6	279.2	40.6	217.6	1441	0	348.9
Sat, Dec 30	284.4	238.6	-45.8	289.9	1441	202.6	339.3
Fri, Dec 29	13.9	284.4	270.5	193.6	1441	4.2	351.8
Thu, Dec 28	52.7	13.9	-38.8	151	1441	0	355.3
Wed, Dec 27	281.8	52.7	-229.1	218.3	1441	1.8	355.3
Tue, Dec 26	220.8	281.8	60.9	238.1	1441	1.7	355.2

Source:	AAF-748	3	Air Temperature	C			
Daily	First	Last	Diff	Average	Samples	Min	Max
Sun, Dec 31	18.8	17.2	-1.6	19.2	1441	17.2	21.6
Sat, Dec 30	18.5	18.8	0.3	19.4	1441	18	21.9
Fri, Dec 29	20.5	18.5	-1.9	19.7	1441	16.9	22.7
Thu, Dec 28	15.2	20.5	5.3	20	1441	13.3	27.4
Wed, Dec 27	18.2	15.2	-3	19.7	1441	15.2	24
Tue, Dec 26	18.6	18.2	-0.5	19.9	1441	17.6	22.8

Source:	AAF-748	4	Humidity	Percent RH			
Daily	First	Last	Diff	Average	Samples	Min	Max
Sun, Dec 31	11.1	11.2	0	11.1	1441	10.9	11.4
Sat, Dec 30	11.1	11.1	0	11.1	1441	10.9	11.5
Fri, Dec 29	11.3	11.1	-0.1	11.1	1441	10.9	11.4
Thu, Dec 28	11.3	11.3	0	11.1	1441	10.8	11.5
Wed, Dec 27	11.2	11.3	0.1	11.1	1441	10.8	11.5
Tue, Dec 26	11.4	11.2	-0.2	11.2	1441	10.9	11.4

Source:	AAF-748	5	Barometric Pressure	hpa			
Daily	First	Last	Diff	Average	Samples	Min	Max
Sun, Dec 31	1008	1008	0	1006	1441	1005	1008
Sat, Dec 30	1005	1008	3	1006	1441	1004	1009
Fri, Dec 29	1013	1005	-8	1006	1441	1003	1013
Thu, Dec 28	1019	1013	-7	1017	1441	1013	1020
Wed, Dec 27	1015	1019	4	1017	1441	1014	1019
Tue, Dec 26	1013	1015	2	1013	1441	1011	1015

Source:	AAF-748	6	Rain Gauge		mm per Hour			
Daily	First	Last	Diff		Average	Samples	Min	Max
Sun, Dec 31	0	0		0	0.5	1441	-220.1	32.6
Sat, Dec 30	0	0		0	0	1441	0	0
Fri, Dec 29	0	0		0	0.6	1441	0	4.5
Thu, Dec 28	0	0		0	0	1441	0	0
Wed, Dec 27	0	0		0	0	1441	0	0
Tue, Dec 26	0	0		0	0	1441	0	0

Appendix 4: Gas monitoring results (December)

ID	DATE	CH4 %	CO2 %	O2 %	H2S ppm	CH4/CO2 %	N %	BALANCE %	BARO%
LVNW2001	31/12/2023	42.5	30.2	0	15	1.41	27.3	27.3	1005
LVNW2002	31/12/2023	51.3	32.7	0.2	4	1.57	15.04	15.8	1005
LVNW2004	31/12/2023	0.4	0.4	20.5	3	1	1.21	78.7	1005
LVNW2005	31/12/2023	68	32.6	0	2	2.09	0	0	1005
LVNW2006	31/12/2023	55.3	36.2	0.1	140	1.53	8.02	8.4	1005
LVNW2008	31/12/2023	50	33.7	0	189	1.48	16.3	16.3	1005
LVNW2009	31/12/2023	64	35.5	0	170	1.8	0.5	0.5	1005
LVNW2010	31/12/2023	55.2	44.3	0	1031	1.25	0.5	0.5	1004
LVNW0009	31/12/2023	56.7	37.5	0.4	45	1.51	3.89	5.4	1004
LVNW0008	31/12/2023	57.4	40.9	0	236	1.4	1.7	1.7	1004
LVNW0007	31/12/2023	57.2	41.1	0	245	1.39	1.7	1.7	1004
LVNW0006	31/12/2023	20.9	20.1	9.6	23	1.04	13.11	49.4	1004
LVNW0010	31/12/2023	36.7	32.1	3.3	13	1.14	15.43	27.9	1004
LVNW0666	31/12/2023	1.5	4.2	18.3	15	0.36	6.83	76	1004
LVNW3006	31/12/2023	56.3	38.8	0.4	126	1.45	2.99	4.5	1004
LVNW3001	31/12/2023	7.3	36.2	3.5	17	0.2	39.77	53	1004
LVNW3002	31/12/2023	55.3	43.3	0	598	1.28	1.4	1.4	1004
LVNW3003	31/12/2023	55	44.1	0	640	1.25	0.9	0.9	1004
LVNW3004	31/12/2023	13.2	9.6	16	28	1.38	0.72	61.2	1004
LVNW3005	31/12/2023	54.4	44.5	0	872	1.22	1.1	1.1	1004
LVNW3007	31/12/2023	55.9	43.4	0	1470	1.29	0.7	0.7	1004
LVNW0005	31/12/2023	11.6	21.3	0.7	39	0.54	63.75	66.4	1006
LVNW1010	31/12/2023	40.9	22.8	0	52	1.79	36.3	36.3	1006
LVNW1009	31/12/2023	24	26.6	0	44	0.9	49.4	49.4	1006
LVNW1008	31/12/2023	5.3	4.8	16.5	9	1.1	11.03	73.4	1006
LVNW1007	31/12/2023	42.9	33.5	0	122	1.28	23.6	23.6	1006
LVNW1006	31/12/2023	13.8	9	15.2	12	1.53	4.54	62	1006
LVNW1005	31/12/2023	51.6	34	0	74	1.52	14.4	14.4	1006
LVNW1004	31/12/2023	0	0.1	21.1	11	0	0	78.8	1006
LVNW1002	31/12/2023	47.9	32.6	0.3	126	1.47	18.07	19.2	1006
BHN01	31/12/2023	55.9	39	0	303	1.43	5.1	5.1	1006
BHN02	31/12/2023	54.4	37.8	0	277	1.44	7.8	7.8	1006

LEVIN LANDFILL GAS MONITORING

JANUARY 2024

Prepared by:

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Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of January, 2024 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

Levin Landfill monthly methane monitoring consent requirements are outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedances require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** *****Note: *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a

new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 13th January 2024 from 9.45 a.m. to 2.00 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty three gas wells in different stages of the landfill were monitored by using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Monitoring sessions were conducted fortnightly.

4. Weather conditions

The weather data is based on data from the Levin landfill on site weather station for this reporting.

There was no rain fall recorded 5 days prior to the survey according to the Levin landfill weather station. The pressure slightly fluctuated prior to the survey date from 1020 hpa to 1024 hpa. See Appendix 3.0 for full details of weather conditions prior to the survey date.

During the survey, the average pressure was 1020 hpa and was fairly consistent throughout the day, though slight fluctuations were observed. The average wind speed throughout the survey was 1.3m/sec. There was no rainfall during the survey. See Appendix 3.0 for full details of the weather conditions on the survey date

5. Survey Results

There were 6 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using bentonite and water. The identified high emission locations include bare soil cover, as well as in grass-covered areas on the final and intermediate cover.

Gas well monitoring was conducted according to the prescheduled dates within the month and from 28 wells the average CH_4 level was 41.47 % with the highest of 64.5% in LVNW2008 and the lowest of 0% in LVNW1005. The average CO_2 level was 28.60 % with the highest of 43.7% in LVNW005 and the lowest of 0% in LVNW1005. The average O_2 level was 4.0 % with the highest of 19.8% in LVNW1005 and the lowest of 0% in seven wells (see the appendix 3.0). The individual gas value and total average values can fluctuate due to many reasons such as the draw of the well, as well as the number of monitoring wells. Additionally, the number of live monitoring gas wells undergoing draw can vary each month depending on the well gas quality or the landfill activity.

5.2 Summary of overall gas monitoring

5.2.1 Gas well monitoring

The average methane percentage was stable at 55% - 56% from June to August in 2023 and then dropped up to 45% in September 2023 before rising to 51% in October 2023. From October to December in 2023, the methane percentage decreased gradually to 39%. From December 2023 to January 2024 the average methane level has slightly increased up to 41.47%.

The general fluctuation of methane percentage is largely dependent on the draw from, and the run-time of, the flare. The number of wells with more than 45% methane in each monitoring round varies depending on the activity around the landfill, and has been decreasing in recent months. This trend has also been observed at several other landfills across New Zealand and is likely to be representative of seasonal weather patterns.

The majority of monitored wells are consistently over 45% methane, and Table 1 shows the number of wells with more than 45% of methane from the total monitored wells in six month period.

Table 1: The number of wells with more than 45% Methane each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
Total monitored wells	29	27	20	20	29	28
Number of wells with over 45% Methane	25	18	17	15	15	16

The average Carbon Dioxide percentage was fairly consistent for June to August in 2023 with around 38% - 36%, and from August to December 2023 a gradual drop of average CO_2 percentage from 36% to 28% was observed. Table 2 represents the total number of wells with over 30% CO_2 each month.

Table 2: The number of wells with more than 30% Carbon Dioxide each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
Total monitored wells	29	27	20	20	29	28
Number of wells with over 30% CO2	27	20	19	16	18	17

The following graphs represent the monthly gas quality and gas quality changes from previous month to January in available selected wells from highest and lowest gas quality readings from January survey.

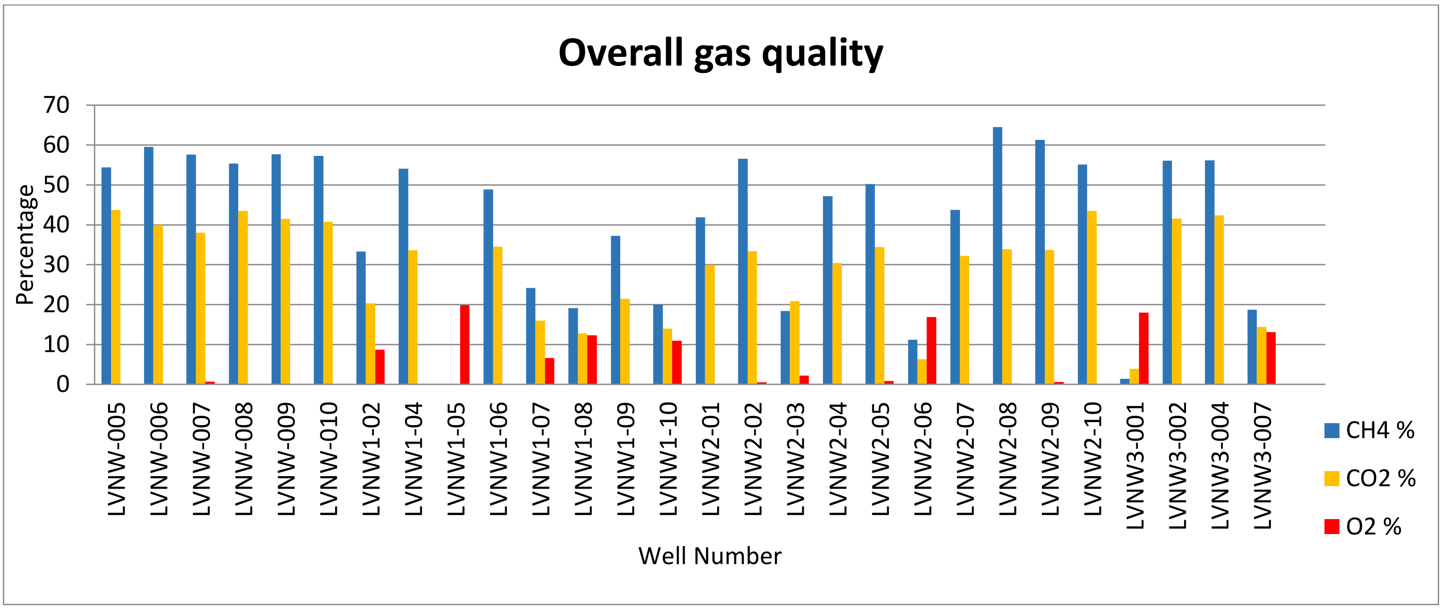


Figure 1: January gas quality in individual wells

The following graph represents the CH4% changes of the highest and lowest value recorded wells from December 2023 to January 2024. Some wells have consistent values of around 50% and some wells fluctuate drastically from low values over 50 % readings. Additionally, the methane percentage dropped from high to lowest below 5% within the period of December to January. These fluctuations occur from the gas flow path change, biological activity changes around well draw perimeter and also change of cover conditions.

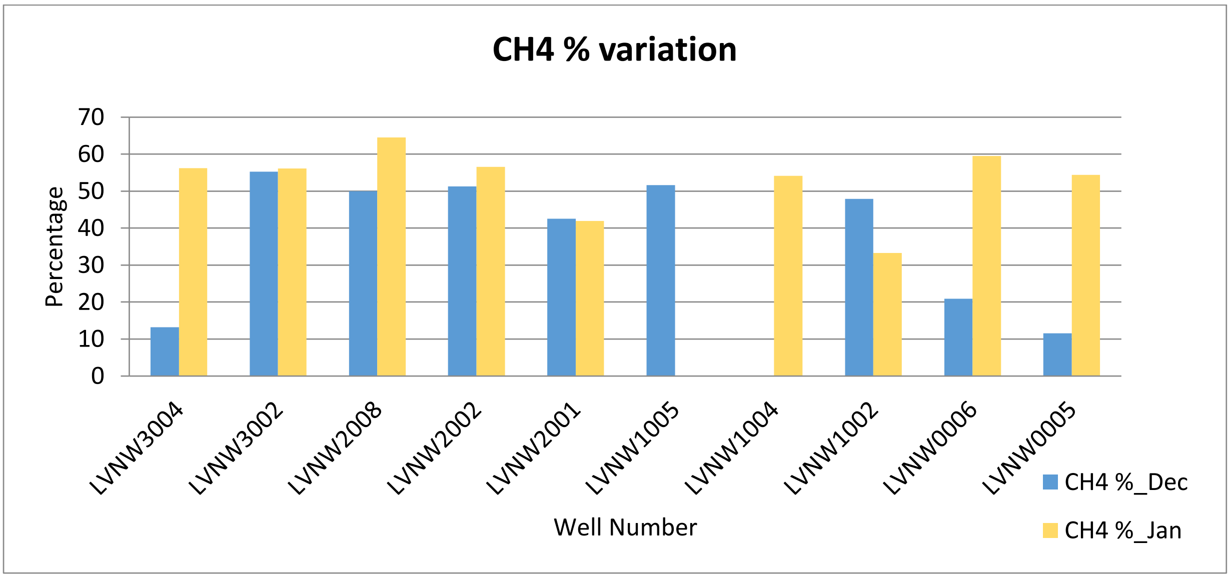


Figure 2: Methane variation from December to January for selected wells

The following graph represents the CO2% changes of the highest and lowest value recorded wells from December 2023 to January 2024. Some wells have consistent values around 30% and some wells fluctuate drastically from low values to over 30 % readings. Also the Carbon Dioxide percentage dropped from high to lowest below 5% within the period of December to January. These fluctuations can occur due to the previous mentioned reasons around well perimeters.

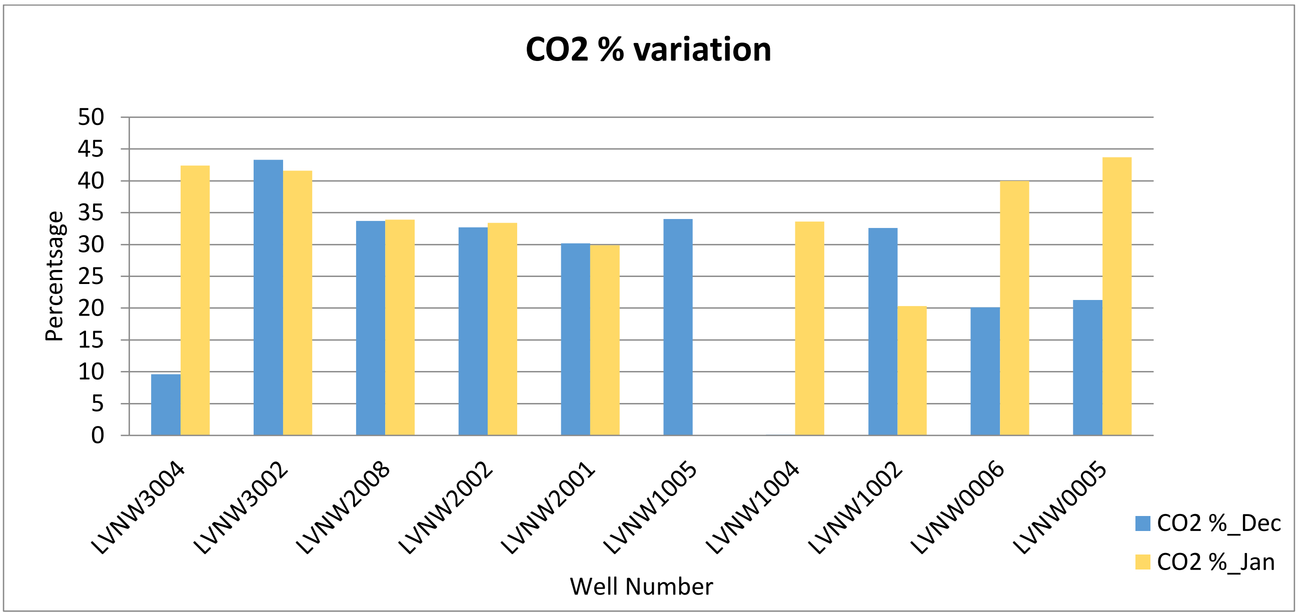


Figure 3: Carbon Dioxide variation from December to January for selected wells

The following graph represents the O2% changes of the highest and lowest value recorded wells from December 2023 to January 2024. Some wells with consistent values around < 5% and some wells fluctuate drastically from low values to over 10 % readings. Oxygen percentage can vary depending on gas line condition, well design, well base condition, and landfill cover. Poor conditions of any of these factors may cause oxygen to be drawn into the gas reticulation system. Therefore, some wells may show highly fluctuating oxygen percentages, while others may show consistent values over the monitoring period.

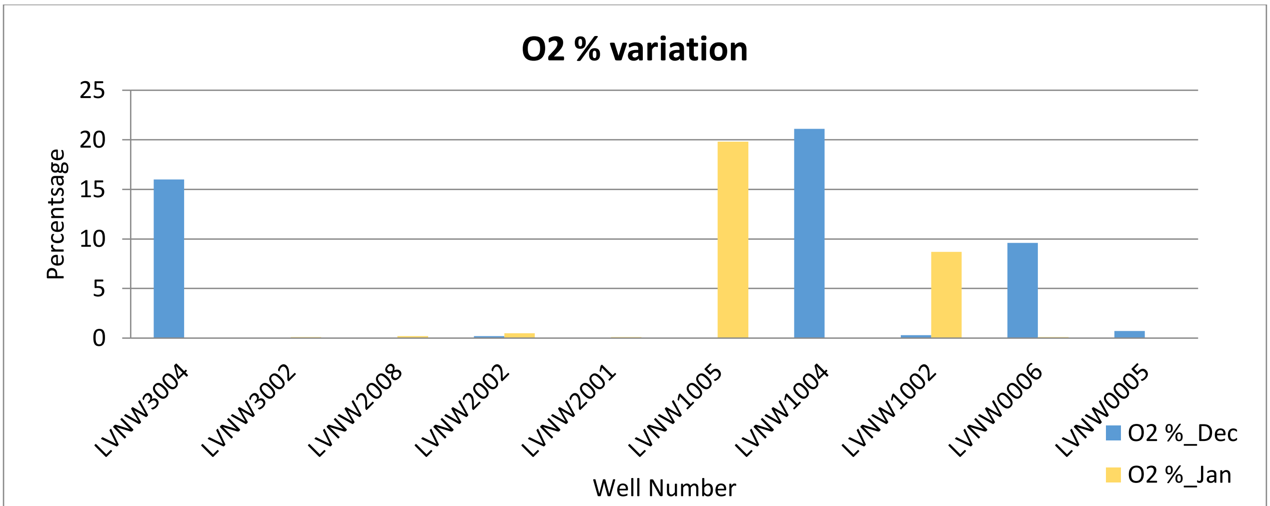


Figure 4: Oxygen percentage variation from December to January for selected wells

5.2.2 Instantaneous surface monitoring

During the period from May 2023 to January 2024, 47 ISM locations were identified and remediated. Compared to December there is a slight increase of high emission areas possibly due to the dry conditions, causing preferential pathways through or capping, but also due to several wells being disconnected while final capping was being placed.

Table 3: The number of identified and remediated ISM exceedances each month.

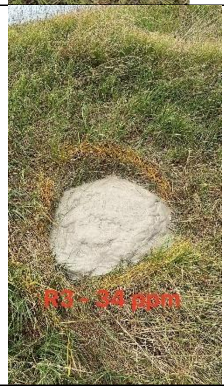
Month	**Identified locations**	**Remediated locations**
May2023	18	18
June 2023	6	6
July 2023	2	2
August 2023	4	4
September 2023	3	3
October 2023	3	3
November 2023	3	3
December 2023	2	2
January 2024	6	6

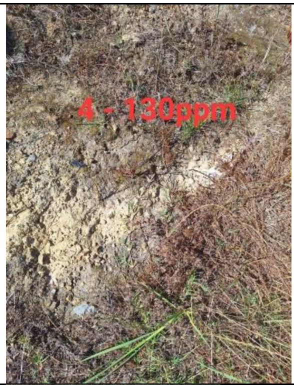
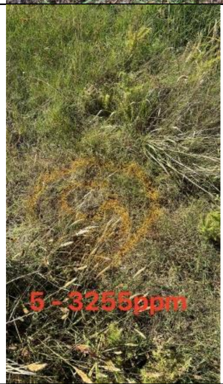
6. Recommendations

Most changes observed this month, namely the slight increase in ISM locations, were expected due to the placement of final capping, and the disconnection of several wells throughout this process. Once the final capping process has been completed, these wells will be reconnected and brought back online.

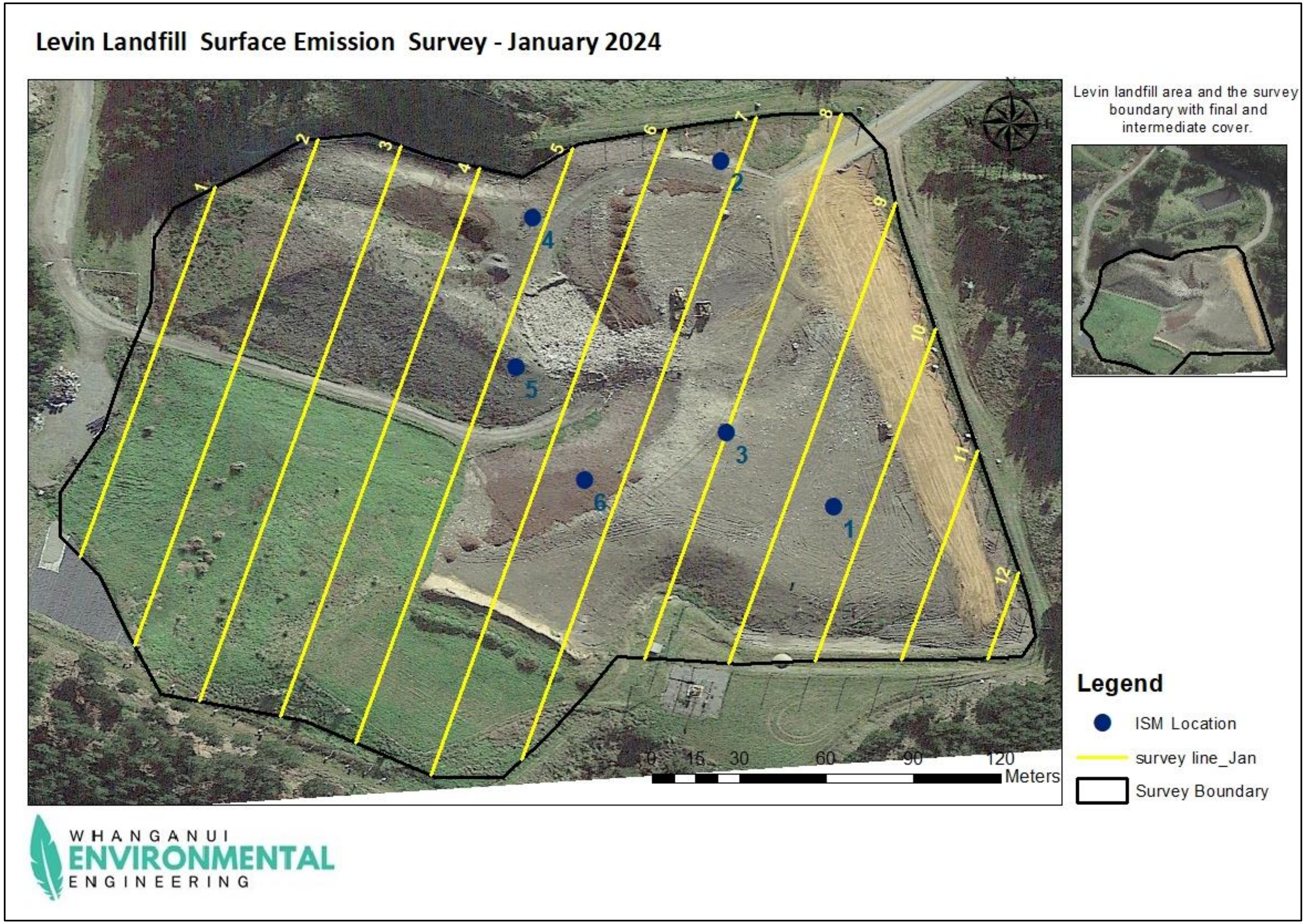
Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular gas well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

Appendix 1. Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	320ppm		South Eastern edge of the landfill, in a dead grass patch	Bentonite and water		18ppm
2	249ppm		North Eastern edge of the landfill, Northern face closer to access road, in a grass patch	Bentonite and water		24ppm
3	400ppm		Middle of the landfill, Southern face, in a grass covered area	Bentonite and water		34ppm

4	130ppm		North edge of the landfill, Northern face closer to access road, in bare soil cover	Bentonite and water		13ppm
5	325ppm		Middle of the landfill, upper western face, in a grass covered area	Bentonite and water		7ppm
6	331ppm		Southern face of the landfill, in bare soil cover	Bentonite and water		12 ppm

Appendix 2.Surface emission map

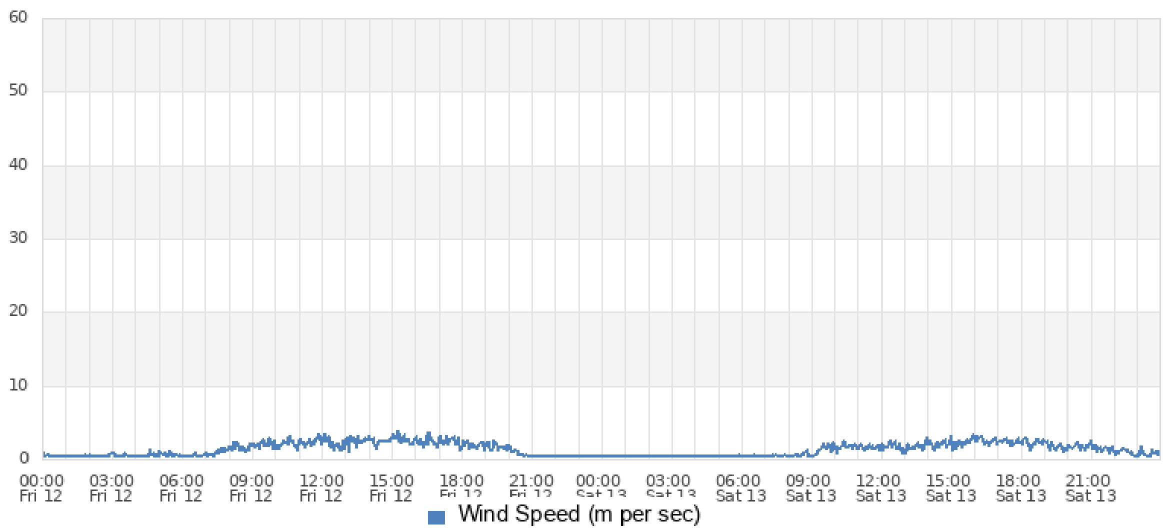


Appendix 3. Weather condition prior to the survey and during the survey

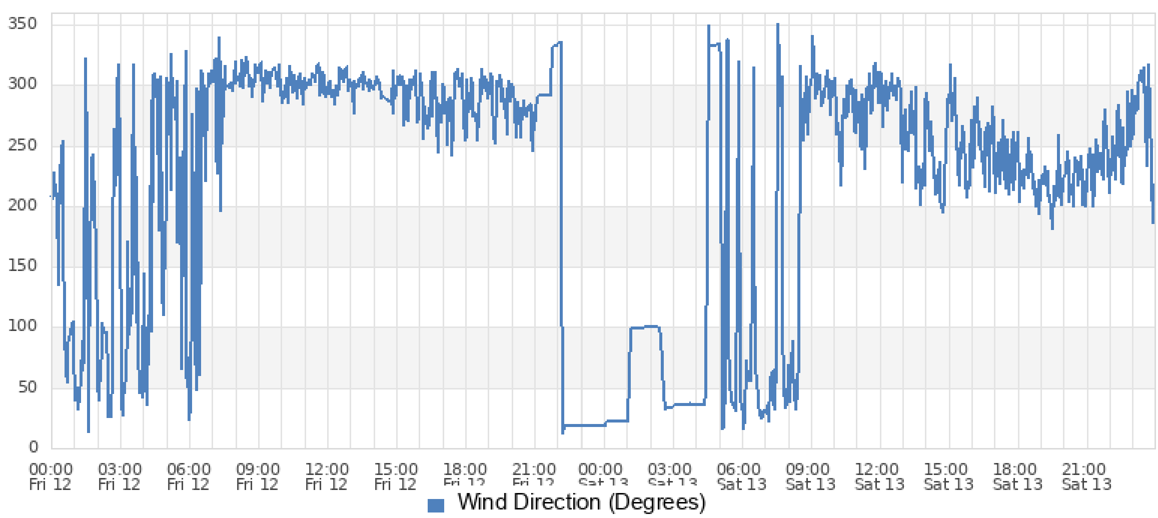
This report includes data up to Jan 14 2024 at 00:00 (UTC+13:00)

Daily weather report

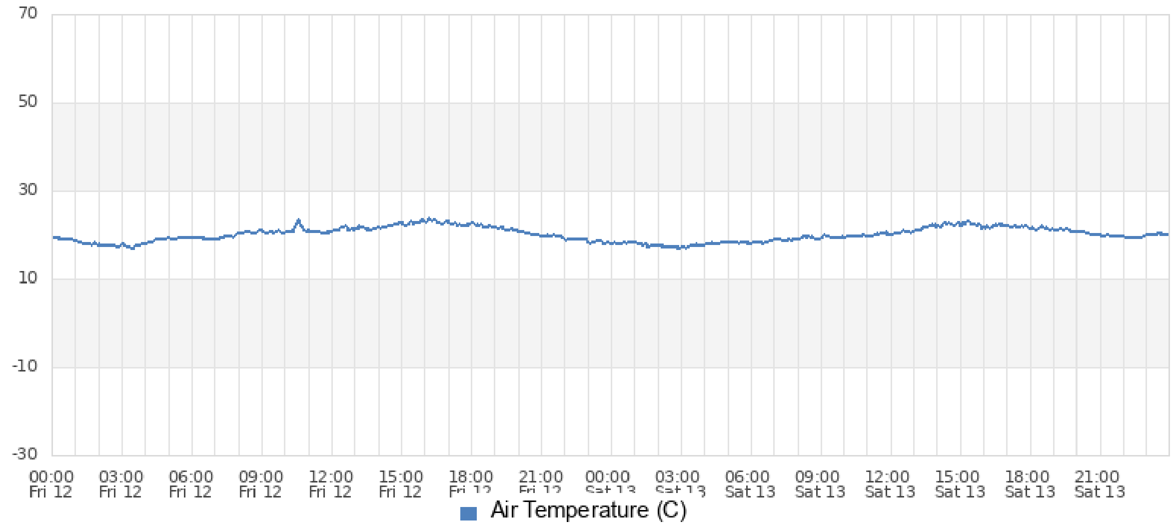
Jan 12 through Jan 13.



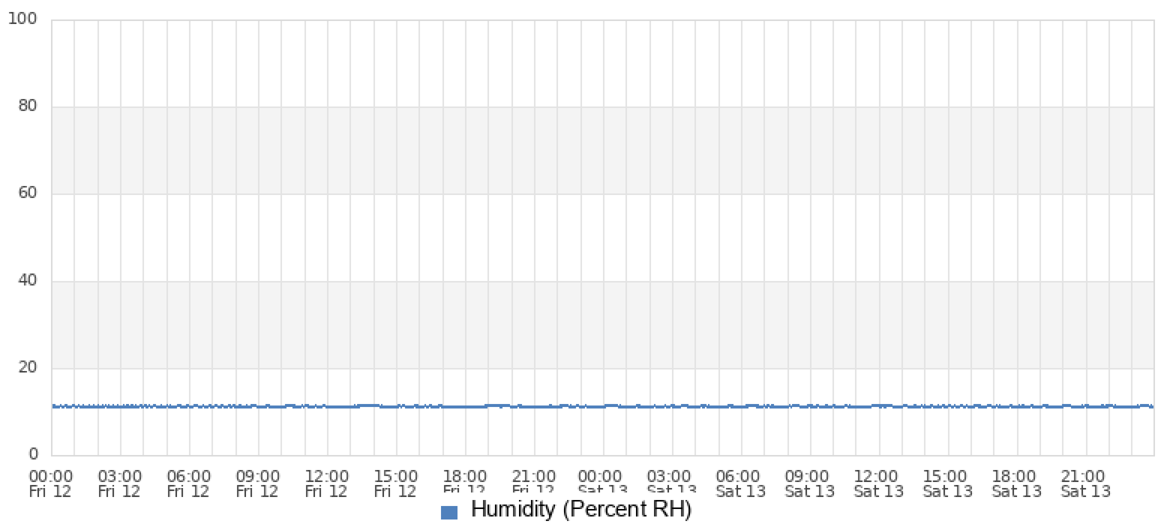
Jan 12 through Jan 13.



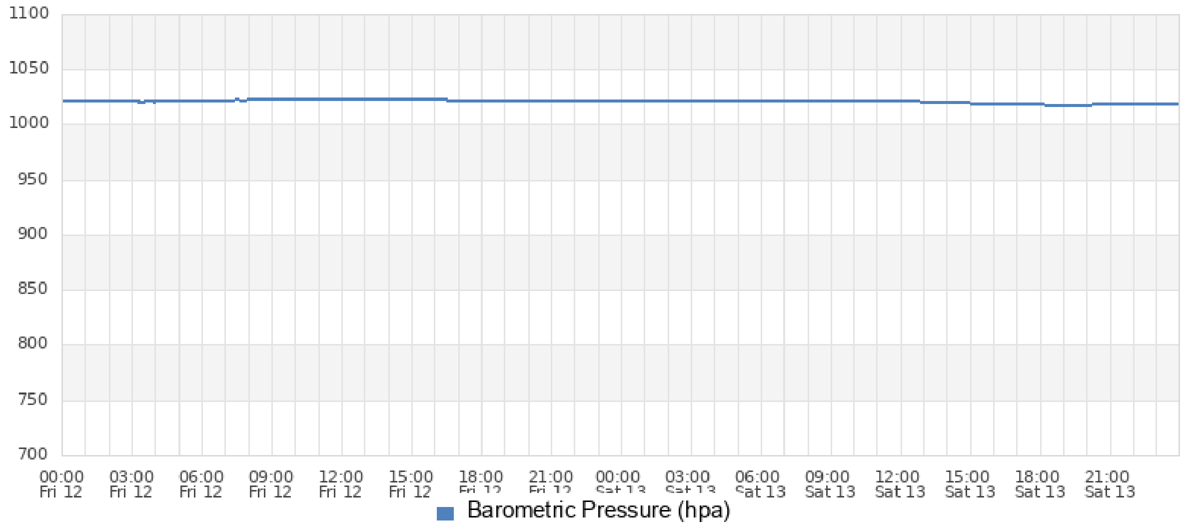
Jan 12 through Jan 13.



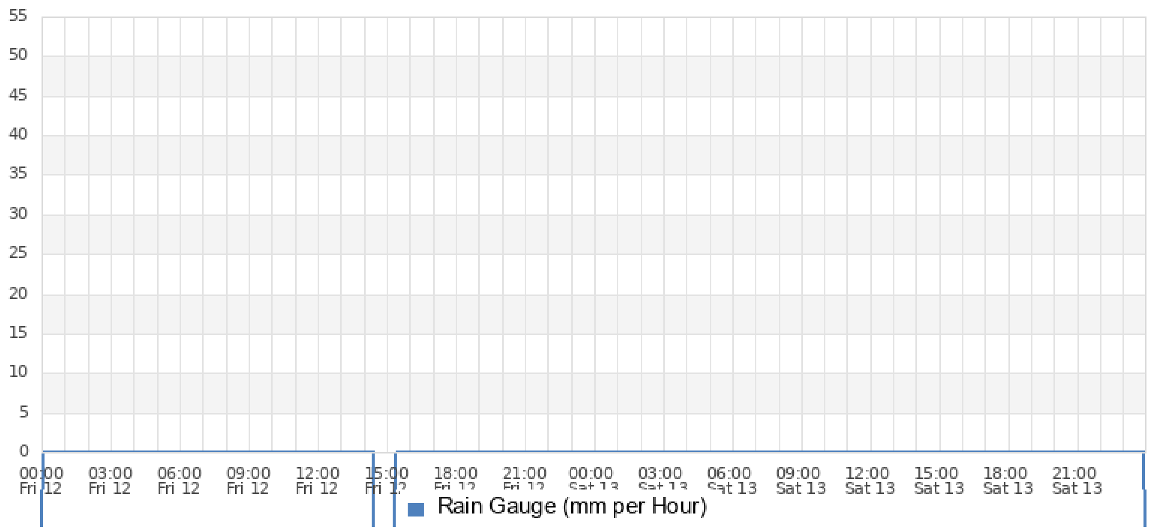
Jan 12 through Jan 13.



Jan 12 through Jan 13.



Jan 12 through Jan 13.



Statistics for AAF-748:1 Wind Speed (m per sec)

Daily	First	Last	Diff	Average	Samples	Min	Max
Mon, Jan 08	0.4	0.4	0.0	1.1	1441	0.4	4.5
Tue, Jan 09	0.4	0.4	0.0	1.3	1441	0.4	4.3
Wed, Jan 10	0.4	0.4	0.0	1.1	1441	0.4	3.5
Thu, Jan 11	0.4	0.6	0.2	1.4	1440	0.4	4.6
Fri, Jan 12	0.6	0.4	-0.2	1.4	1416	0.4	4.9
Sat, Jan 13	0.4	0.4	0.0	1.3	1440	0.4	4.2

Statistics for AAF-748:2 Wind Direction (Degrees)

Daily	First	Last	Diff	Average	Samples	Min	Max
Mon, Jan 08	79.6	160.7	81.1	217.5	1441	0.1	354.2
Tue, Jan 09	160.7	174.9	14.2	203.0	1441	5.5	353.2
Wed, Jan 10	174.9	333.3	158.4	166.0	1441	0.0	355.3
Thu, Jan 11	333.3	193.9	-139.3	214.5	1440	0.0	355.2
Fri, Jan 12	193.9	19.1	-174.9	234.9	1416	0.6	354.5
Sat, Jan 13	19.1	263.6	244.5	196.3	1440	15.4	354.2

Statistics for AAF-748:3 Air Temperature (C)

Daily	First	Last	Diff	Average	Samples	Min	Max
Mon, Jan 08	15.1	17.0	2.0	19.3	1441	12.7	25.9
Tue, Jan 09	17.0	17.3	0.2	19.8	1441	15.5	24.7
Wed, Jan 10	17.3	19.2	1.9	20.6	1441	14.2	26.1
Thu, Jan 11	19.2	19.4	0.2	20.7	1440	18.0	24.1
Fri, Jan 12	19.4	18.0	-1.4	20.2	1416	17.0	23.8
Sat, Jan 13	18.0	19.9	2.0	19.8	1440	17.0	23.1

Statistics for AAF-748:4 Humidity (Percent RH)

Daily	First	Last	Diff	Average	Samples	Min	Max
Mon, Jan 08	11.1	11.1	0.0	11.1	1441	10.8	11.5
Tue, Jan 09	11.1	11.1	0.0	11.1	1441	10.8	11.5
Wed, Jan 10	11.1	11.0	-0.1	11.1	1441	10.8	11.5
Thu, Jan 11	11.0	11.0	0.0	11.2	1440	10.8	11.5
Fri, Jan 12	11.0	11.2	0.1	11.1	1416	10.8	11.5
Sat, Jan 13	11.2	11.1	-0.1	11.2	1440	10.8	11.5

Statistics for AAF-748:5 Barometric Pressure (hpa)

Daily	First	Last	Diff	Average	Samples	Min	Max
Mon, Jan 08	1021	1022	1	1022	1441	1020	1023
Tue, Jan 09	1022	1023	1	1022	1441	1021	1023
Wed, Jan 10	1023	1022	0	1023	1441	1021	1024
Thu, Jan 11	1022	1021	-1	1022	1440	1021	1023
Fri, Jan 12	1021	1022	1	1022	1416	1021	1023
Sat, Jan 13	1022	1019	-3	1020	1440	1018	1022

Statistics for AAF-748:6 Rain Gauge (mm per Hour)

Daily	First	Last	Diff	Average	Samples	Min	Max
Mon, Jan 08	0.0	0.0	0.0	0.0	1441	0.0	0.0
Tue, Jan 09	0.0	0.0	0.0	0.0	1441	0.0	0.0
Wed, Jan 10	0.0	0.0	0.0	0.0	1441	0.0	0.0
Thu, Jan 11	0.0	0.0	0.0	0.0	1440	0.0	0.0
Fri, Jan 12	0.0	0.0	0.0	-10.3	1416	-440.1	0.0
Sat, Jan 13	0.0	0.0	0.0	0.0	1440	0.0	0.0

Appendix 4.Gas monitoring results for January 2024

ID	DATE	CH4 %	CO2 %	O2 %	BALANCE %	PEAKCH4	PEAKCO2	MIN O2	BARO mb
LVNW-006	13/01/2024	59.5	40	0.1	0.4	59.5	40	0.1	1020
LVNW2-01	13/01/2024	41.9	29.9	0.1	28.1	41.9	30.2	0.1	1021
LVNW2-02	13/01/2024	56.6	33.4	0.5	9.5	56.6	33.4	0.5	1021
LVNW2-03	13/01/2024	18.4	20.9	2.2	58.5	56.7	34.6	0.6	1021
LVNW2-04	13/01/2024	47.2	30.4	0.1	22.3	47.2	30.4	0.1	1021
LVNW2-05	13/01/2024	50.2	34.4	0.8	14.6	50.2	35.9	0.1	1021
LVNW2-06	13/01/2024	11.2	6.3	16.9	65.6	48.9	33.6	0.9	1021
LVNW2-07	13/01/2024	43.7	32.2	0.1	24	43.7	32.2	0.1	1021
LVNW2-08	13/01/2024	64.5	33.9	0.2	1.4	64.6	34.3	0.1	1021
LVNW2-09	13/01/2024	61.3	33.7	0.6	4.4	64.9	33.7	0.3	1021
LVNW2-10	13/01/2024	55.1	43.5	0.1	1.3	55.1	43.5	0.1	1020
LVNW-008	13/01/2024	55.4	43.5	0	1.1	55.4	43.6	0	1020
LVNW-007	13/01/2024	57.6	38	0.7	3.7	60.3	40.1	0.7	1018
LVNW-009	13/01/2024	57.7	41.5	0	0.8	57.7	41.5	0	1018
LVNW3-001	13/01/2024	1.4	3.9	18	76.7	53.2	38.8	0.6	1018
LVNW3-002	13/01/2024	56.1	41.6	0.1	2.2	56.1	41.6	0.1	1018
LVNW3-004	13/01/2024	56.2	42.4	0	1.4	56.2	42.4	0	1018
LVNW3-007	13/01/2024	18.7	14.4	13.1	53.8	55.8	41.5	0.1	1018
LVNW-005	13/01/2024	54.4	43.7	0	1.9	54.4	43.8	0	1018
LVNW-010	13/01/2024	57.3	40.8	0	1.9	57.3	40.8	0	1018
LVNBNH02	13/01/2024	50.9	36.4	0.2	12.5	50.9	36.4	0.2	1020
LVNBNH01	13/01/2024	50.6	32.2	0	17.2	50.6	32.2	0	1020
LVNFLARE	13/01/2024	50.8	35.3	0.1	13.8	50.9	35.4	0.1	1020
LVNW1-02	13/01/2024	33.3	20.3	8.7	37.7	33.3	20.3	8.7	1020
LVNW1-04	13/01/2024	54.1	33.6	0	12.3	54.1	33.6	0	1020
LVNW1-05	13/01/2024	0	0	19.8	80.2	55.1	34.9	0.1	1020
LVNW1-06	13/01/2024	48.9	34.5	0.1	16.5	48.9	34.6	0.1	1020
LVNW1-07	13/01/2024	24.2	16	6.6	53.2	48.9	34.8	0.1	1020
LVNW1-08	13/01/2024	19.1	12.8	12.3	55.8	25.1	17.4	6.6	1020
LVNW1-09	13/01/2024	37.2	21.4	0.1	41.3	37.2	21.4	0.1	1020
LVNW1-10	13/01/2024	20	14	10.9	55.1	37.1	21.4	0	1020

WHANGANUI
ENVIRONMENTAL
ENGINEERING

LEVIN LANDFILL GAS MONITORING

FEBRUARY 2024

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Environmental Engineer

Contents

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The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

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Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Details of the survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission Survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 10th February 2024 from 9.00 a.m. to 2.00 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty two gas wells in different stages of the landfill were monitored using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used is determined by the gas content and quality in the well. Monitoring sessions were conducted fortnightly.

4.0 Weather conditions

The meteorological data utilized in this report is sourced from the Levin landfill's on-site weather station. There was no recorded rainfall in the three days leading up to the survey. Additionally, the atmospheric pressure exhibited a gradual increase from 1011.5 hPa to 1043 hPa prior to the survey date. For comprehensive insights into the pre-survey weather conditions, please refer to Appendix 3.0.

During the survey itself, the average atmospheric pressure remained at 1011 hPa, gradually declining from the initial 1043 hPa. The average wind speed observed throughout the survey period was 2.6 m/s, and no precipitation occurred during this time. Detailed information regarding the weather conditions on the survey date can be found in Appendix 3.0.

5.0 Survey Results

There were 3 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using Bentonite and water. The identified high emission locations include in bare soil cover, as well as in grass-covered areas on the final and intermediate cover.

Gas well monitoring was conducted according to the prescheduled dates within the month and from 32 wells the average CH_4 level was 51.23 % with the highest of 66.4% in LVNW2010 and the lowest of 0.1% in LVNW3006. The average CO_2 level was 33.24 % with the highest of 44.4% in LVNW005 and the lowest of 0% in LVNW1005. The average O_2 level was 2.29 % with the highest of 20.5% in LVNW3006 and the lowest of 0% in ten wells (see the appendix 3). The individual gas value and total average values can fluctuate due to many reasons such as the draw of the well, as well as the number of monitoring wells. Additionally, the number of live monitoring gas wells undergoing draw can vary each month depending on the well gas quality or the landfill activity.

5.2 Summary of Overall Gas Monitoring

5.2.1 Gas Well Monitoring

The average methane percentage was stable at 55% - 56% from June to August in 2023 and then dropped to 45% in September 2023 before rising again to 51% in October 2023. From October to December in 2023, the methane percentage decreased gradually to 39%. From December 2023 to January 2024 the average methane level has slightly increased up to 41.47% and further increased in February up to 51.23%.

The general fluctuation of methane percentage is largely dependent on the draw from, and the run-time of, the flare. The number of wells with more than 45% methane in each monitoring round varies depending on the activity around the landfill, and has been increased significantly during this month.

The majority of monitored wells are consistently over 45% methane, and Table 1 shows the number of wells with over 45% of methane from the total monitored wells in the six month period.

Table 1: The number of wells with more than 45% Methane each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Total monitored wells	29	27	20	20	29	28	32
Number of wells with over 45% Methane	25	18	17	15	15	16	26

The average Carbon Dioxide percentage was fairly consistent for June to August in 2023 with around 38% - 36%, and from August to December 2023 a gradual drop of average CO_2 percentage from 36% to 28% was observed. During the month of February the percentage has gradually increased up to 33.24.

Table 2 represents the total number of wells with over 30% CO_2 each month.

Table 2: The number of wells with more than 30% Carbon Dioxide each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Total monitored wells	29	27	20	20	29	28	32
Number of wells with over 30% CO2	27	20	19	16	18	17	25

The following graphs represent the monthly gas quality and gas quality changes from previous months to January in available selected wells from highest and lowest gas quality readings from the January survey.

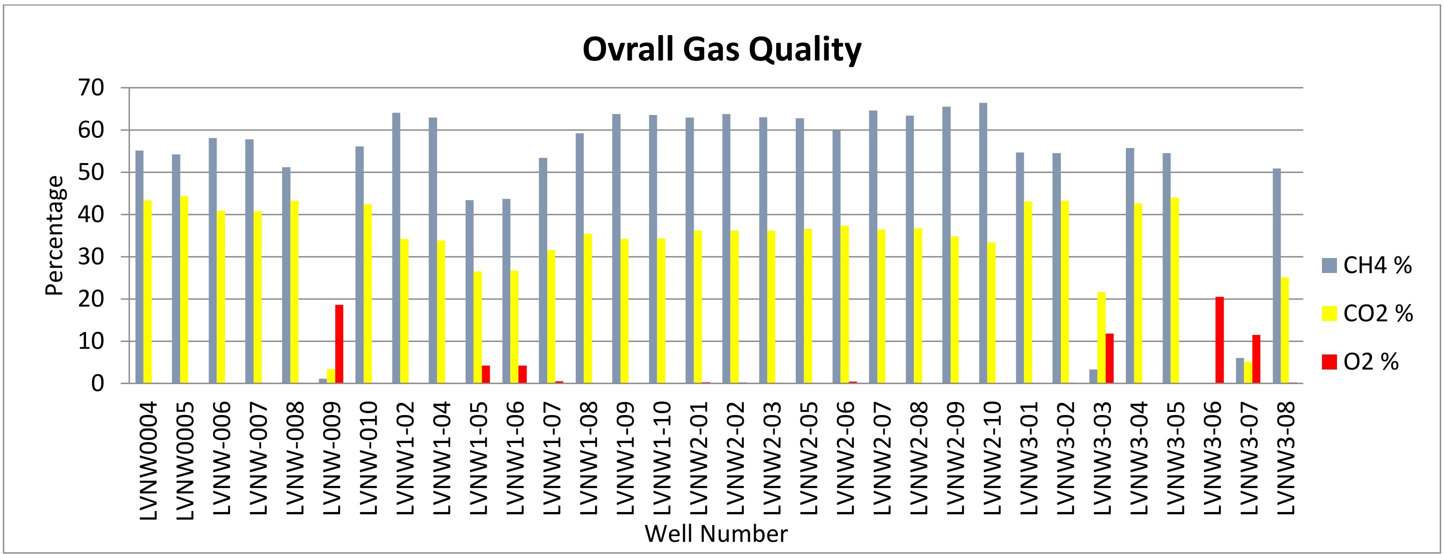


Figure 1: February gas quality in individual wells

Following graph represents the CH4% changes of the highest and lowest value recorded wells from January 2024 to February 2024. Some wells maintain consistent values around 50% and some wells fluctuate drastically from low values up over 50 % readings. Some wells maintain a relatively low concentration of methane (<30%). These fluctuations occur from gas flow path changes, biological activity changes around well draw perimeter and also change of cover conditions.

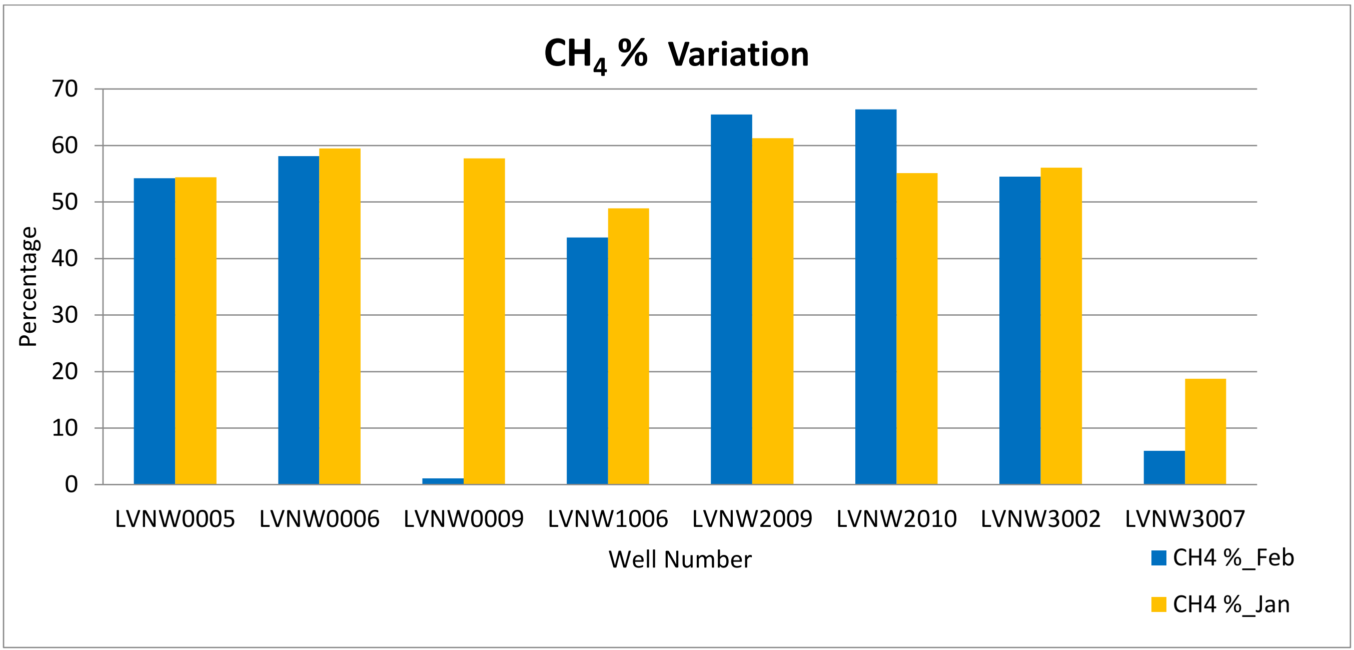


Figure 2: Methane variation from January to February for selected wells

The following graph represents the CO2% changes of the highest and lowest value recorded wells from January 2024 to February 2024. Some wells maintain consistent values around 30% and some wells fluctuate drastically from low values up to over 30%. The well CO2 gas content behaves similarly to methane content with low productive wells maintaining a low percentage and high productive wells consistently providing a high percentage. These fluctuations can occur due to the previous mentioned reasons around well perimeter.

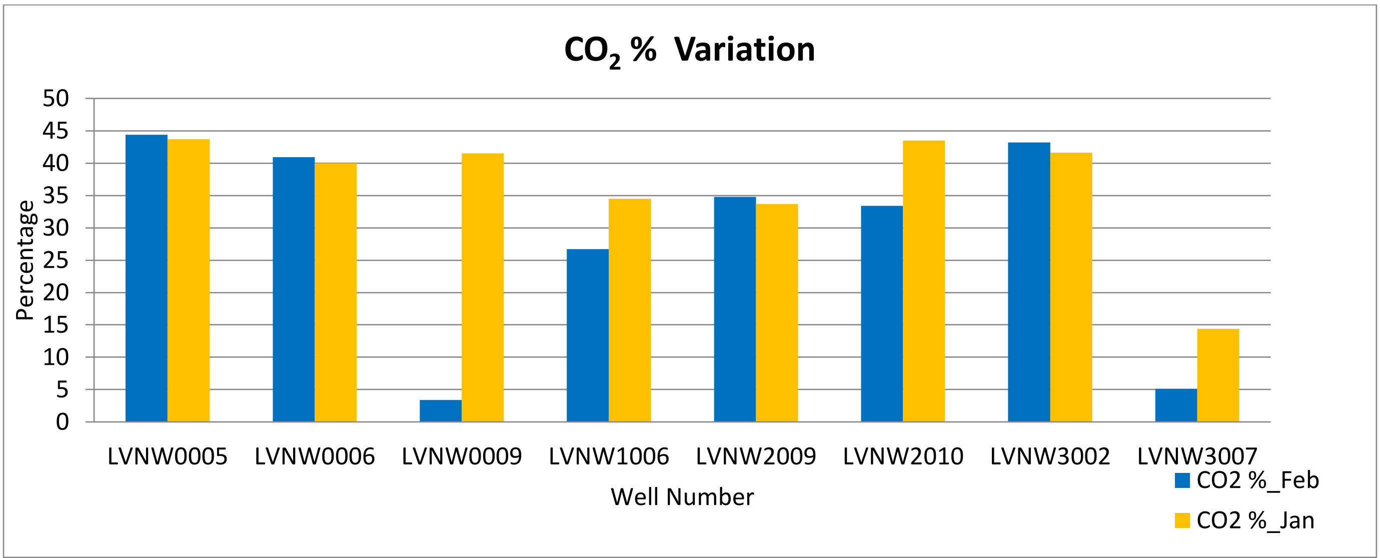


Figure 3: Carbon Dioxide variation from January to February for selected wells

The following graph represents the O2% changes of the highest and lowest value recorded wells from January to February 2024. Some wells maintain consistent values around < 5% and some wells fluctuate drastically from high values to low readings. Oxygen percentage can vary depending on gas line condition, well design, well base condition, and landfill cover. Poor conditions of any of these factors may cause oxygen to be drawn into the gas reticulation system. Therefore, some wells may show highly fluctuating oxygen percentages, while others may show consistent values over the monitoring period.

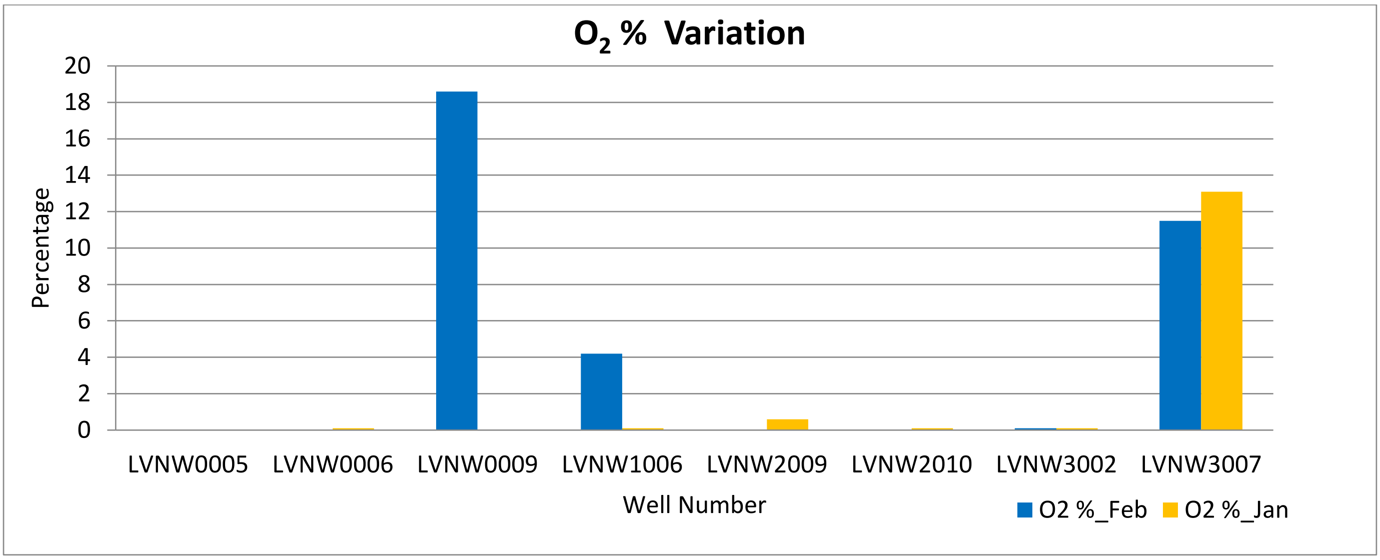


Figure 4: Oxygen percentage variation from January to February for selected wells

5.2.2 Instantaneous Surface Monitoring

During the period from May 2023 to February 2024, 50 ISM locations were identified and remediated. Compared to the trailing months there is a decrease of high emission areas due to the new cover and favourable weather conditions.

Table 3: The number of identified and remediated ISM exceedances each month.

Month	**Identified locations**	**Remediated locations**
May2023	18	18
June 2023	6	6
July 2023	2	2
August 2023	4	4
September 2023	3	3
October 2023	3	3
November 2023	3	3
December 2023	2	2
January 2024	6	6
February 2024	3	3

6.0 Recommendations

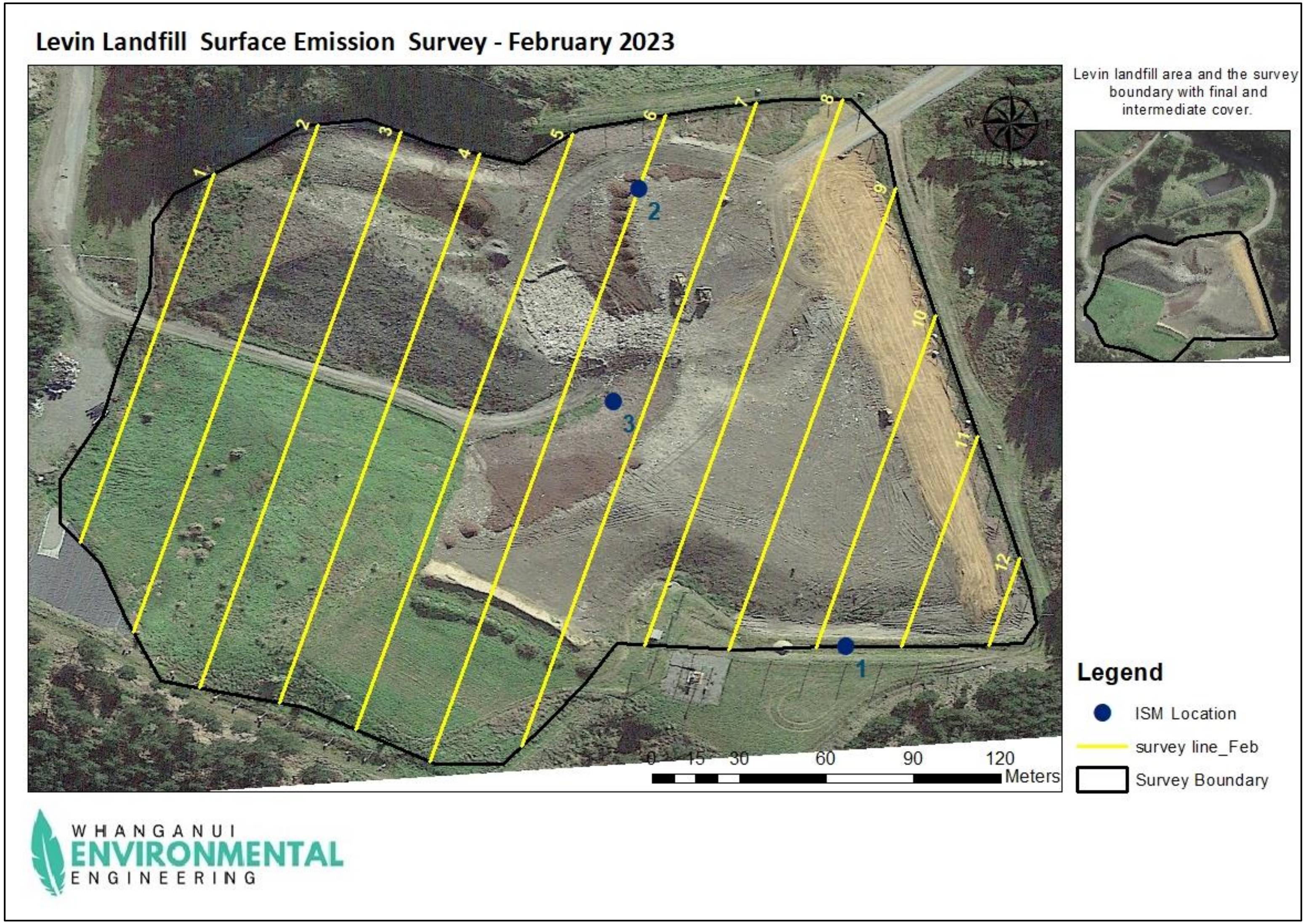
Changes observed this month, namely the slight decrease in ISM locations, were expected due to the placement of final capping. With the final capping process having been completed, the disconnected wells will shortly be reconnected and brought back online.

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular gas well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

Appendix 1. Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	310ppm		Southern face of the landfill in South Eastern edge, dead grass patch	Bentonite and water		20ppm
2	240ppm		Northern face of the landfill in grass covered area	Bentonite and water		19ppm
3	380ppm		Middle of the landfill, South western face in a grass covered area	Bentonite and water		30ppm

Appendix 2.Surface emission monitoring map



Appendix 3. Weather condition prior to the survey and during the survey

Weather History for ILEVIN45

https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2024-02-10/2024-02-1010/daily

Daily Mode | February | 10 | 2024 | View

Previous Next

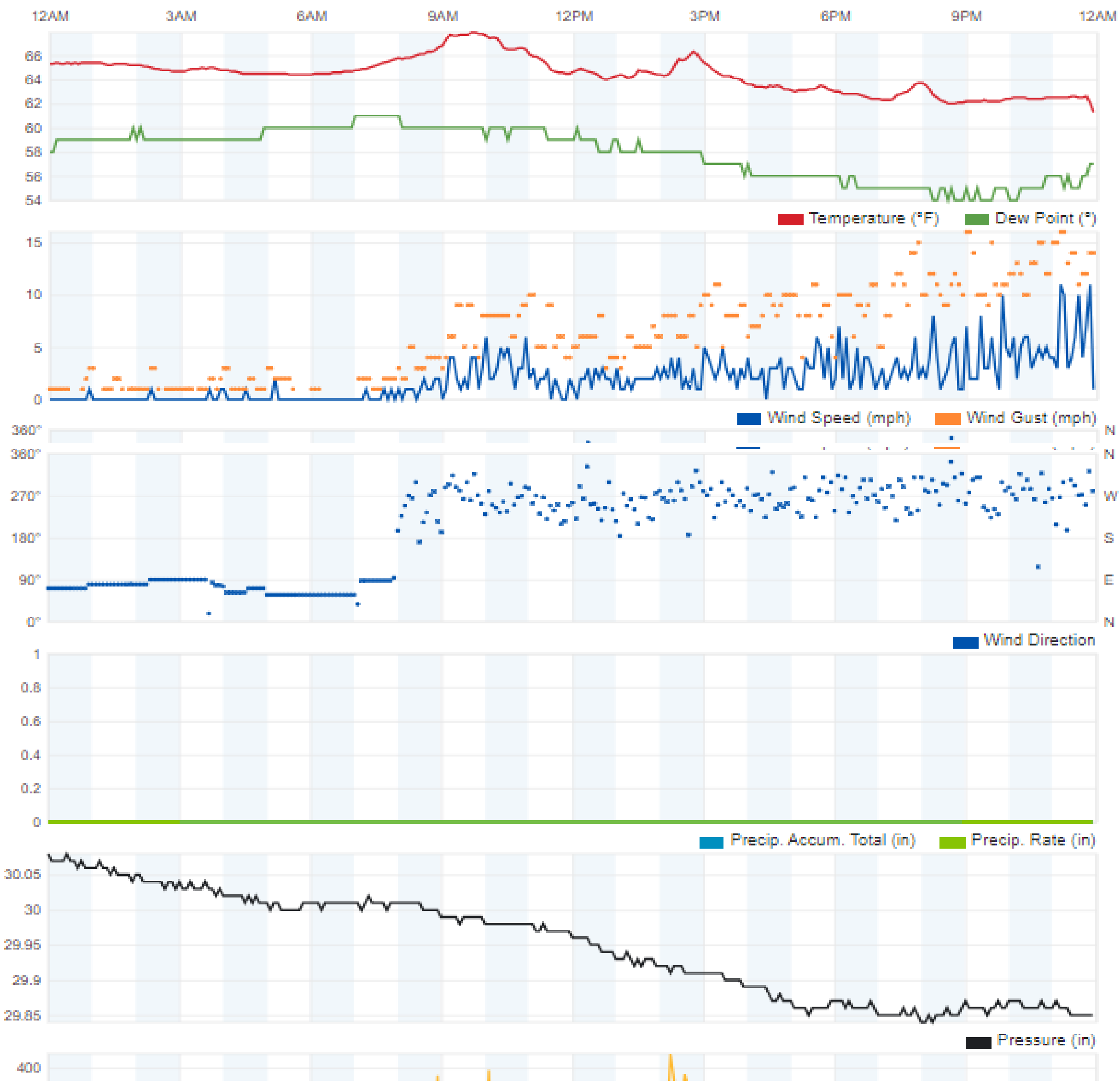
Summary
February 10, 2024

	High	Low	Average
Temperature	67.9 °F	61.3 °F	64.4 °F
Dew Point	61.0 °F	54.0 °F	57.9 °F
Humidity	87 %	73 %	80 %
Precipitation	0.00 in	--	--

	High	Low	Average
Wind Speed	11.0 mph	0.0 mph	2.0 mph
Wind Gust	16.0 mph	--	6.0 mph
Wind Direction	--	--	
Pressure	30.08 in	29.84 in	--

Graph | Table

February 10, 2024



Weather History for ILEVIN45

https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2024-02-10/2024-02-1010/weekly

Weekly Mode | February | 11 | 2024 | View

Previous

Next

Summary

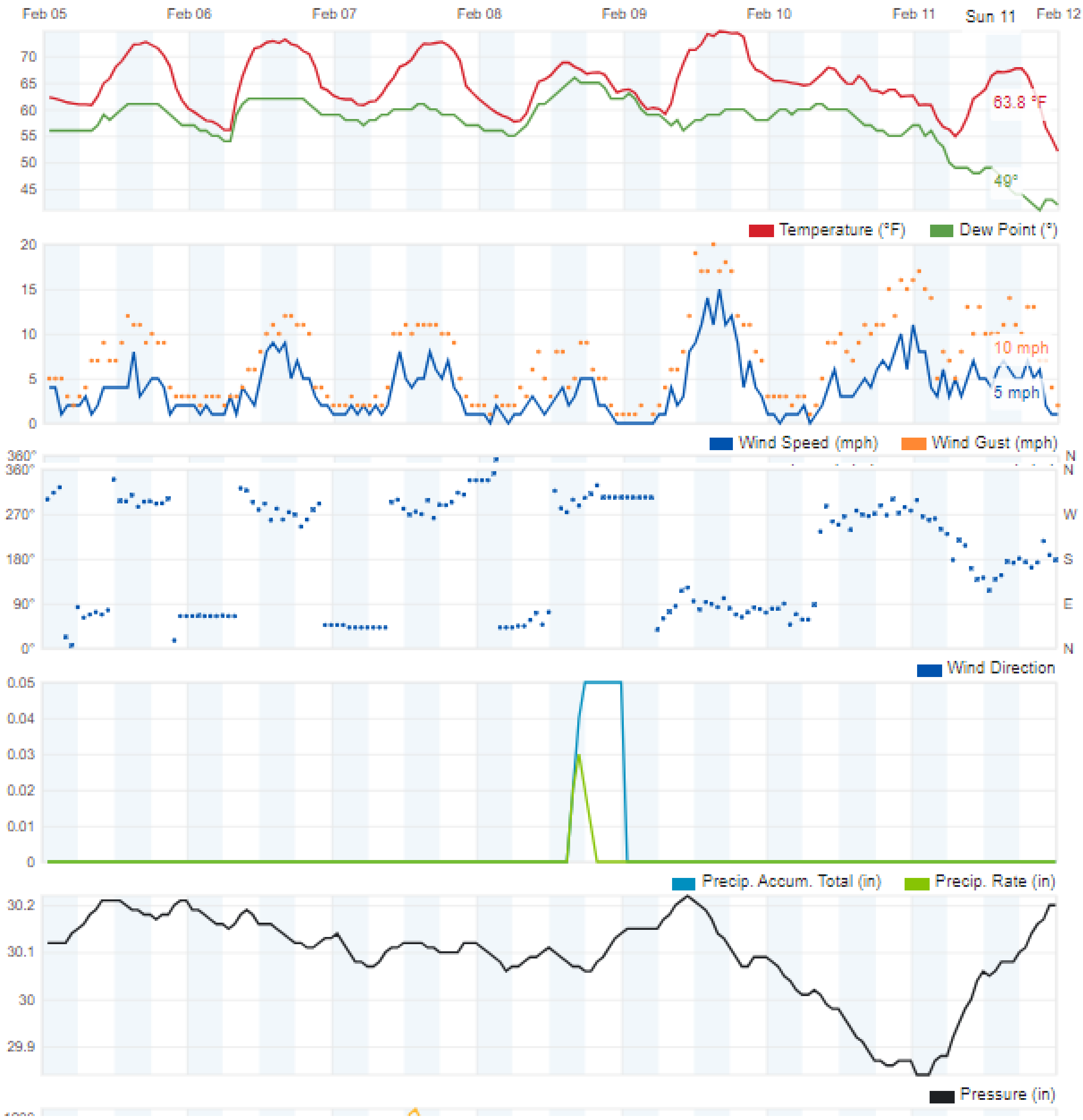
February 5, 2024 - February 11, 2024

	High	Low	Average
Temperature	74.7 °F	50.3 °F	64.5 °F
Dew Point	66.0 °F	40.0 °F	57.0 °F
Humidity	97 %	39 %	78 %
Precipitation	0.05 in	--	--

	High	Low	Average
Wind Speed	15.0 mph	0.0 mph	1.7 mph
Wind Gust	20.0 mph	--	5.4 mph
Wind Direction	--	--	West
Pressure	30.22 in	29.82 in	--

Graph | Table

February 5, 2024 - February 11, 2024



Appendix 4.Gas monitoring results for February 2024

ID	DATE	CH4 %	CO2 %	O2 %	BALA %	H2S ppm	Nitrogen %	BAR mb
LVNW2-01	10/02/2024	62.9	36.2	0.3	0.6	326	0	1011
LVNW2-02	10/02/2024	63.8	36.2	0.2	0	310	0	1011
LVNW2-03	10/02/2024	63	36.2	0.1	0.7	339	0.32	1011
LVNW2-05	10/02/2024	62.8	36.6	0.1	0.5	139	0.12	1011
LVNW2-06	10/02/2024	59.9	37.3	0.4	2.4	113	0.89	1011
LVNW2-07	10/02/2024	64.6	36.4	0	0	202	0	1011
LVNW2-08	10/02/2024	63.4	36.7	0	0	357	0	1011
LVNW2-09	10/02/2024	65.5	34.8	0	0	248	0	1011
LVNW2-10	10/02/2024	66.4	33.4	0	0.2	198	0.2	1011
LVNW-008	10/02/2024	51.2	43.2	0.1	5.5	1055	5.12	1009
LVNW-007	10/02/2024	57.8	40.8	0.1	1.3	237	0.92	1009
LVNW-006	10/02/2024	58.1	40.9	0	1	1009	1	1009
LVNW-009	10/02/2024	1.1	3.4	18.6	76.9	53	6.59	1009
LVNW3-01	10/02/2024	54.7	43.1	0.1	2.1	314	1.72	1010
LVNW3-02	10/02/2024	54.5	43.2	0.1	2.2	274	1.82	1010
LVNW3-03	10/02/2024	3.3	21.6	11.8	63.3	23	18.7	1010
LVNW3-04	10/02/2024	55.7	42.6	0.1	1.6	773	1.22	1010
LVNW3-05	10/02/2024	54.5	44	0	1.5	852	1.5	1010
LVNW3-06	10/02/2024	0	0.1	20.5	79.4	21	1.91	1010
LVNW0004	10/02/2024	55.1	43.3	0.1	1.5	1842	1.12	1010
LVNW0005	10/02/2024	54.2	44.4	0	1.4	1258	1.4	1010
LVNW3-08	10/02/2024	50.9	25.1	0.2	23.8	925	23.04	1010
LVNW3-07	10/02/2024	6	5.1	11.5	77.4	269	33.93	1010
LVN-010	10/02/2024	56.1	42.4	0.1	1.4	346	1.02	1010
LVNFLARE	10/02/2024	58.4	38.8	0.2	2.6	192	1.84	1010
LVNBH02	10/02/2024	58.2	38.6	0.3	2.9	242	1.77	1010
LVNBH01	10/02/2024	61.4	37	0	1.6	164	1.6	1010
LVNW1-02	10/02/2024	64.1	34.2	0.1	1.6	20	1.22	1010
LVNW1-04	10/02/2024	62.9	33.8	0.1	3.2	26	2.82	1010
LVNW1-05	10/02/2024	43.4	26.5	4.2	25.9	13	10.02	1010
LVNW1-06	10/02/2024	43.7	26.7	4.2	25.4	15	9.52	1010
LVNW1-07	10/02/2024	53.4	31.6	0.5	14.5	11	12.61	1010
LVNW1-08	10/02/2024	59.2	35.4	0	5.4	63	5.4	1010
LVNW1-09	10/02/2024	63.8	34.2	0	2	156	2	1010
LVNW1-10	10/02/2024	63.5	34.3	0	2.2	134	2.2	1010

END

WHANGANUI ENVIRONMENTAL ENGINEERING

LEVIN LANDFILL GAS MONITORING

MARCH 2024

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

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Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of March, 2024 in compliance with the resource consent.

2.0 Objective

2.1 Resource consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedance require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** ***Note:** *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Details of Survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission Survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 23rd March 2024 from 9.00 a.m. to 2.00 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty two gas wells in different stages of the landfill were monitored by using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Monitoring sessions were conducted fortnightly.

4. Weather Conditions

The meteorological data utilized in this report is sourced from the Levin landfill's on-site weather station. There was no recorded rainfall in the three days leading up to the survey. Additionally, the atmospheric pressure exhibited a gradual increase from 1010.0 hPa to 1015 hPa prior to the survey date. For comprehensive insights into the pre-survey weather conditions, please refer to Appendix 3.0.

During the survey itself, the average atmospheric pressure remained at 1015 hPa, gradually declining to 1011 hPa. The wind speed observed throughout the survey period was to low record, and no precipitation occurred during this time. Detailed information regarding the weather conditions on the survey date can be found in Appendix 3.0.

5. Survey Results

There were 2 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using Bentonite and water. The identified high emission locations include in dead grass patches with some bare soil cover on the final and intermediate cover.

Gas well monitoring was conducted according to the prescheduled dates within the month and from 30 wells the average CH_4 level was 38.92 % with the highest of 59.0% in LVNW2010 and the lowest of 0.0% in LVNW1005 and LVNW1008. The average CO_2 level was 27.74 % with the highest of 44.2% in LVNW008 and the lowest of 0.1% in LVNW1008. The average O_2 level was 4.34 % with the highest of 20.1% in LVNW1008 and the lowest of 0% in five wells (see the appendix 3). The individual gas value and total average values can fluctuate due to many reasons such as the draw of the well, as well as the number of monitoring wells. Additionally, the number of live monitoring gas wells undergoing draw can vary each month depending on the well gas quality or the landfill activity.

5.2 Summary of Overall Gas Monitoring

5.2.1 Gas Well Monitoring

The average methane percentage was stable at 55% - 56% from June to August in 2023 and then dropped to 45% in September 2023 before rising to 51% in October 2023. From October to December in 2023, the methane percentage decreased gradually to 39%. From December 2023 to January 2024 the average methane level has slightly increased up to 41.47% and further increased in February up to 51.23%. There is a considerable drop in March in comparison to February.

The general fluctuation of methane percentage is largely dependent on the draw from, and the run-time of, the flare. The number of wells with more than 45% methane in each monitoring round varies depending on the activity around the landfill, and has been decreased significantly during this month.

The number of wells with a high percentage of Methane production has reduced and Table 1 shows the number of wells with over 45% of methane from the total monitored wells in the six month period.

Table 1: The number of wells with more than 45% Methane each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Total monitored wells	29	27	20	20	29	28	32	30
Number of wells with over 45% Methane	25	18	17	15	15	16	26	17

The average Carbon Dioxide percentage was fairly consistent for June to August in 2023 with around 38% - 36%, and from August to December 2023 a gradual drop of average CO_2 percentage from 36% to 28% was observed. During the period from February to March the percentage has gradually dropped up to 27.74%. Table 2 represents the total number of wells with over 30% CO_2 each month.

Table 2: The number of wells with more than 30% Carbon Dioxide each monitoring round.

Month	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Total monitored wells	29	27	20	20	29	28	32	30
Number of wells with over 30% CO2	27	20	19	16	18	17	25	14

The following graph represents the monthly gas quality and gas quality changes from the previous month to March in available selected wells from highest and lowest gas quality readings from the March survey.

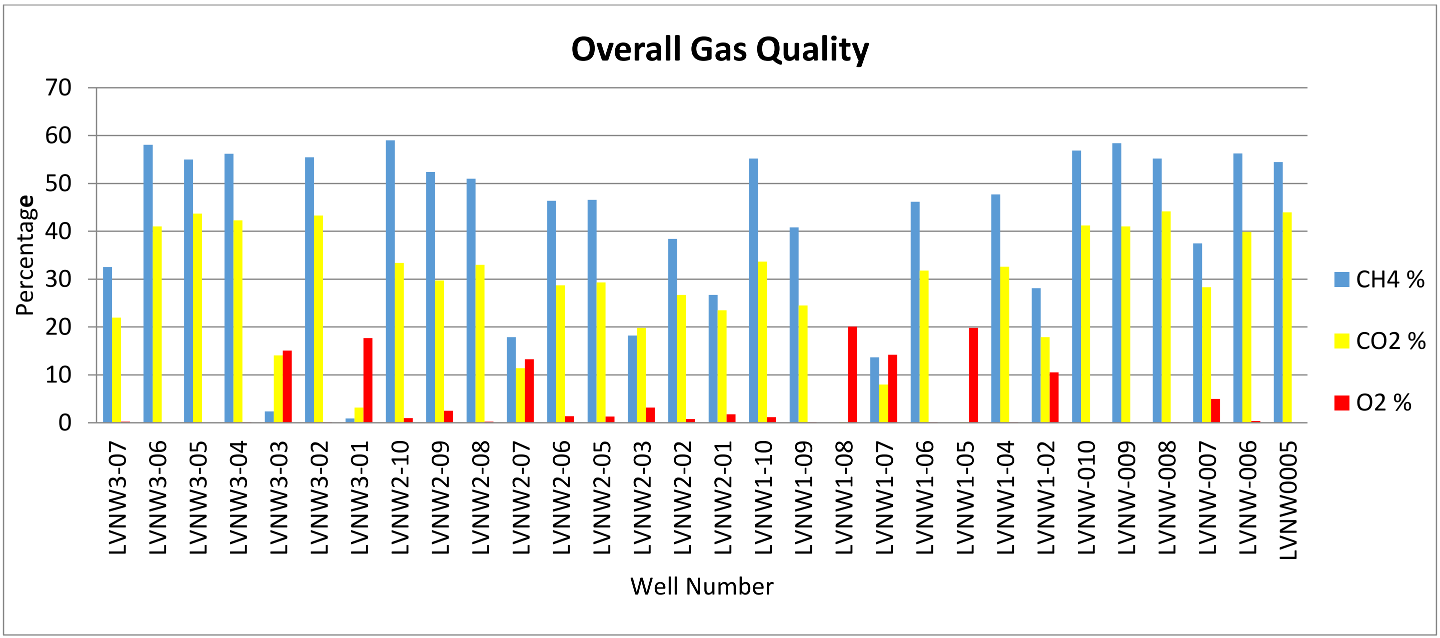


Figure 1: March gas quality in individual wells.

The following graph represents the CH4% changes of the highest and lowest value recorded wells from February to March 2024. Some wells maintained consistent values around 50% and some wells fluctuate drastically from low values up over 50 % readings. Few wells maintain a low concentration of Methane below 30%. These fluctuations occur from the gas flow path change, biological activity changes around well draw perimeter and also change of cover conditions.

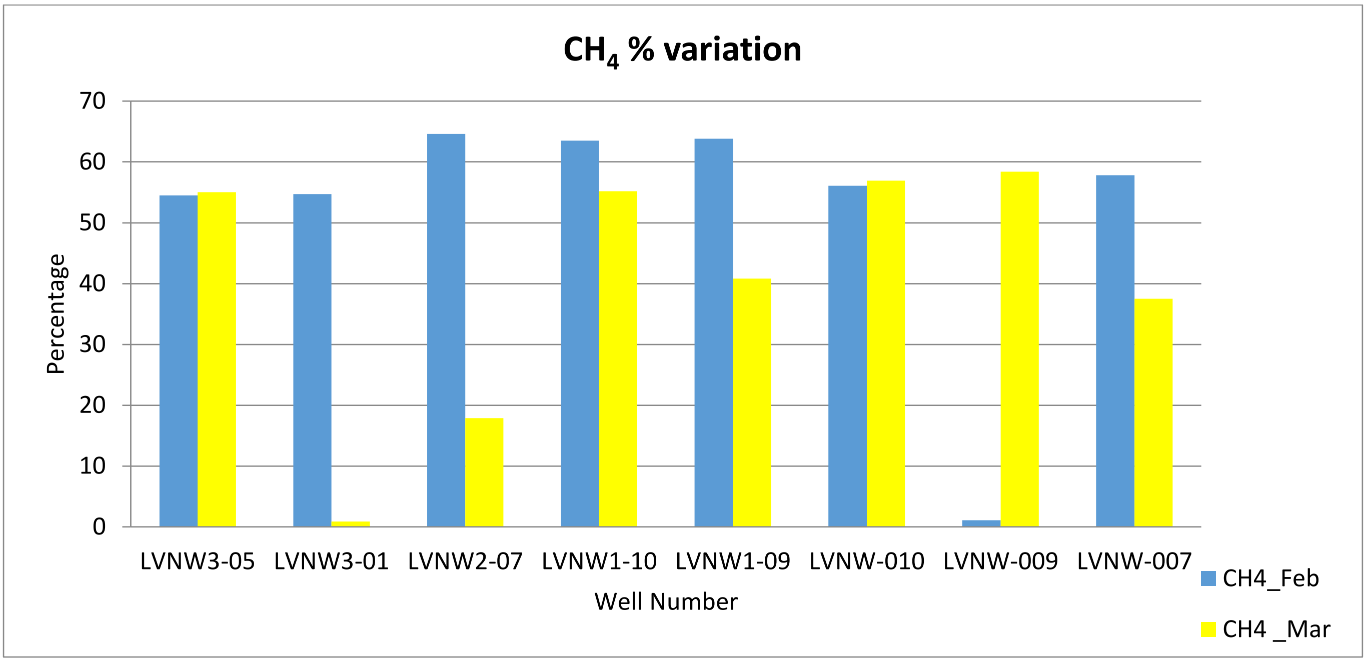


Figure 2: Methane variation from February to March 2024 for selected wells

The following graph represents CO2% changes of the highest and lowest value recorded wells from February to March 2024. Some wells maintained consistent values around 30% - 40% and some wells fluctuate drastically from low values up to over 30 % readings.

The well CO2 gas content behaves similarly to methane content with low productive wells maintaining a low percentage and high productive wells consistently providing a high percentage. These fluctuations can occur due to the previous mentioned reasons around well perimeter.

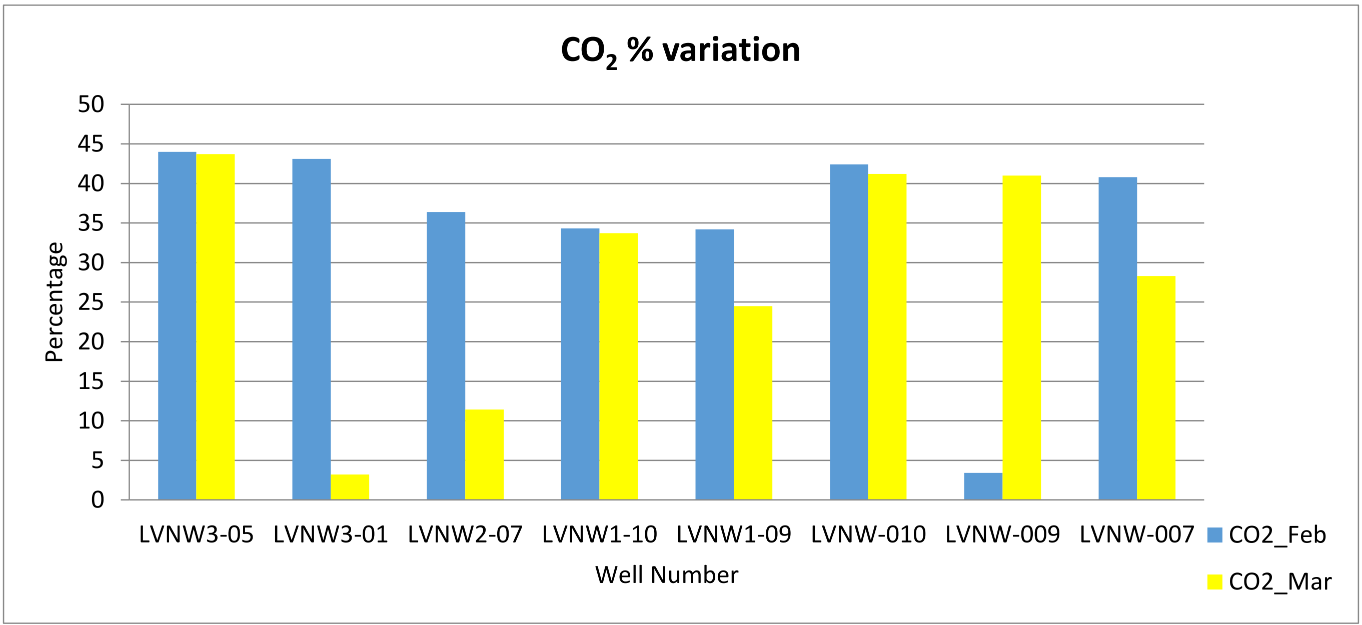


Figure 3: Carbon Dioxide variation from February to March for selected wells

Following graph represent the O2% changes of the highest and lowest value recorded wells from February to March 2024. Some wells with consistence values around < 5% and some wells fluctuate highly from low values to high readings. Oxygen percentage can vary depending on gas line condition, well design, well base condition, and landfill cover. Poor conditions of any of these factors may cause oxygen to be drawn into the gas reticulation system. Therefore, some wells may show highly fluctuating oxygen percentages, while others may show consistent values over the monitoring period.

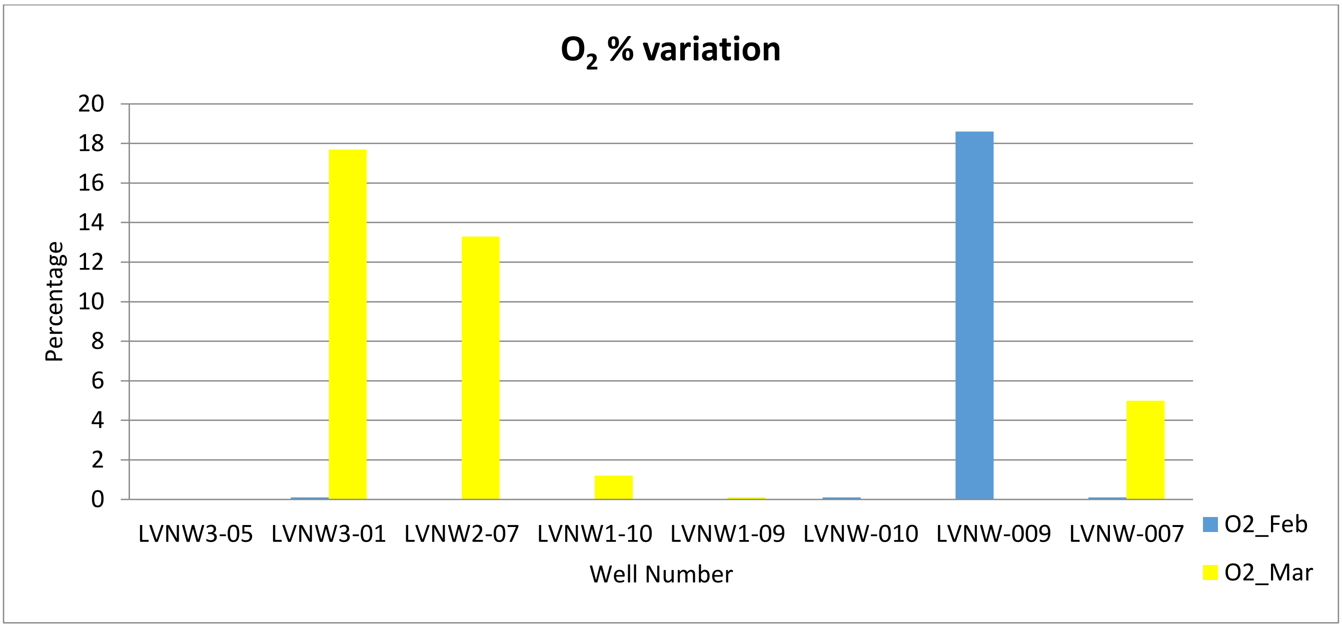


Figure 4: Oxygen percentage variation from February to March for selected wells

5.2.2 Instantaneous Surface Monitoring

During the period from May 2023 to March 2024, 52 ISM locations were identified and remediated. Compared to the trailing months there is a decrease of high emission areas due to the new cover and favourable weather conditions.

Table 3: The number of identified and remediated ISM exceedances each month.

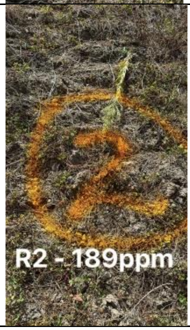
Month	**Identified locations**	**Remediated locations**
May2023	18	18
June 2023	6	6
July 2023	2	2
August 2023	4	4
September 2023	3	3
October 2023	3	3
November 2023	3	3
December 2023	2	2
January 2024	6	6
February 2024	3	3
March 2024	2	2

6. Summary

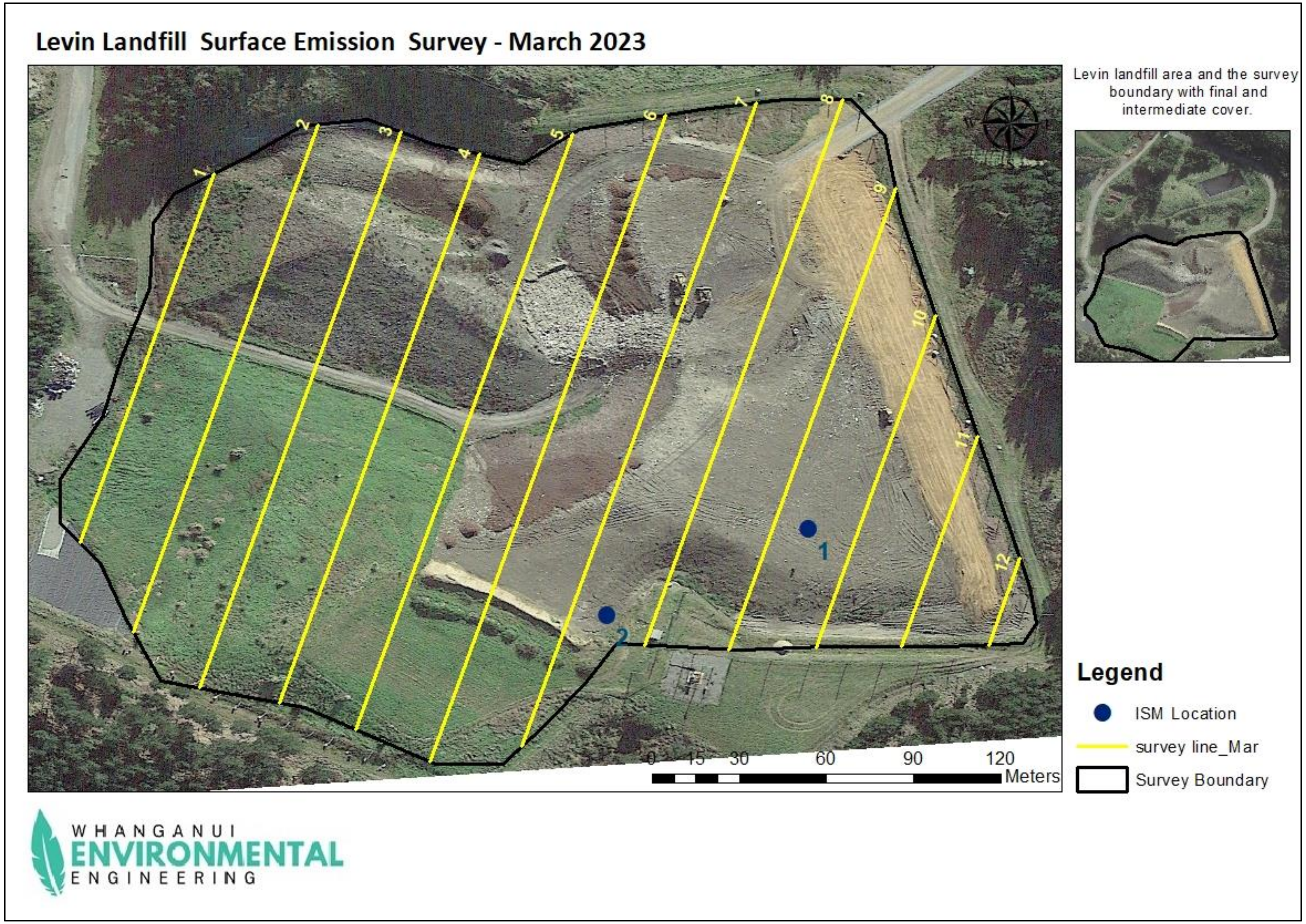
Corrective tuning was carried out throughout March on the well that experienced high oxygen content in February (LVNW-009) and as a result the oxygen concentration has returned to a low, stable condition. The other wells that have experienced notable increases in oxygen this month are being closely monitored.

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular gas well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

Appendix 1. Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	227ppm		South Eastern face of the landfill in a dead grass patch, fracture in clay cover	Bentonite and water		18ppm
2	189ppm		Southern face of the landfill in dead grass patch, fracture in clay cover	Bentonite and water		22ppm

Appendix 2.Surface emission map



Appendix 3. Weather condition prior to the survey and during the survey

https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2024-03-23 /2024-03-23/daily

Previous | Daily Mode | March | 23 | 2024 | View | Next

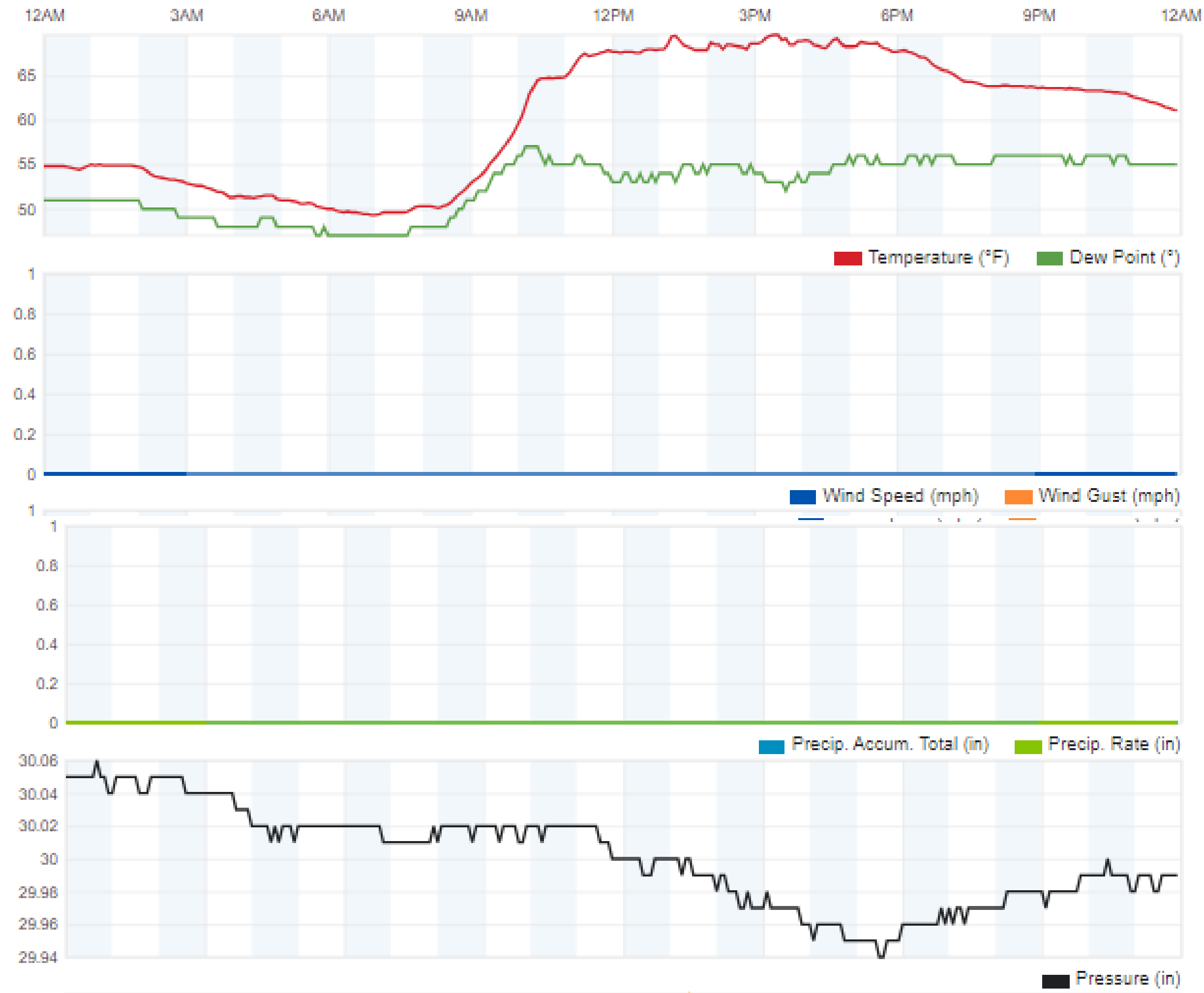
Summary
March 23, 2024

	High	Low	Average
Temperature	69.6 °F	49.3 °F	60.3 °F
Dew Point	57.0 °F	47.0 °F	52.6 °F
Humidity	94 %	55 %	77 %
Precipitation	0.00 in	--	--

	High	Low	Average
Wind Speed	0.0 mph	0.0 mph	0.0 mph
Wind Gust	0.0 mph	--	0.0 mph
Wind Direction	--	--	North
Pressure	30.06 in	29.94 in	--

Graph | Table

March 23, 2024



Weather History for ILEVIN44

https://www.wunderground.com/dashboard/pws/ILEVIN45/graph/2024-03-23/2024-03-23/weekly

Previous | Weekly Mode | March | 24 | 2024 | View | Next

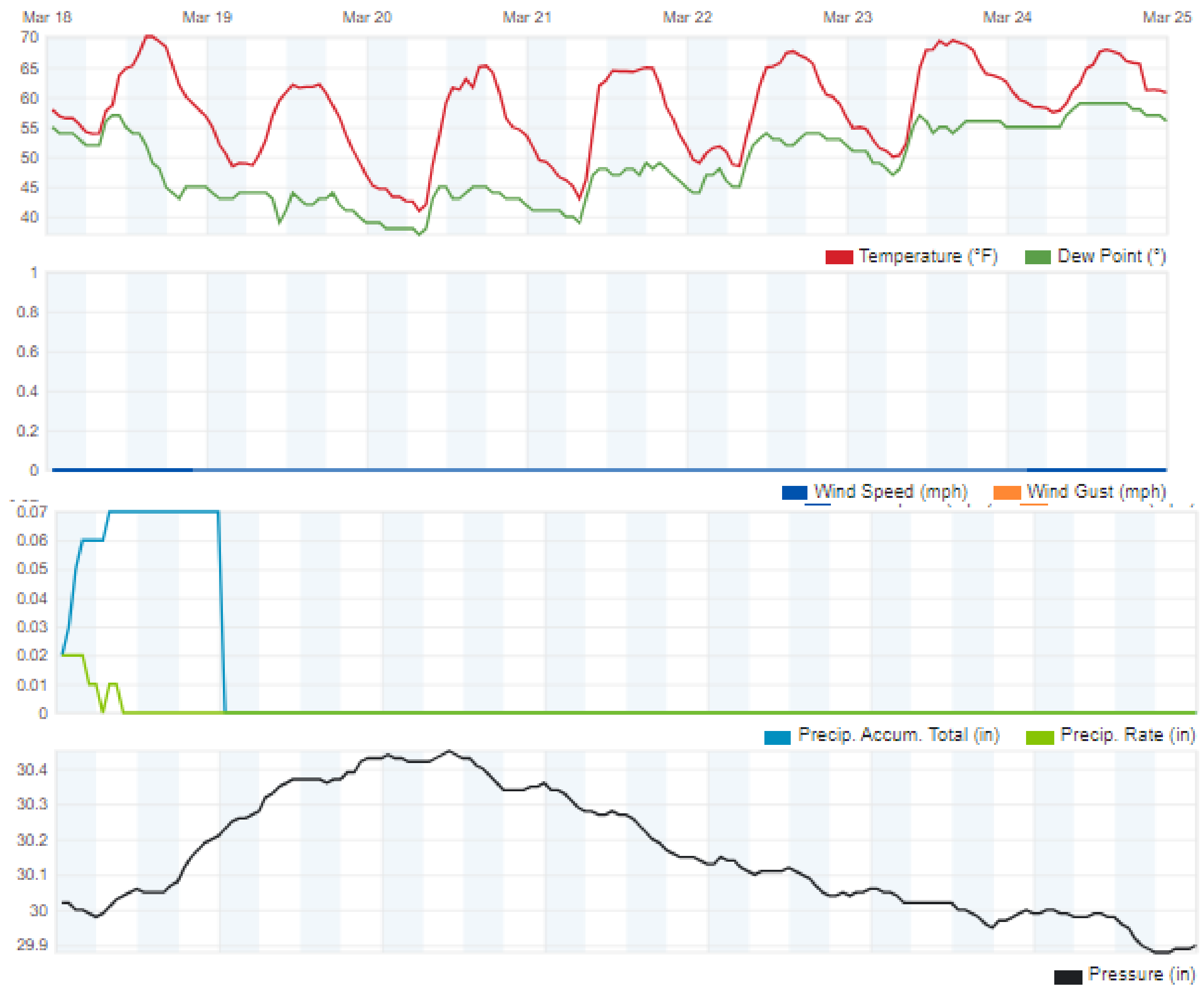
Summary
March 18, 2024 - March 24, 2024

	High	Low	Average
Temperature	70.2 °F	40.5 °F	57.3 °F
Dew Point	59.0 °F	36.0 °F	48.0 °F
Humidity	96 %	40 %	73 %
Precipitation	0.07 in	--	--

	High	Low	Average
Wind Speed	0.0 mph	0.0 mph	0.0 mph
Wind Gust	0.0 mph	--	0.0 mph
Wind Direction	--	--	North
Pressure	30.45 in	29.87 in	--

Graph | Table

March 18, 2024 - March 24, 2024



Appendix 4.Gas monitoring results for March 2024

Well_ID	Date	CH4 %	CO2 %	O2 %	Baro	H2S ppm	Res N %
LVNW2-01	23/03/24	26.7	23.5	1.8	1013	0	41.2
LVNW2-02	23/03/24	38.4	26.7	0.8	1013	0	31.08
LVNW2-03	23/03/24	18.2	19.8	3.2	1013	0	46.7
LVNW2-05	23/03/24	46.6	29.3	1.3	1013	0	17.89
LVNW2-06	23/03/24	46.4	28.7	1.4	1013	0	18.21
LVNW2-07	23/03/24	17.9	11.4	13.3	1013	38	7.13
LVNW2-08	23/03/24	51	33	0.2	1013	136	15.04
LVNW2-09	23/03/24	52.4	29.7	2.5	1013	171	5.95
LVNW2-10	23/03/24	59	33.4	1	1013	149	2.82
LVNW-008	23/03/24	55.2	44.2	0.1	1012	1323	0.12
LVNW-007	23/03/24	37.5	28.3	5	1012	59	10.3
LVNW-006	23/03/24	56.3	39.9	0.4	1012	223	1.89
LVNW-009	23/03/24	58.4	41	0	1012	987	0.6
LVNW3-01	23/03/24	0.9	3.2	17.7	1012	54	11.29
LVNW3-02	23/03/24	55.5	43.3	0.1	1012	367	0.72
LVNW3-03	23/03/24	2.4	14.1	15.1	1012	32	11.32
LVNW3-04	23/03/24	56.2	42.3	0.1	1012	713	1.02
LVNW3-05	23/03/24	55	43.7	0	1012	755	1.3
LVNW3-06	23/03/24	58.1	41	0	1012	1041	0.9
LVNW3-07	23/03/24	32.5	22	0.2	1012	735	44.54
LVNW0005	23/03/24	54.5	44	0	1012	1175	1.5
LVNW-010	23/03/24	56.9	41.2	0	1012	312	1.9
LVNW1-02	23/03/24	28.1	17.9	10.5	1014	17	3.81
LVNW1-04	23/03/24	47.7	32.6	0.1	1014	78	19.22
LVNW1-05	23/03/24	0	0.1	19.8	1014	20	5.26
LVNW1-06	23/03/24	46.2	31.8	0.1	1014	103	21.52
LVNW1-07	23/03/24	13.7	8	14.2	1014	16	10.42
LVNW1-08	23/03/24	0	0.1	20.1	1014	13	3.82
LVNW1-09	23/03/24	40.8	24.5	0.1	1014	62	34.22
LVNW1-10	23/03/24	55.2	33.7	1.2	1014	13	5.36

LEVIN LANDFILL GAS MONITORING

APRIL 2024

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of April, 2024 in compliance with the resource consent.

2.0 Objective

2.1 Resource Consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedance require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** *Note: *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission Survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 21st April 2024 from 9.00 a.m. to 2.00 p.m. Pre-planned survey lines directing 20NE in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty two gas wells in different stages of the landfill were monitored using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Monitoring sessions were conducted fortnightly.

4. Weather Conditions

The meteorological data utilized in this report was sourced from the online Levin weather station (https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-04-21/2024-04-21/daily). There was no recorded rainfall in the four days leading up to the survey. Additionally, the atmospheric pressure exhibited a gradual decrease from 1016.25 hPa to 1009.14 hPa prior to the survey date. For comprehensive insights into the pre-survey weather conditions, please refer to Appendix 3.0.

During the survey itself, the average atmospheric pressure remained at 1007.45 hPa, gradually increasing to 1009.14 hPa. The average wind speed observed throughout the survey period was 7.7 km/h, with extended periods below 5 km/h and no precipitation occurred during this time. Detailed information regarding the weather conditions on the survey date can be found in Appendix 3.0.

5. Survey Results

There were 3 locations identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using bentonite and water. The identified high emission locations include in the edge of the clay cover and dead grass patches on the final and intermediate cover.

Gas well monitoring was conducted according to the prescheduled dates within the month and from 30 wells the average CH_4 level was 44.88 % with the highest of 62.8% in LVNW2009 and the lowest of 0.0% in LVNW1008. The average CO_2 level was 29.67 % with the highest of 44.1% in LVNW005 and the lowest of 0.1% in LVNW1008. The average O_2 level was 2.94 % with the highest of 18.0% in LVNW1008 and the lowest of 0% in six wells (see the appendix 4). The individual gas value and total average values can fluctuate due to many reasons such as the draw of the well, as well as the number of monitoring wells connected. Additionally, the number of live monitoring gas wells undergoing draw can vary each month depending on the well gas quality or the landfill activity.

5.2 Summary of Overall Gas Monitoring

5.2.1 Gas Well Monitoring

The average methane percentage was stable at 55% - 56% from June to August in 2023 and then dropped up to 45% in September 2023 before rising to 51% in October 2023. From October to December in 2023, the methane percentage decreased gradually to 39%. From December 2023 to January 2024 the average methane level has slightly increased up to 41.47% and further increased in February up to 51.23%. There is a slight increase from 38.92% to 44.88 % From March to April 2024.

The general fluctuation of methane percentage is largely dependent on the draw from, and the run-time of, the flare. The number of wells with more than 45% methane in each monitoring round varies depending on the activity around the landfill, and this has increased this month.

The number of wells with a high percentage of Methane production has increased compared to the previous month and Table 1 shows the number of wells with over 45% of methane from the total monitored wells in during the monitoring period.

Table 1: The number of wells with more than 45% Methane each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
Total monitored wells	29	27	20	20	29	28	32	30	30
Number of wells with over 45% Methane	25	18	17	15	15	16	26	17	21

The average Carbon Dioxide percentage was fairly consistent for June to August in 2023 at around 36% - 38%, and from August to December 2023 a gradual drop of average CO_2 percentage from 36% to 28% was observed. During February to March the percentage has gradually dropped up to 27.74%. There is a slight increase in April up to 29.67% compared to the previous month. Table 2 represents the total number of wells with over 30% CO_2 each month.

Table 2: The number of wells with more than 30% Carbon Dioxide each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
Total monitored wells	29	27	20	20	29	28	32	30	30
Number of wells with over 30% CO2	27	20	19	16	18	17	25	14	16

The following graphs compare the this month's gas quality, and gas quality changes to March in available selected wells from highest and lowest gas quality readings from the March survey.

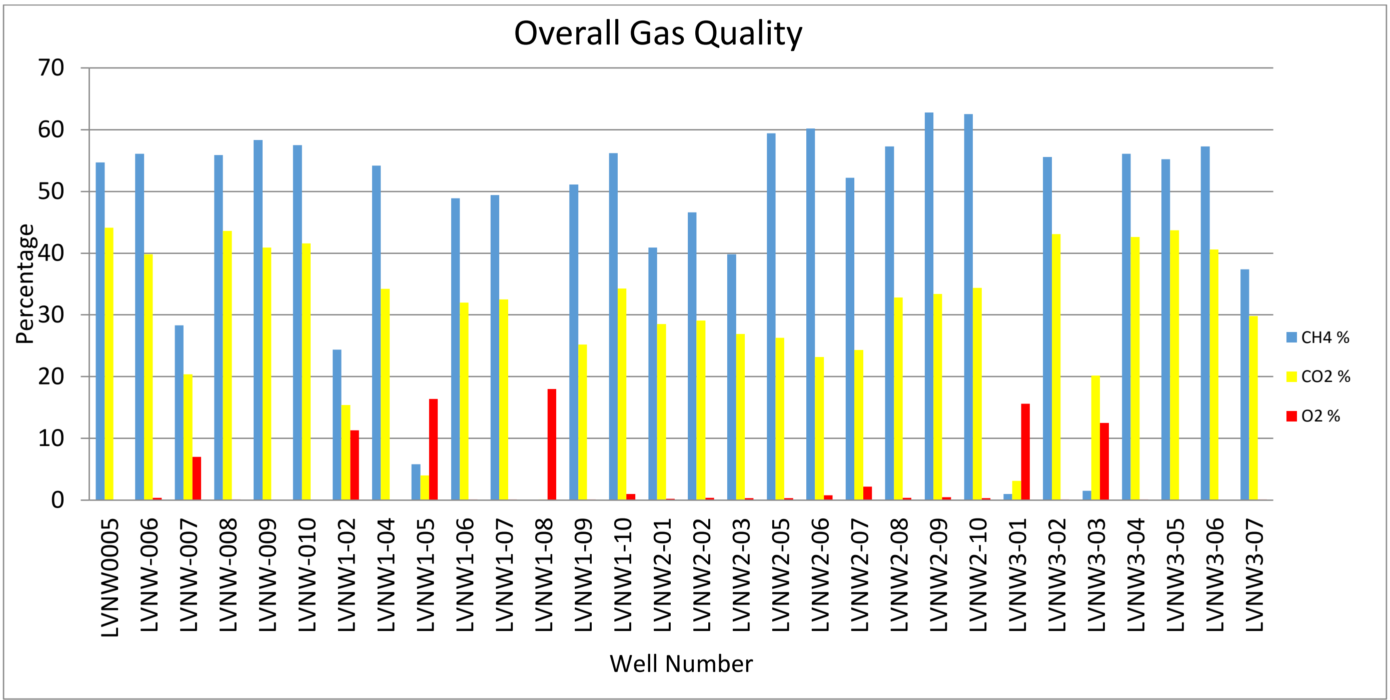


Figure 1: Overall gas quality in individual wells in April 2024

The following graph represents the CH4% changes during the March to April 2024 period from selected wells of the highest and lowest value recorded in the April survey. Some wells maintain consistent values around 50%, and a few indicate minor changes during this period. There are a limited number of wells that maintain the low range of Methane below 30%. These fluctuations occur from the gas flow path change, biological activity changes around well draw perimeter and also change of cover conditions.

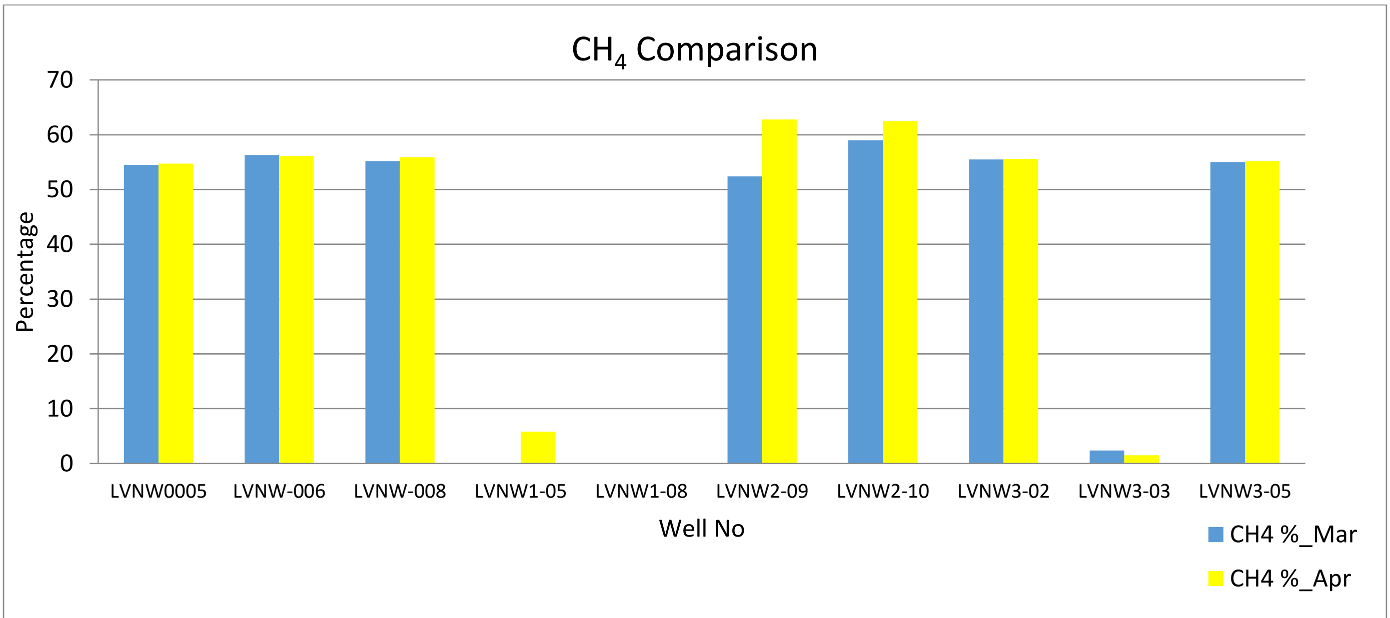


Figure 2: Methane variation from March to April 2024 for selected wells

The following graph represents the CO_2% changes during March to April 2024 from selected wells of the highest and lowest value recorded in April survey. Some wells maintain consistent values around 30% - 40%, and few indicate minor changes during this period. The well CO2 gas content behaves similarly to methane content with low productive wells maintaining a low percentage and high productive wells consistently maintaining a high percentage. These fluctuations can occur due to the previous mentioned reasons around the well perimeters.

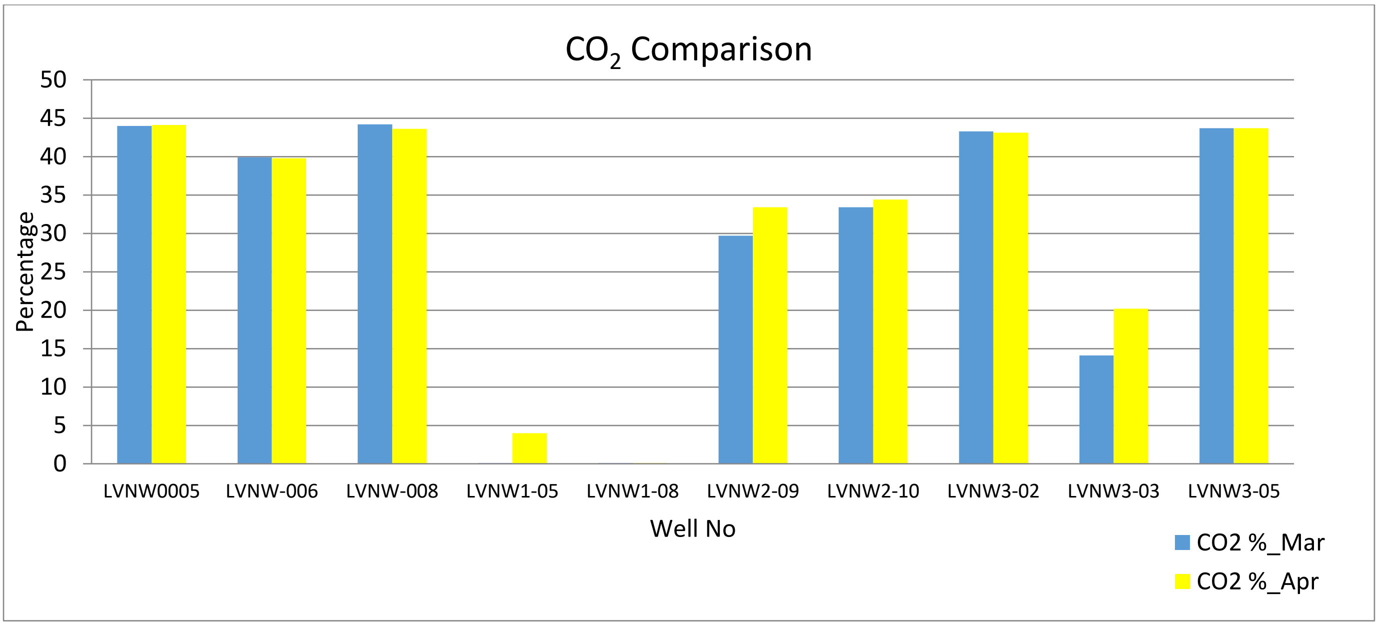


Figure 3: Carbon Dioxide variation from March to April for selected wells

The following graph represents the O2% changes from March to April from the highest and lowest value recorded wells from the April 2024 survey. Some wells maintain consistent values of <5% and some wells fluctuate slightly as a decreasing trend within this period. Oxygen percentage can vary depending on gas line condition, well design, well base condition, and landfill cover. Poor conditions of any of these factors may cause oxygen to be drawn into the gas reticulation system. Therefore, some wells may show highly fluctuating oxygen percentages, while others may show consistent values over the monitoring period.

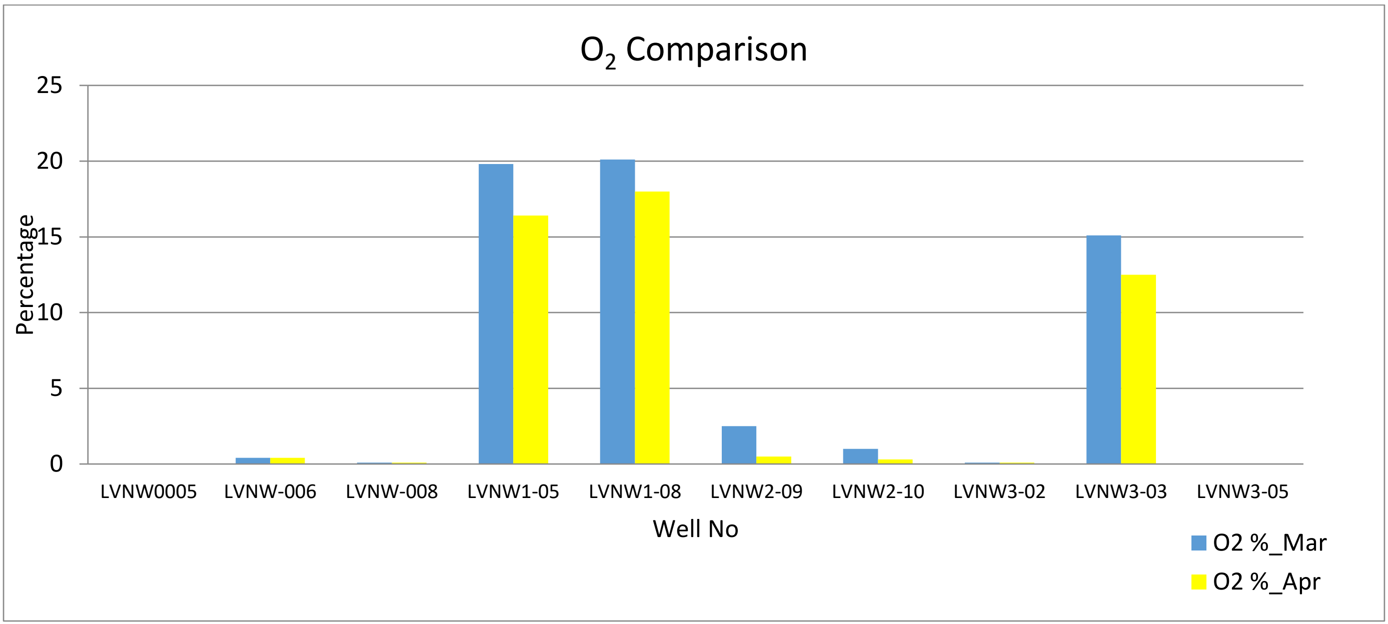


Figure 4: Oxygen percentage variation from March to April for selected wells

5.2.2 Instantaneous Surface Monitoring

During the period from May 2023 to April 2024, 55 ISM locations were identified and remediated. Compared to last month, there are fewer locations of high emission areas due to the new cover and change of weather condition.

Table 3: The number of identified and remediated ISM exceedances each month.

Month	**Identified locations**	**Remediated locations**
May2023	18	18
June 2023	6	6
July 2023	2	2
August 2023	4	4
September 2023	3	3
October 2023	3	3
November 2023	3	3
December 2023	2	2
January 2024	6	6
February 2024	3	3
March 2024	2	2
April 2024	3	3

6. Recommendations

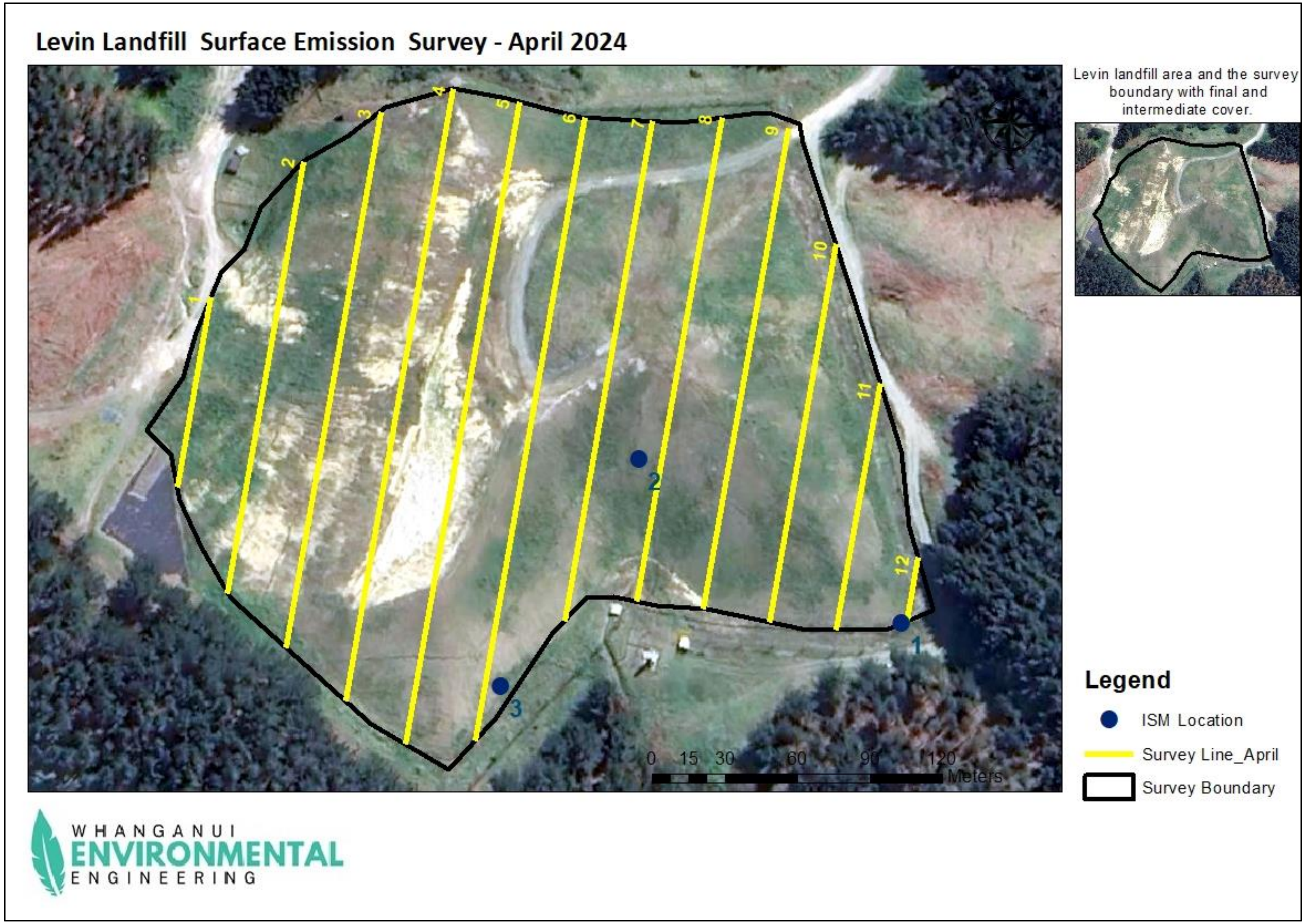
The gas quality of the wells has generally been stable this month when compared against last month. This could be due to many of the wells having become adapted to the draw from the flare, and the bioactivity in the wells stabilising. Stabilised weather conditions can also play a significant part in this, particularly in regards to the temperature, but also more consistent rainfall and water ingress.

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

Appendix 1. Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	227ppm		Edge of the South and East faces of the landfill, bottom edge of the clay cover	Bentonite and water		18ppm
2	189ppm		Southern face of the landfill in dead grass patch, fracture in clay cover	Bentonite and water		22ppm
3	348ppm		South western face of the landfill in grass covered area, bottom edge of the clay cover	Bentonite and water		13ppm

Appendix 2.Surface emission map



Appendix 3. Weather condition prior to the survey and during the survey

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-04-21/2024-04-21/daily

Weather History for ILEVIN75

Previous | Daily Mode | April | 21 | 2024 | View | Next

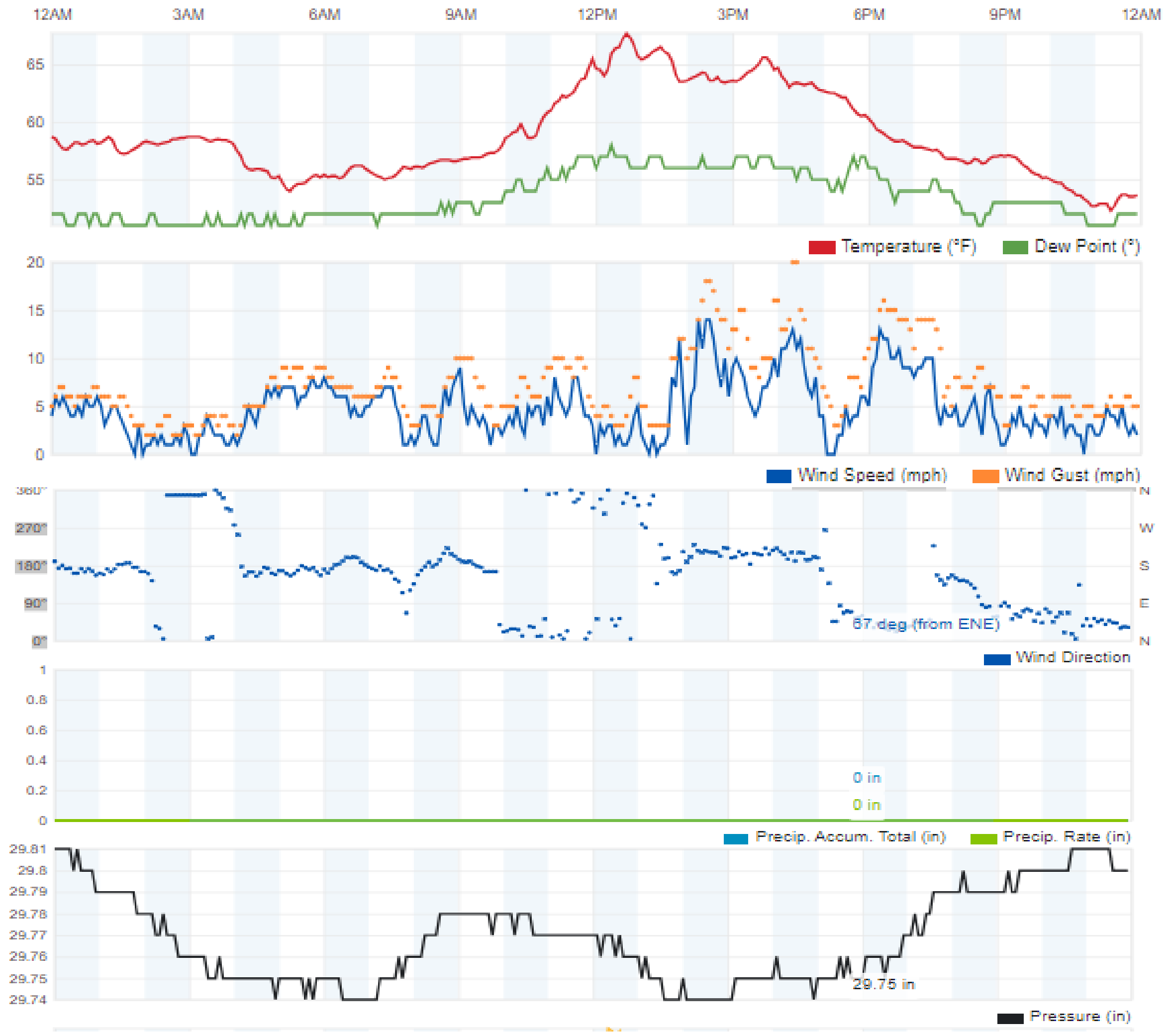
Summary
April 21, 2024

	High	Low	Average
Temperature	67.7 °F	52.3 °F	58.8 °F
Dew Point	58.0 °F	51.0 °F	53.4 °F
Humidity	95 %	68 %	83 %
Precipitation	0.00 in	--	--

	High	Low	Average
Wind Speed	14.0 mph	0.0 mph	4.8 mph
Wind Gust	20.0 mph	--	7.3 mph
Wind Direction	--	--	SSE
Pressure	29.81 in	29.74 in	--

Graph | Table

April 21, 2024



Weather History for ILEVIN75

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-04-21/2024-04-2/weekly

Previous | Weekly Mode | April | 21 | 2024 | View | Next

Summary

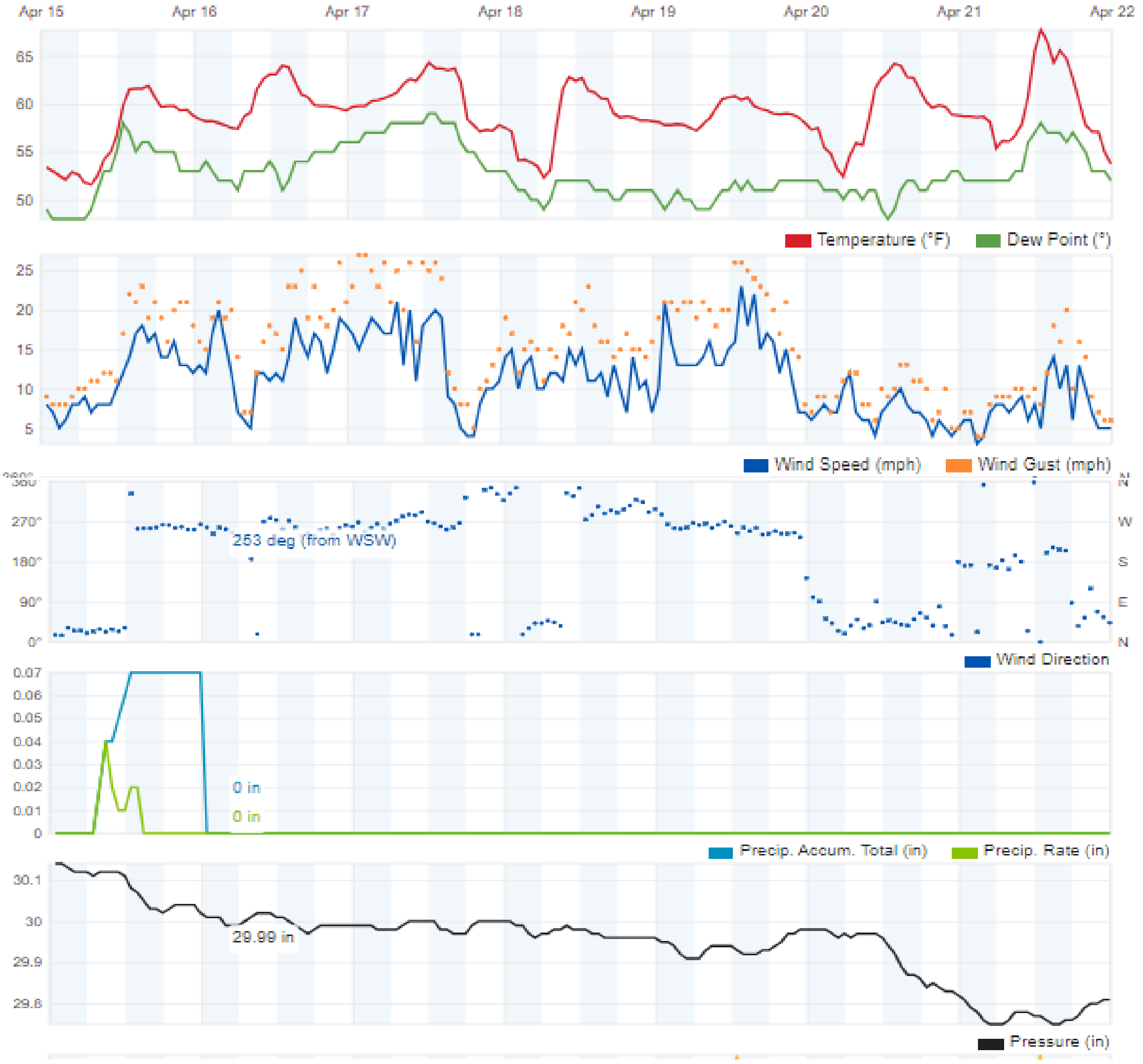
April 15, 2024 - April 21, 2024

	High	Low	Average
Temperature	67.7 °F	51.1 °F	58.5 °F
Dew Point	59.0 °F	45.0 °F	52.2 °F
Humidity	95 %	51 %	80 %
Precipitation	0.07 in	--	--

	High	Low	Average
Wind Speed	23.0 mph	0.0 mph	7.3 mph
Wind Gust	27.0 mph	--	12.6 mph
Wind Direction	--	--	WSW
Pressure	30.14 in	29.74 in	--

Graph | Table

April 15, 2024 - April 21, 2024



Appendix 4.Gas monitoring results for March 2024

Well ID	DATE	CH4 %	CO2 %	O2 %	H2S	BALANCE	BARO
LVNW0005	21/04/2024	54.7	44.1	0	1113	1.2	1004
LVNW-006	21/04/2024	56.1	39.8	0.4	224	3.7	1004
LVNW-007	21/04/2024	28.3	20.4	7	81	44.3	1004
LVNW-008	21/04/2024	55.9	43.6	0.1	1903	0.4	1004
LVNW-009	21/04/2024	58.3	40.9	0	668	0.8	1004
LVNW-010	21/04/2024	57.5	41.6	0	273	0.9	1004
LVNW1-02	21/04/2024	24.4	15.4	11.3	16	48.9	1006
LVNW1-04	21/04/2024	54.2	34.2	0	77	11.6	1006
LVNW1-05	21/04/2024	5.8	4	16.4	20	73.8	1006
LVNW1-06	21/04/2024	48.9	32	0.1	73	19	1006
LVNW1-07	21/04/2024	49.4	32.5	0.1	61	18	1006
LVNW1-08	21/04/2024	0	0.1	18	17	81.9	1006
LVNW1-09	21/04/2024	51.1	25.2	0.1	26	23.6	1006
LVNW1-10	21/04/2024	56.2	34.3	1	12	8.5	1006
LVNW2-01	21/04/2024	40.9	28.5	0.2	0	30.4	1006
LVNW2-02	21/04/2024	46.6	29.1	0.4	0	23.9	1006
LVNW2-03	21/04/2024	39.8	26.9	0.3	2	33	1006
LVNW2-05	21/04/2024	59.4	26.3	0.3	0	14	1006
LVNW2-06	21/04/2024	60.2	23.2	0.8	94	15.8	1006
LVNW2-07	21/04/2024	52.2	24.3	2.2	120	21.3	1006
LVNW2-08	21/04/2024	57.3	32.8	0.4	174	9.5	1006
LVNW2-09	21/04/2024	62.8	33.4	0.5	192	3.3	1006
LVNW2-10	21/04/2024	62.5	34.4	0.3	198	2.8	1006
LVNW3-01	21/04/2024	1	3.1	15.6	131	80.3	1004
LVNW3-02	21/04/2024	55.6	43.1	0.1	359	1.2	1004
LVNW3-03	21/04/2024	1.5	20.2	12.5	57	65.8	1004
LVNW3-04	21/04/2024	56.1	42.6	0.1	696	1.2	1004
LVNW3-05	21/04/2024	55.2	43.7	0	274	1.1	1004
LVNW3-06	21/04/2024	57.3	40.6	0	671	2.1	1005
LVNW3-07	21/04/2024	37.4	29.8	0.1	215	32.7	1004

LEVIN LANDFILL GAS MONITORING

MAY 2024

Prepared by:

Shanka Samarathunge
Environmental Technician

Reviewed and approved by:

Ryan Hughes
Environmental Engineer

Contents

1.0 Introduction

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2.0 Objective

2.1 Resource Consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedance require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** *Note: *Favourable weather conditions*	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the Survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating procedure for all Landfills. The survey was conducted on 19th May 2024 from 9.00 a.m. to 2.00 p.m. Pre-planned survey lines directing 16NW in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Thirty two gas wells in different stages of the landfill were monitored by using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well. Monitoring sessions were conducted fortnightly.

4. Weather Conditions

The weather data is based on according to the online Levin weather station data for this reporting. (https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-05-19/2024-05-19/daily)

There was a 3.81mm rain fall recorded 20 hours prior to the survey according to the weather station data. The pressure fluctuated between 1020.99 hpa to 1017.60 hpa prior to the survey. For comprehensive insights into the pre-survey weather conditions, please refer to Appendix 3.0.

During the survey, the average atmospheric pressure slightly fluctuated from 1018.28 hpa to 1017.27 hpa. The average wind speed observed throught the survey period was 8.0 km/h. There was no rainfall during the survey. Detailed information regarding the weather conditions on the survey date can be found in Appendix 3.0.

5. Survey Results

There was 1 location identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using bentonite and water. The identified high emission locations include in the edge of the clay cover and dead grass patches on the final and intermediate cover.

Gas well monitoring was conducted according to prescheduled dates within the month and from 31 wells the average CH_4 level was 44.27 % with the highest of 66.8% in LVNW2009 and the lowest of 0.0% in LVNW1008. The average CO_2 level was 31.62 % with the highest of 44.9% in LVNW3008 and the lowest of 0.1% in LVNW1008. The average O_2 level was 2.77 % with the highest of 19.0% in LVNW1008 and the lowest of 0% in nine wells (see the appendix 4). The flare readings before the survey were 44.5% of CH_4, 1.26% of O_2 and 51 m3 of flow rate. After the gas well tuning the flare readings were 49.4 % of CH_4, 0.71% of O_2 and 72 m3 of flow rate. The individual gas value and total average values can fluctuate due to many reasons such as the draw of the well, as well as the number of monitoring wells. Additionally, the number of live monitoring gas wells undergoing draw can vary each month depending on the well gas quality or the landfill activity.

5.2 Summary of Overall Gas Monitoring

5.2.1 Gas Well Monitoring

The average methane percentage was stable at 55% - 56% from June to August in 2023 and then dropped up to 45% in September 2023 before rising to 51% in October 2023. From October to December in 2023, the methane percentage decreased gradually to 39%. From December 2023 to January 2024 the average methane level has slightly increased up to 41.47% and further increased in February up to 51.23%. There is a slight increase from 38.92% to 44.88 % from March to April 2024 and up to May, methane percentage is stable within 44% with a minor decrease of 44.88% to 44.27%.

The general fluctuation of methane percentage is largely dependent on the draw from, and the run-time of, the flare. The number of wells with more than 45% methane in each monitoring round varies depending on the activity around the landfill, and this has increased this month.

Number of wells with the high percentage of Methane production has increased compared to the previous month and Table 1 shows the number of wells with over 45% of methane from the total monitored wells in during the monitoring period.

Table 1: The number of wells with more than 45% Methane each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Total monitored wells	29	27	20	20	29	28	32	30	30	31
Number of wells with over 45% Methane	25	18	17	15	15	16	26	17	21	21

The average Carbon Dioxide percentage was fairly consistent for June to August in 2023 with around 38% - 36%, and from August to December 2023 a gradual drop of average CO_2 percentage from 36% to 28% was observed. During February to March the percentage has gradually dropped up to 27.74%. There is a slight increase in April up to 29.67% and further increased in May up to 31.62%. Table 2 represents the total number of wells with over 30% CO_2 in each month.

Table 2: The number of wells with more than 30% Carbon Dioxide each monitoring round.

Month	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Total monitored wells	29	27	20	20	29	28	32	30	30	31
Number of wells with over 30% CO2	27	20	19	16	18	17	25	14	16	19

The following graphs represent this months gas quality, and gas quality changes to April in available selected wells from highest and lowest gas quality readings from the April survey.

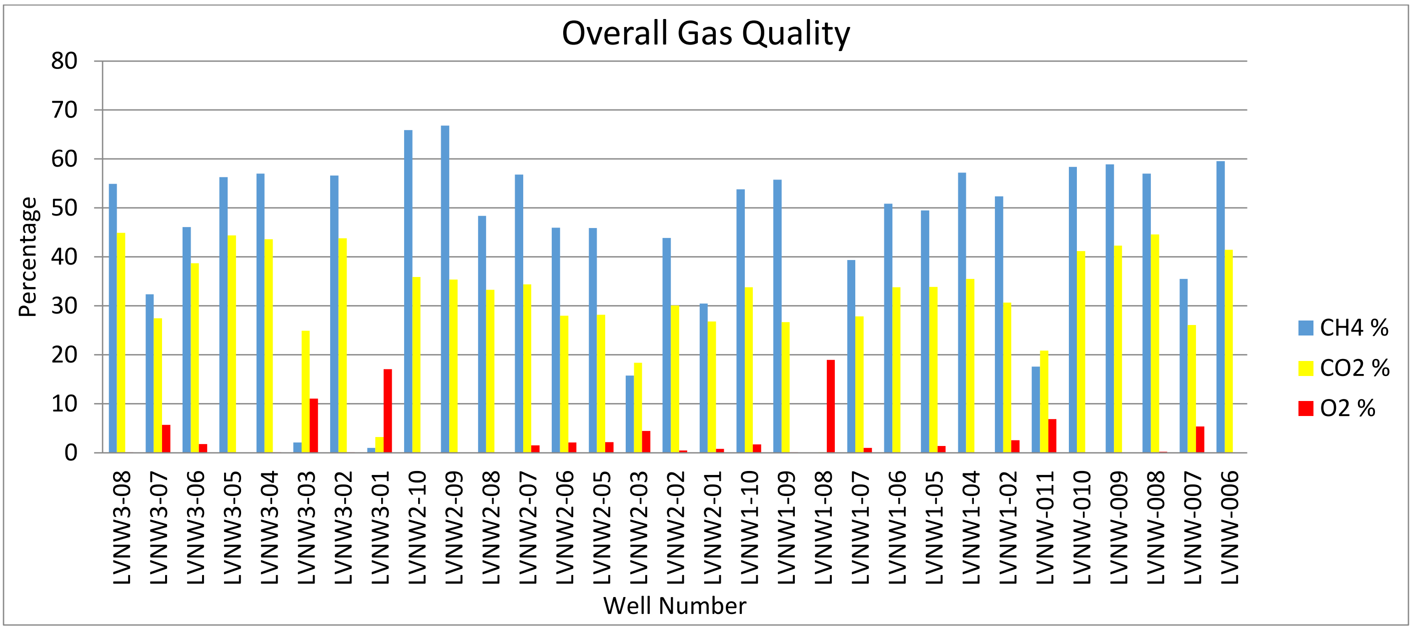


Figure 1: Overall gas quality in individual wells in May 2024

The following graph represents the CH4% changes during the April to May 2024 period from selected wells of the highest and lowest value recorded in the May survey. Some wells maintain consistent values 50%, and few indicate notable changes during this period. There are a limited number of wells that maintain a low range low range of Methane below 10%. These fluctuations occur from the gas flow path change, biological activity changes around well draw perimeter and also change of cover conditions.

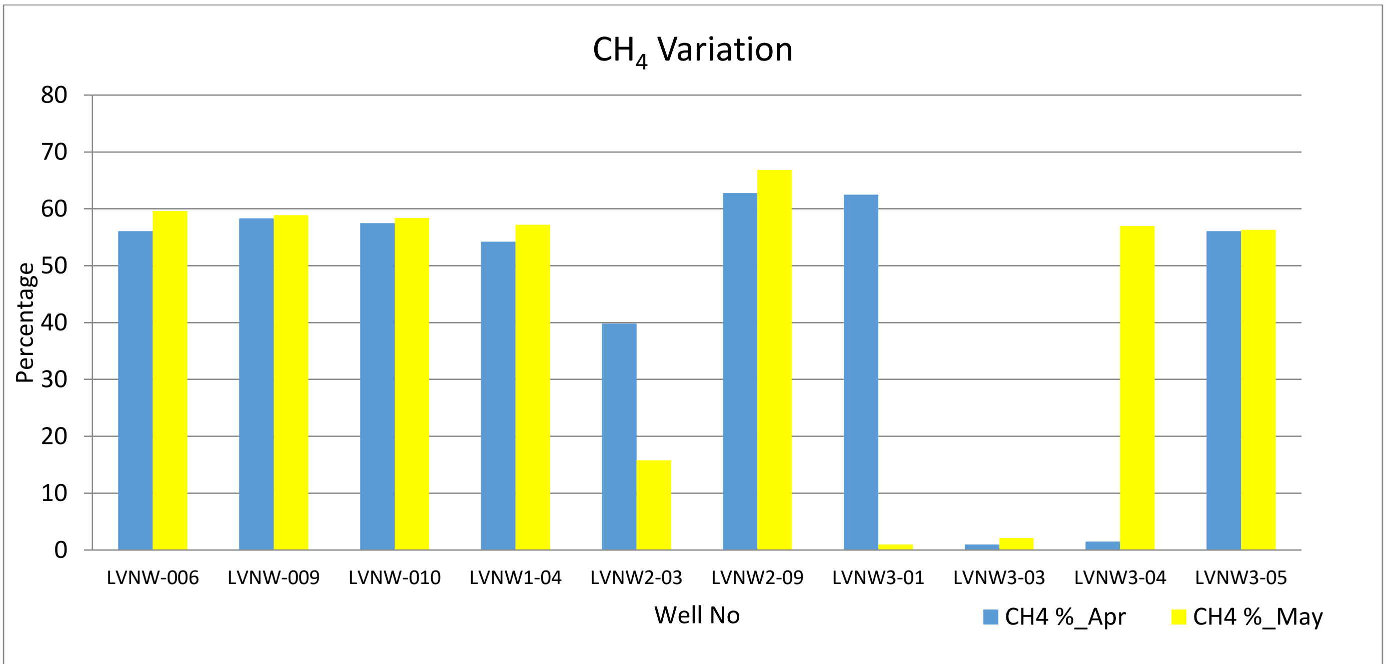


Figure 2: Methane variation from April to May 2024 for selected wells

The following graph represents the CO_2% changes during April to May 2024 from selected wells of the highest and lowest value recorded in the May survey. Some wells maintain consistent values around 30% - 40%, and a few indicate notable changes during this period. The well CO2 gas content behaves similarly to methane content with low productive wells maintaining a low percentage and high productive wells consistently maintaining a high percentage. These fluctuations can occur due to the previous mentioned reasons around well perimeter.

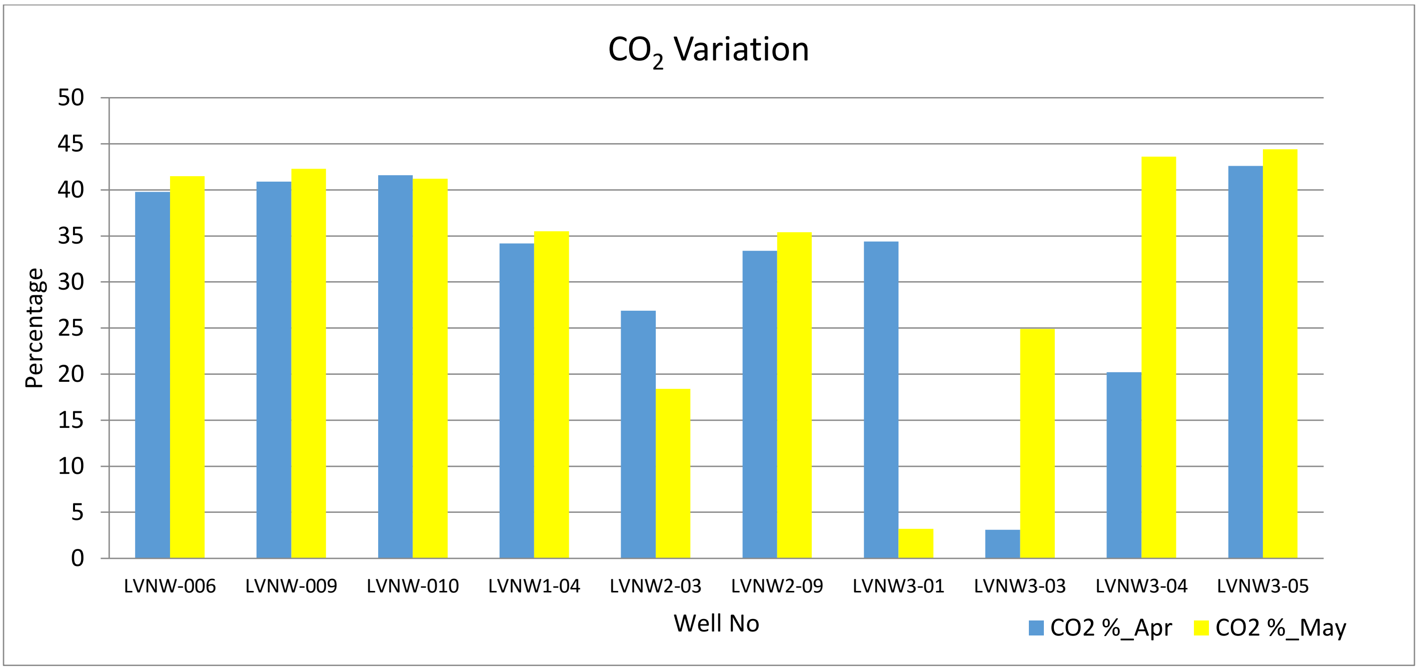


Figure 3: Carbon Dioxide variation from April to May for selected wells

The following graph represents the O2% changes from April to May from the highest and lowest value recorded wells from May 2024 survey. Some wells maintain consistent values of < 5% and some wells fluctuate as increasing and decreasing trends within this period. Oxygen percentage can vary depending on gas line condition, well design, well base condition, and landfill cover. Poor conditions of any of these factors may cause oxygen to be drawn into the gas reticulation system. Therefore, some wells may show highly fluctuating oxygen percentages, while others may show consistent values over the monitoring period.

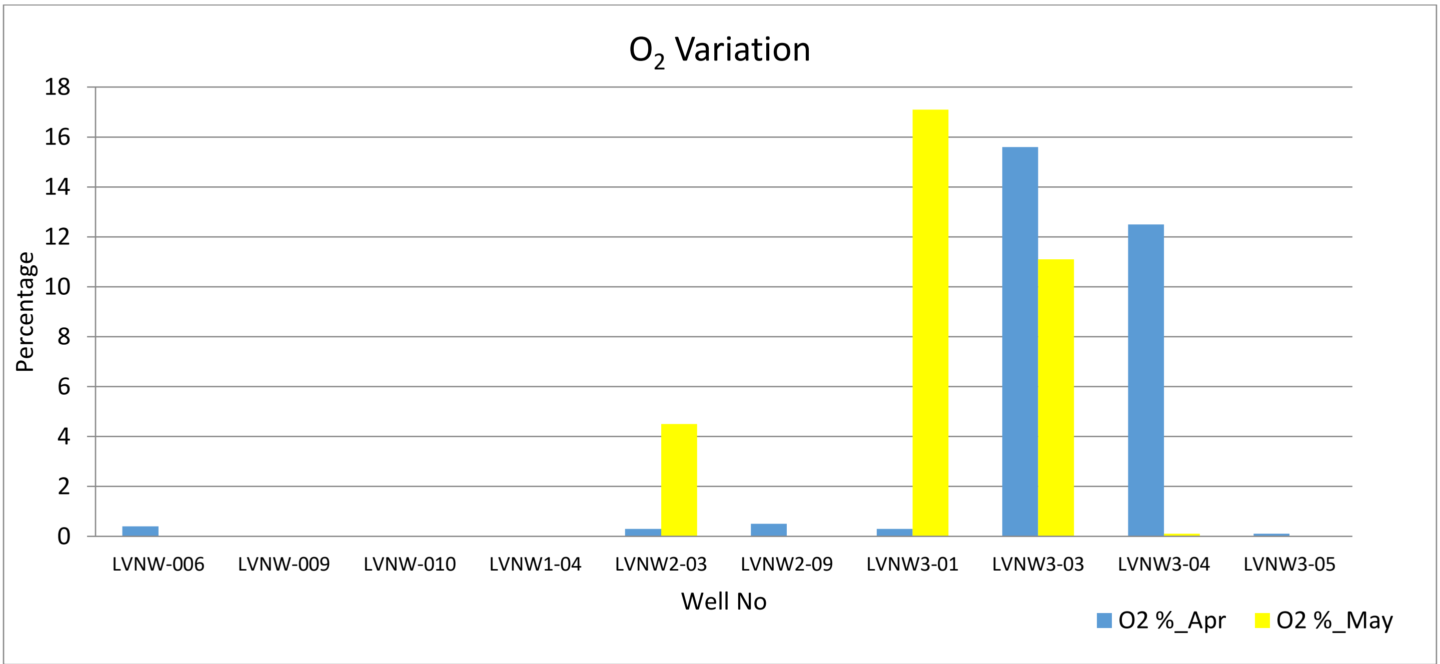


Figure 4: Oxygen percentage variation from April to May for selected wells

5.2.2 Instantaneous Surface Monitoring

During the period from May 2023 to May 2024, 56 ISM locations were identified and remediated. Compared to last month there are fewer locations of high emission areas due to the new cover and change of weather conditions.

Table 3: The number of identified and remediated ISM exceedances each month.

Month	**Identified locations**	**Remediated locations**
May2023	18	18
June 2023	6	6
July 2023	2	2
August 2023	4	4
September 2023	3	3
October 2023	3	3
November 2023	3	3
December 2023	2	2
January 2024	6	6
February 2024	3	3
March 2024	2	2
April 2024	3	3
May 2024	1	1

6. Recommendations

The gas quality of the wells has generally been relatively stable again this month when compared against last month. There are a small number of wells that have had some larger changes and these will be monitored closely. The oxygen in general has decreased across the wells.

Many of the wells may have become adapted to the draw from the flare, and the bioactivity in the wells may have been stabilising. Stabilised weather conditions can also play a significant part in this, particularly in regards to the temperature, but also more consistent rainfall and water ingress.

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

Appendix 1. Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	398ppm		Edge of the Southern faces of the landfill, bottom area of the clay cover	Bentonite and water		53ppm

Appendix 2.Surface emission map

Levin Landfill Surface Emission Survey - May 2024

Appendix 3. Weather condition prior to the survey and during the survey

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-05-19/2024-05-19/daily

Weather History for ILEVIN75

Previous | Daily Mode | May | 19 | 2024 | View | Next

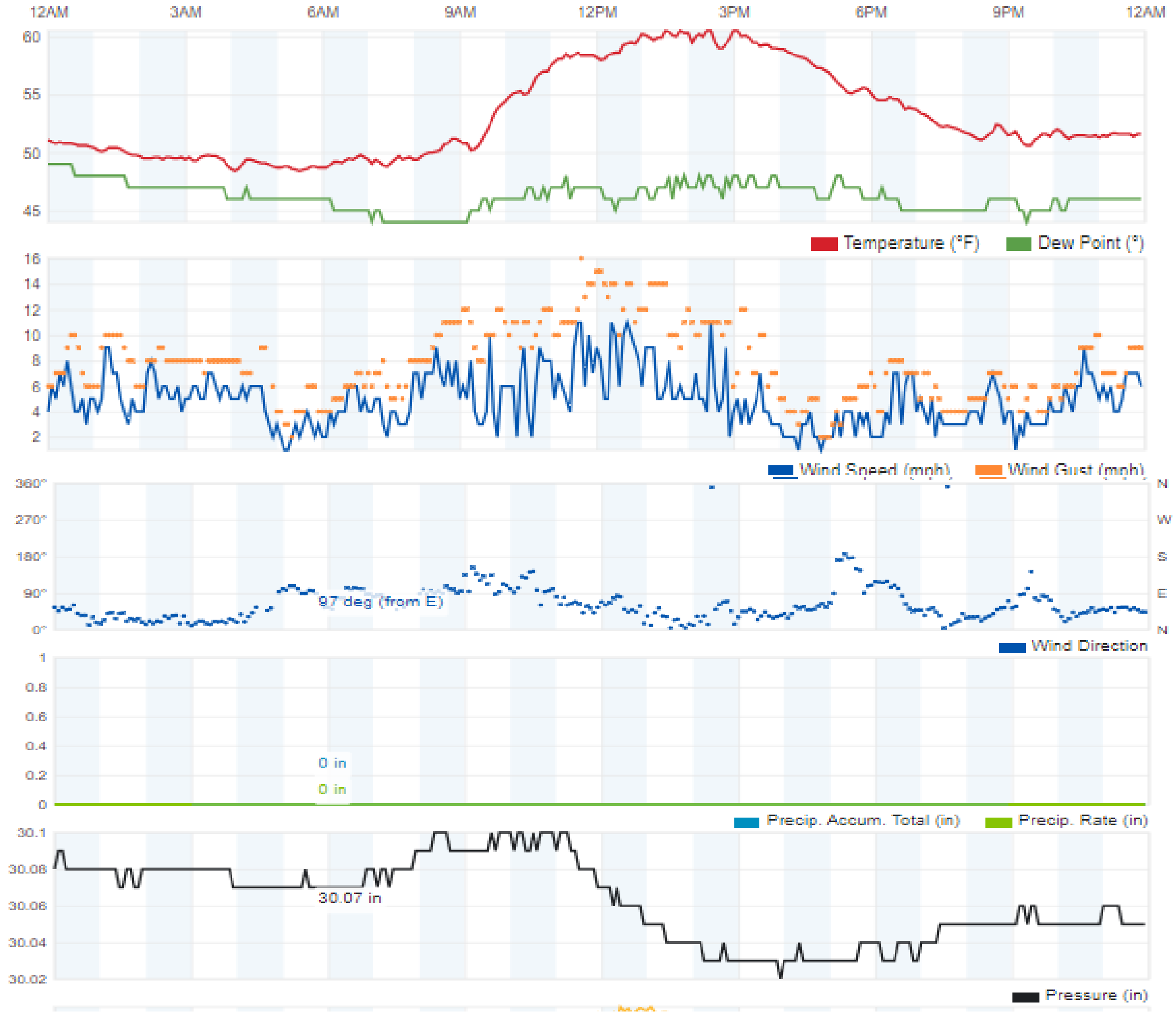
Summary
May 19, 2024

	High	Low	Average
Temperature	60.5 °F	48.4 °F	53.3 °F
Dew Point	49.0 °F	44.0 °F	46.2 °F
Humidity	93 %	59 %	78 %
Precipitation	0.00 in	--	--

	High	Low	Average
Wind Speed	11.0 mph	1.0 mph	5.0 mph
Wind Gust	16.0 mph	--	7.8 mph
Wind Direction	--	--	NE
Pressure	30.10 in	30.02 in	--

Graph | Table

May 19, 2024



Weather History for ILEVIN75

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-05-19/2024-05-19/weekly

Previous | Weekly Mode | May | 19 | 2024 | View | Next

Summary

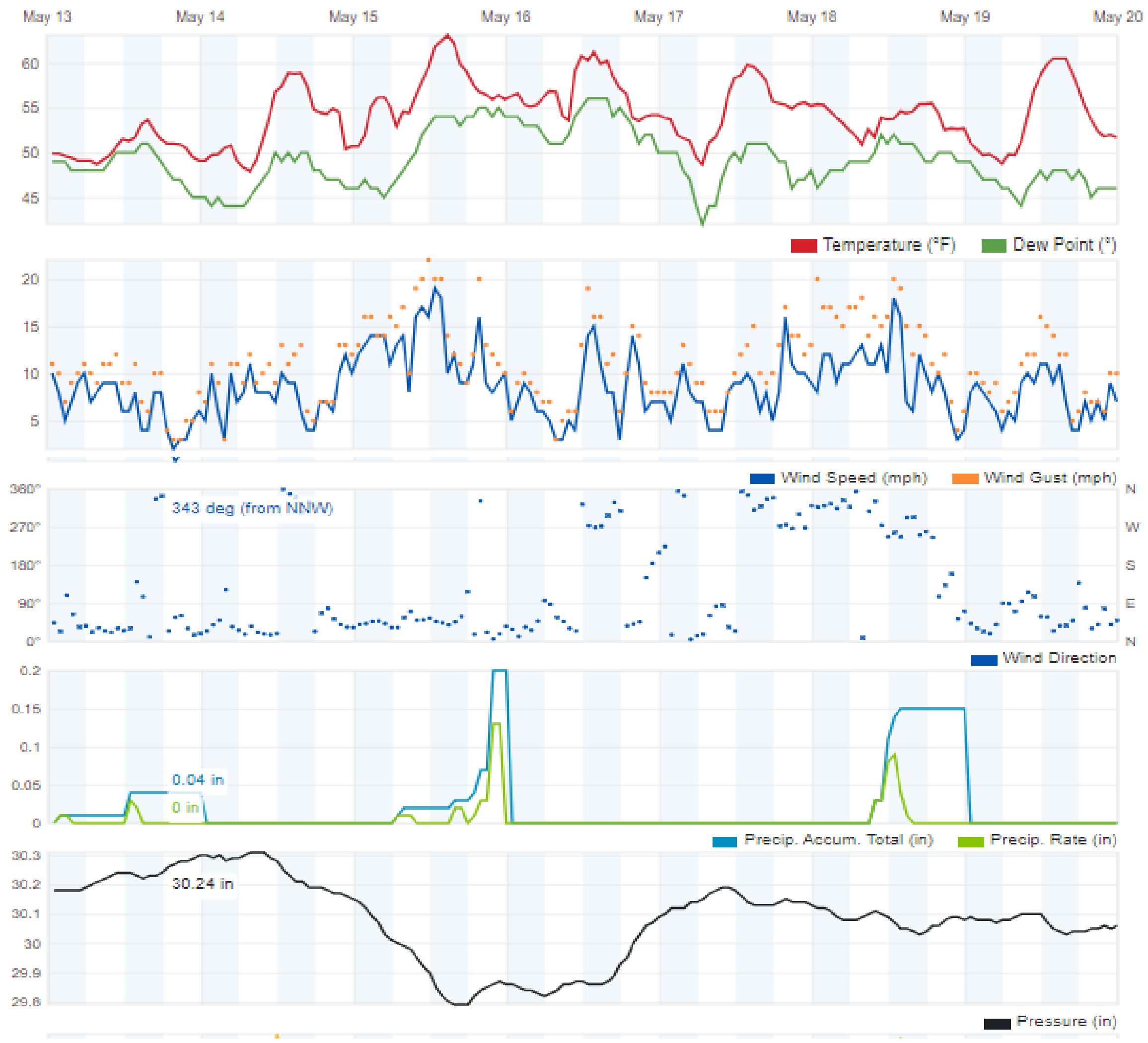
May 13, 2024 - May 19, 2024

	High	Low	Average
Temperature	63.1 °F	47.0 °F	53.6 °F
Dew Point	56.0 °F	42.0 °F	48.5 °F
Humidity	97 %	59 %	83 %
Precipitation	0.39 in	--	--

	High	Low	Average
Wind Speed	19.0 mph	0.0 mph	5.4 mph
Wind Gust	22.0 mph	--	8.8 mph
Wind Direction	--	--	ESE
Pressure	30.31 in	29.77 in	--

Graph | Table

May 13, 2024 - May 19, 2024



Appendix 4. Gas monitoring results for May 2024

ID	Date	CH4 %	CO2 %	O2 %	H2S ppm	Res N %	Bal	Baro mb
LVNW-006	19/05/2024	59.6	41.5	0	211	0	0	1015
LVNW-007	19/05/2024	35.5	26.1	5.4	81	12.59	33	1015
LVNW-008	19/05/2024	57	44.6	0.2	1818	0	0	1015
LVNW-009	19/05/2024	58.9	42.3	0	913	0	0	1015
LVNW-010	19/05/2024	58.4	41.2	0	287	0.4	0.4	1014
LVNW-011	19/05/2024	17.6	20.9	6.9	15	28.52	54.6	1015
LVNW1-02	19/05/2024	52.4	30.7	2.6	16	4.47	14.3	1017
LVNW1-04	19/05/2024	57.2	35.5	0	78	7.3	7.3	1017
LVNW1-05	19/05/2024	49.5	33.9	1.4	14	9.91	15.2	1017
LVNW1-06	19/05/2024	50.9	33.8	0	71	15.3	15.3	1017
LVNW1-07	19/05/2024	39.4	27.9	1	13	27.92	31.7	1017
LVNW1-08	19/05/2024	0	0.1	19	10	9.08	80.9	1017
LVNW1-09	19/05/2024	55.8	26.7	0.1	17	17.02	17.4	1017
LVNW1-10	19/05/2024	53.8	33.8	1.7	9	4.27	10.7	1017
LVNW2-01	19/05/2024	30.5	26.8	0.8	0	38.88	41.9	1016
LVNW2-02	19/05/2024	43.9	30.1	0.5	0	23.61	25.5	1016
LVNW2-03	19/05/2024	15.8	18.4	4.5	0	44.29	61.3	1016
LVNW2-05	19/05/2024	45.9	28.2	2.2	0	15.38	23.7	1016
LVNW2-06	19/05/2024	46	28	2.1	0	15.96	23.9	1016
LVNW2-07	19/05/2024	56.8	34.4	1.5	17	1.63	7.3	1016
LVNW2-08	19/05/2024	48.4	33.3	0	107	18.3	18.3	1016
LVNW2-09	19/05/2024	66.8	35.4	0	204	0	0	1016
LVNW2-10	19/05/2024	65.9	35.9	0	170	0	0	1016
LVNW3-01	19/05/2024	1	3.2	17.1	44	14.06	78.7	1015
LVNW3-02	19/05/2024	56.6	43.8	0.1	268	0	0	1015
LVNW3-03	19/05/2024	2.1	24.9	11.1	46	19.94	61.9	1015
LVNW3-04	19/05/2024	57	43.6	0.1	711	0	0	1015
LVNW3-05	19/05/2024	56.3	44.4	0	679	0	0	1015
LVNW3-06	19/05/2024	46.1	38.7	1.8	39	6.6	13.4	1015
LVNW3-07	19/05/2024	32.4	27.5	5.7	19	12.85	34.4	1015
LVNW3-08	19/05/2024	54.9	44.9	0.1	988	0	0.1	1014

WHANGANUI ENVIRONMENTAL ENGINEERING

LEVIN LANDFILL GAS MONITORING

JUNE 2024

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Environmental Technician

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Contents

1.0 Introduction

Whanganui Environmental Engineering is working with the Horowhenua District Council to assist in managing the environmental impacts of the Levin landfill. This survey provides a qualitative assessment of landfill gas from the Levin landfill for the month of June, 2024 in compliance with the resource consent.

2.0 Objective

2.1 Resource Consent

Levin Landfill monthly methane monitoring consent requirement is outlined in discharge permit 6011, sections 5(e), 5(f) and 5(m(iv)). Monthly methane monitoring is required to be conducted across all areas of the landfill with a temporary or permanent cap. The report is to include the description of survey procedures, as well as the meteorological conditions at the time of monitoring. The methane limits vary depending on the type of capping being surveyed, but all exceedance require remediation and retesting within 24hours. If post-remediation testing continues to show an exceedance, then an action plan needs to be developed and provided to the Manawatu-Whanganui Regional Council within 48 hours.

2.2 Requirements

The main components of the monitoring required by Discharge Permit 6011 are gas well monitoring and surface emission monitoring. Gas well monitoring is a continuous monitoring process in dedicated gas well heads and this monitoring process is only slightly influenced by weather conditions, namely atmospheric pressure. The surface emission survey must be conducted in favourable weather conditions in order to accurately identify leaks through the capping and obtain representative survey results. The following table describes the ideal weather conditions required for the survey.

Criteria	**Resource consent requirements None** ***Note:** ***Favourable weather conditions***	**Whanganui Environmental Engineering SOP Guidelines**
Average wind speed	*Less than 25km/h, ideally 5-10km/h	Less than 15km/h ideally less than10km/h
Rainfall	*0.5mm in 48hours	Less than 0.5mm having fallen in 2 days prior
Landfill surface grass height	-	Less than 100 mm
Landfill surface	-	Dry
Atmospheric pressure	-	Ideally declining atmospheric pressure after several days of high pressure

3.0 Detail of the Survey

3.1 Site Description

Levin landfill is located at 665 Hokio Beach Road, Levin comprising an area of roughly 4 Ha in the 71.5 Ha parcel. The Levin Landfill site is comprised of two landfills: an old, closed and unlined landfill and a new, lined landfill that has been recently closed. The new landfill footprint has been developed in stages and that is the monitoring area for the gas and surface emissions.

3.2 Surface Emission survey

A Bascom-Turner Gas-Rover detector is used to assess the levels of emissions of methane. The instantaneous surface emission monitoring is done by the Surface Emission Survey Standard Operating procedure for all Landfills. Horowhenua District Council has requested to conduct weekly surface emission surveys and the surveys were conducted on 2nd, 16th, 23rd and 29th of June 2024. Pre-planned survey lines directing 16NW in 25m intervals were used as primary survey lines along the landfill surface. Random locations beyond the survey line for probable high surface emission such as dead grass patches, cracked or widely opened clay cover and highly eroded faces were also monitored.

3.3 Gas Well Monitoring

Horowhenua District Council requested weekly gas monitoring sessions for June 2024, and conducted on 2nd, 16th, 23rd and 29th of June 2024 by using a GA 5000 Landfill Gas Analyser. Additionally, a separate thermometer was used to monitor the temperature of selected wells. The selection of the wells with which a thermometer was used determined on the gas content and quality in the well.

4. Weather Conditions

The weather data is based on according to the online Levin weather station data for this reporting. (https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-06-23/2024-06-23/daily)

The weather conditions for the 23thJune 2024 survey are detailed in this paragraph. According to the weather station data, there was no rain fall recorded 72 hours prior to the survey. The atmospheric pressure fluctuated between 1024.38 hpa to 1017.60 hpa prior to the survey. For comprehensive insights into the pre-survey weather conditions, please refer to Appendix 3.0. During the survey, the average atmospheric pressure varied slightly from 1014.56 hpa to 1012.86 hpa. The average wind speed fluctuates between 0 km/h to 13 km/h throughout the survey period. There was no significant rainfall during the survey, with only 2.2 mm recorded in the morning, which likely did not affects to the overall survey results. Detailed weather conditions for the survey date are available in Appendix 3.0.

Similarly, the weather conditions for the June 29, 2024 survey are outlined here. There was no rainfall recorded 48 hours prior to the survey according to the weather station data. The atmospheric pressure ranged between 1024.04 hpa to 1017.94 hpa prior to the survey. For detailed pre- survey weather information, refer appendix 3.0. During the survey, the average atmospheric pressure slightly fluctuated from 1016.93 hpa to 1019.30 hpa. The average wind speed varied between 0 km/h to 8.3 km/h throughout the survey period. There was no significant rainfall recorded during the survey. Detailed weather conditions for the survey date can be found in Appendix 3.0.

5. Survey Results

There were 10 location identified from the methane surface emission survey in the final and intermediate cover. All the locations were remediated using bentonite and water. The identified high emission locations include in the final clay cover and dead grass patches on the final and intermediate cover.

Gas well monitoring was conducted on the specified dates, and the average CH4 levels recorded were 51.89% on June 2nd, 50.66% on June 16th, 50.21% on June 23rd, and 53.29% on June 29th. The average CO2 levels were 34.84% on June 2nd, 34.60% on June 16th, 34.11% on June 23rd, and 34.39% on June 29th. The average O2 levels were 2.17% on June 2nd, 2.01% on June 16th, 2.62% on June 23rd, and 2.29% on June 29th. The flare was not operational during the survey period due to a technical issues. It should be noted that individual gas values and total average values can fluctuate due to several factors, including the draw of the well and the number of monitoring wells. Additionally, the number of active monitoring gas wells can vary each month depending on the gas quality or landfill activity.

5.2 Summary of Overall Gas Monitoring

5.2.1 Gas Well Monitoring

The average methane percentage was stable at 55% - 56% from June to August in 2023 and then dropped up to 45% in September 2023 before rising to 51% in October 2023. From October to December in 2023, the methane percentage decreased gradually to 39%. From December 2023 to January 2024 the average methane level has slightly increased up to 41.47% and further increased in February up to 51.23%. There was a slight increase from 38.92% to 44.88 % from March to April 2024 and in May to June the percentage has increased from 44.27% to 51.52%.

The general fluctuation of methane percentage is largely dependent on the draw from, and the run-time of, the flare. The number of wells with more than 45% methane in each monitoring round varies depending on the activity around the landfill, and this has increased this month.

The number of wells with high methane production increased compared to the previous month, as indicated by the survey results on June 29, 2024. Table 1 presents the number of wells with methane concentrations exceeding 45% of the total monitored wells during the monitoring period.

Table 1: The number of wells with more than 45% Methane each monitoring round.

Month	**Aug** 2024	**Sep**	**Oct**	**Nov**	**Dec**	**Jan** 2024	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Total monitored wells	29	27	20	20	29	28	32	30	30	31	31
Number of wells with over 45% Methane	25	18	17	15	15	16	26	17	21	21	26

The average carbon dioxide (CO2) percentage remained fairly consistent from June to August 2023, ranging between 36% and 38%. From August to December 2023, a gradual decline was observed, with average CO2 levels decreasing from 36% to 28%. Between February and March 2024, the percentage dropped further to 27.74%. A slight increase was noted in April, reaching 29.67%, followed by a further rise to 31.62% in May. The period from May to June saw a continued increase in CO2 levels, peaking at 38.18% based on the survey results from June 29, 2024. Table 2 details the total number of wells with CO2 concentrations exceeding 30% each month.

Table 2: The number of wells with more than 30% Carbon Dioxide each monitoring round.

Month	**Aug** 2023	**Sep**	**Oct**	**Nov**	**Dec**	**Jan** 2024	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Total monitored wells	29	27	20	20	29	28	32	30	30	31	31
Number of wells with over 30% CO2	27	20	19	16	18	17	25	14	16	19	27

The following graphs represent this monthly gas quality, and gas quality changes in June from the selected wells for each survey round.

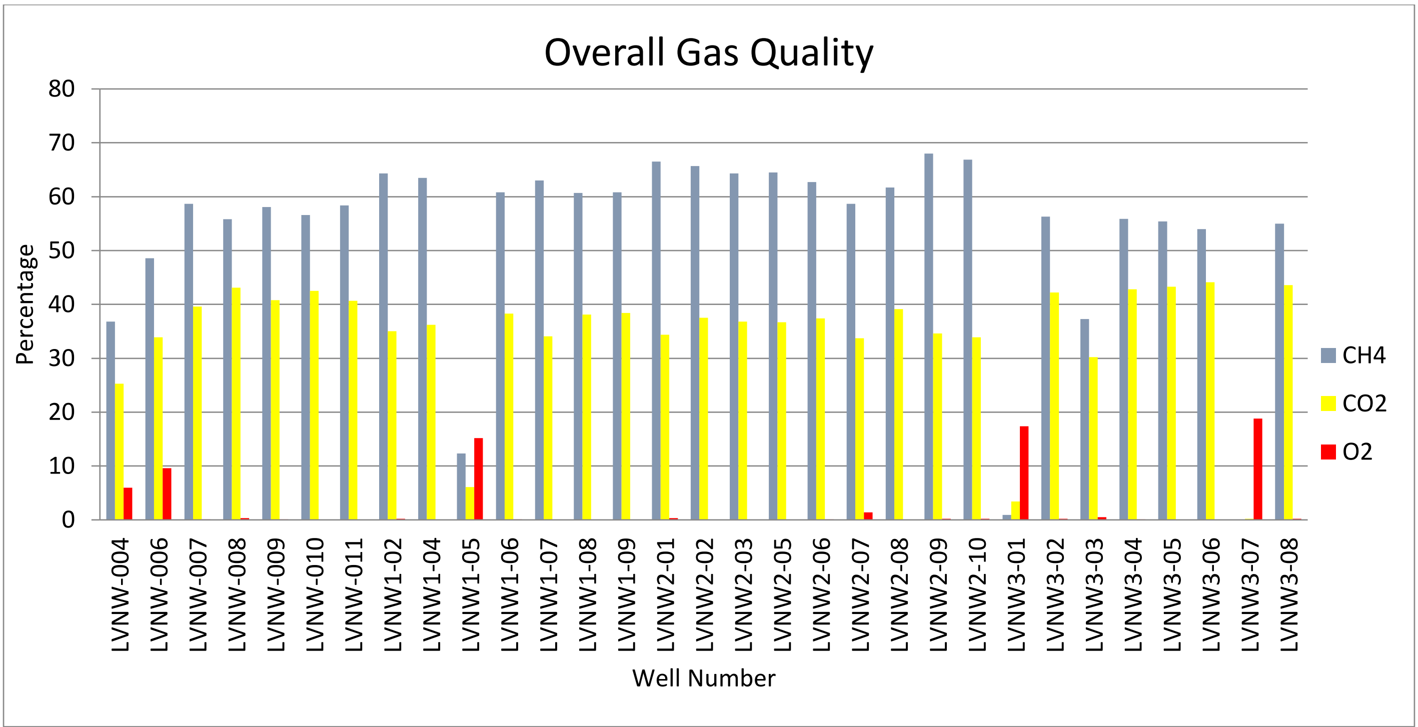


Figure 1: Overall gas quality in individual wells in June 2024

The following graph illustrates the changes in CH4 percentages during the survey rounds conducted on June 2nd, 16th, 23rd, and 29th, 2024. Methane levels remained consistent in wells with high concentrations, while significant fluctuations were observed in wells with lower concentrations. These fluctuations can be attributed to changes in gas flow paths, variations in biological activity around the well draw perimeter, and alterations in cover condition.

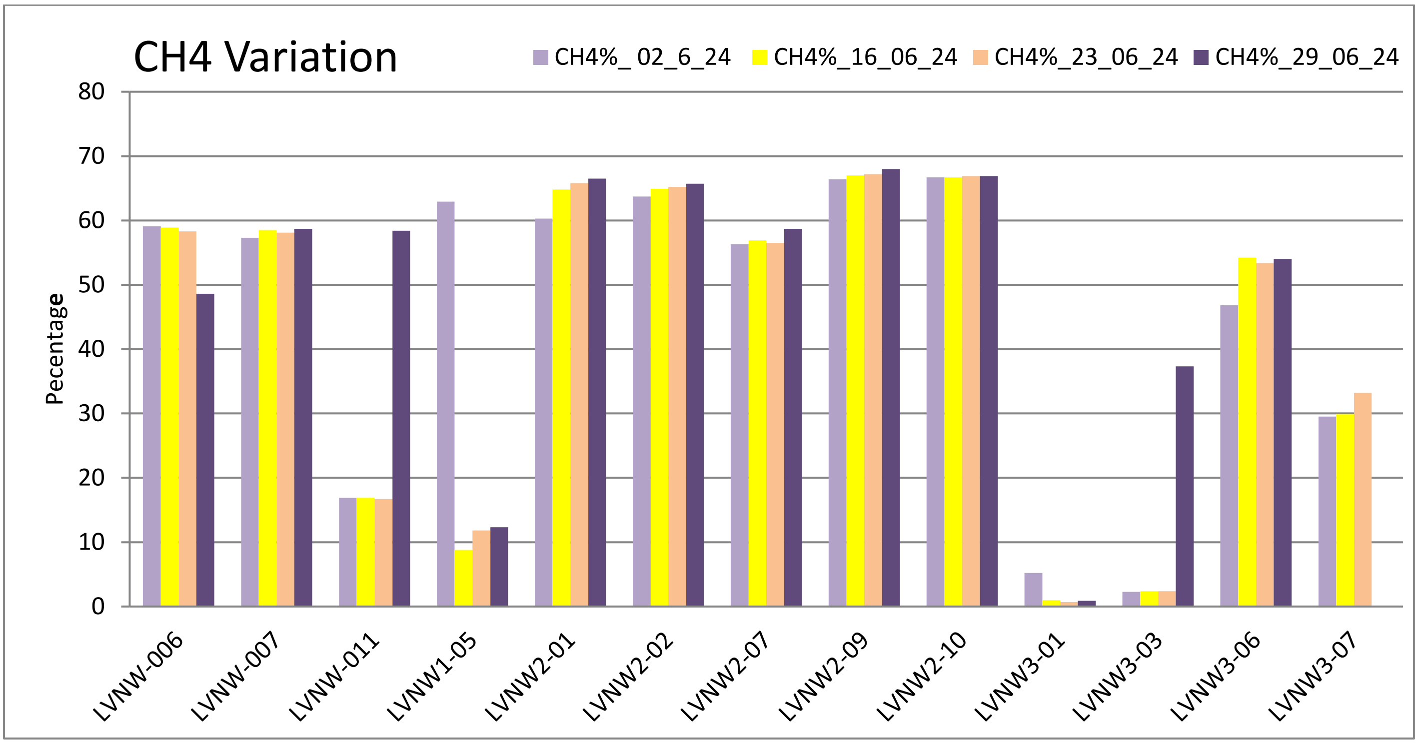


Figure 2: Methane variation in June 2024 surveys for selected wells

The following graph depicts the changes in CO2 percentages during the survey rounds on June 2nd, 16th, 23rd, and 29th, 2024. CO2 levels remained consistent in wells with high concentrations, while notable fluctuations were observed in wells with lower concentrations. The behaviour of CO2 gas content in wells is similar to that of methane, with low-producing wells maintaining low percentages and high-producing wells consistently maintaining high percentages. These fluctuations can be attributed to changes in gas flow paths, variations in biological activity around the well perimeter, and alterations in cover conditions.

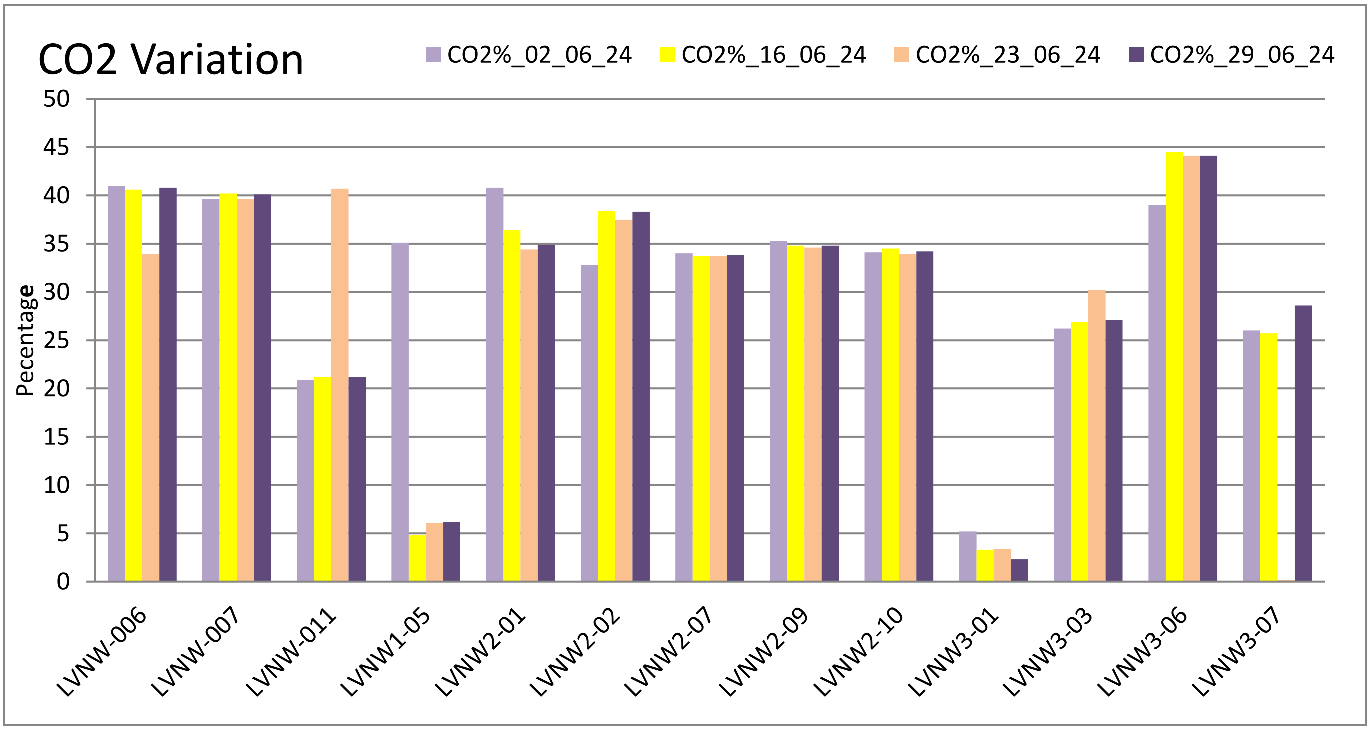


Figure 3: Carbon Dioxide variation in June 2024 surveys for selected wells

The following graph illustrates the changes in O2 percentages during the survey rounds conducted on June 2nd, 16th, 23rd, and 29th, 2024. While some wells maintained consistent values within high and low ranges, others exhibited increasing and decreasing trends during this period. Oxygen percentages can vary due to factors such as gas line condition, well design, well base condition, and landfill cover. Poor conditions in any of these areas may cause oxygen to be drawn into the gas reticulation system, resulting in highly fluctuating oxygen percentages in some wells, while others may show consistent values over the monitoring period.

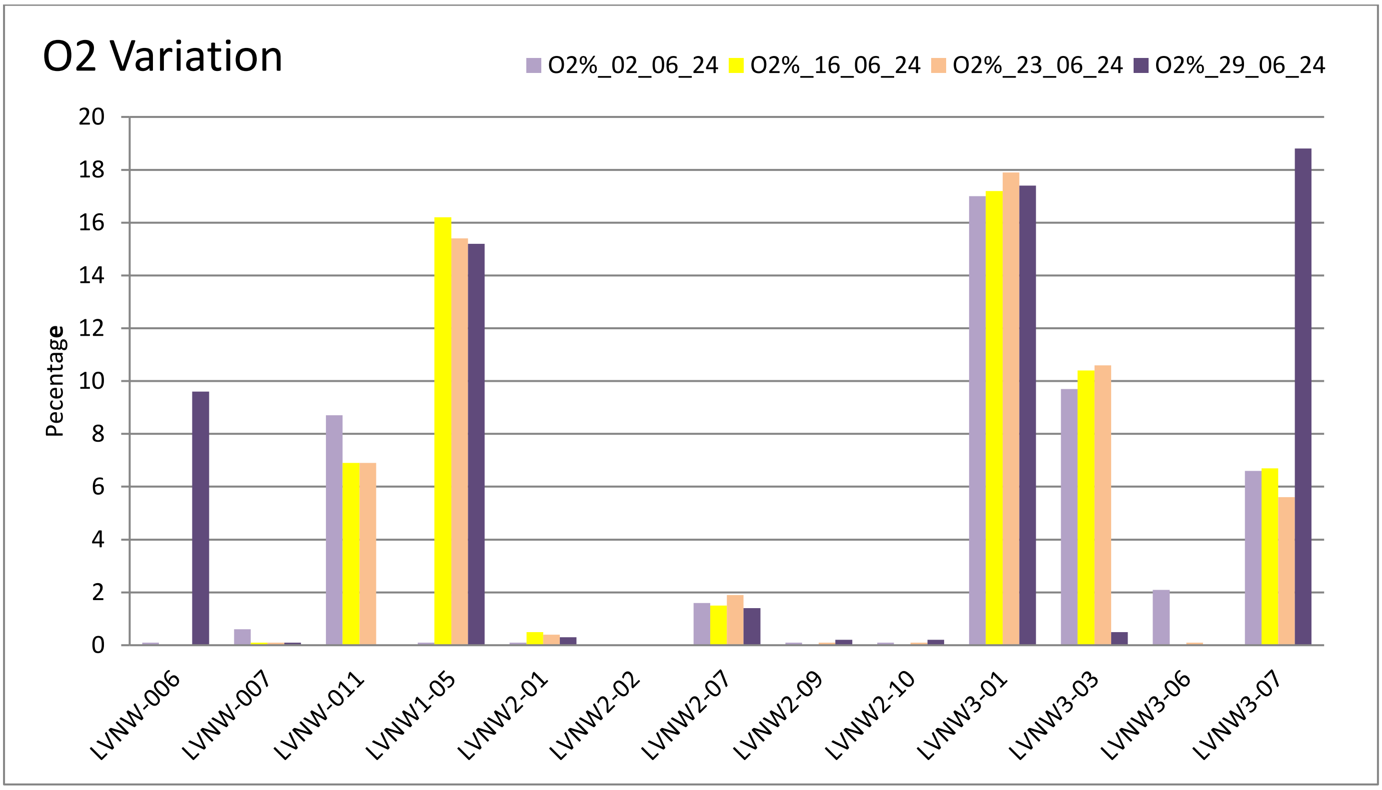


Figure 4: Oxygen percentage variation in June 2024 surveys for selected wells

5.2.2 Instantaneous Surface Monitoring

During the period from May 2023 to June 2024, 66 ISM locations were identified and remediated. Compared to last month there are additional locations of high emission areas due to the weekly monitoring schedule and the flare operational issues.

Table 3: The number of identified and remediated ISM exceedances each month.

Month	**Identified locations**	**Remediated locations**
May2023	18	18
June 2023	6	6
July 2023	2	2
August 2023	4	4
September 2023	3	3
October 2023	3	3
November 2023	3	3
December 2023	2	2
January 2024	6	6
February 2024	3	3
March 2024	2	2
April 2024	3	3
May 2024	1	1
June 2024	10	10

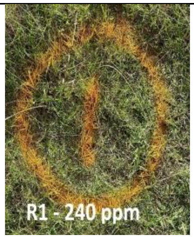
6. Recommendations

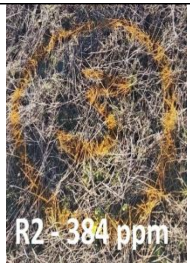
The gas quality of the wells has generally been relatively stable again this month when compared against last month. There are a small number of wells that have had some considerable changes and the close monitoring every week represents better gas quality changes and its behaviour during this month.

An increasing trend in surface emissions can be observed due to issues with flare operation. Without proper suction from the gas wells, more gas tends to escape gradually, depending on the generated gas pressure from the landfill. The gas inside landfills generally tends to be under positive relative pressure due to gas production occurring and the landfill capping impeding its emittance to the atmosphere. It is notably difficult to prevent gas surface emissions in landfills when the gas capture and destruction infrastructure is down. However, observations of the gas surface emissions from this month suggest that the capping is in good order and impeding gas surface emissions well when compared to what would be expected for a landfill of this size, or what would likely have been observed prior to the capping upgrades that Horowhenua District Council have undertaken.

Continuous monitoring should be carried out to observe the trends of the gas wells and to observe the entire behaviour of the landfill. The flare has a considerable effect on gas well behaviour and surface emissions. Regular well monitoring and tuning serves as the primary control for ensuring continuous flare operation, and reducing surface emissions, and therefore is the most important aspect of gas management in closed landfills.

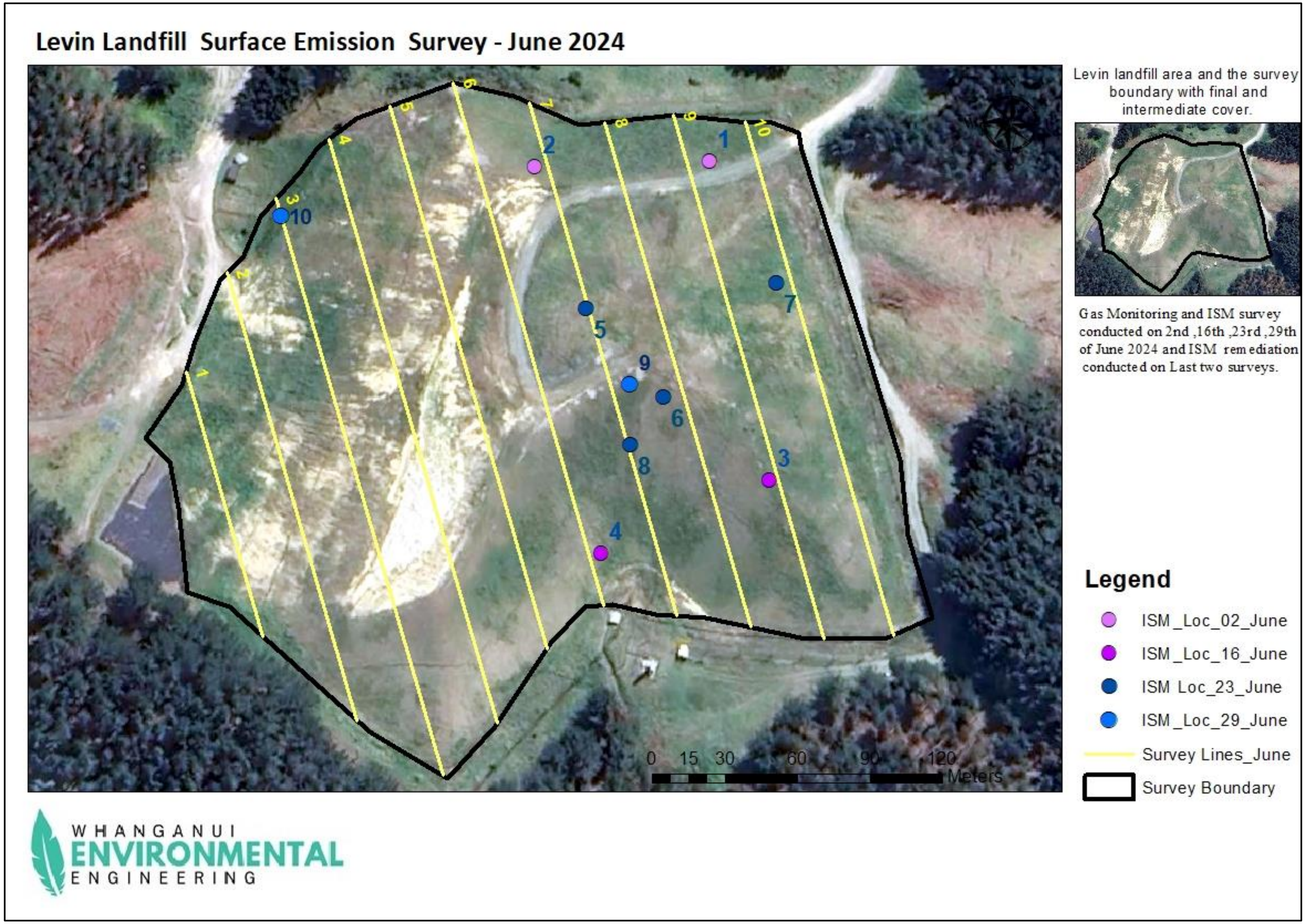
Appendix 1. Methane readings and locations

Location Number	CH_4 Reading	Site Photographs	Location and description	Action Required	Remediation and description	Retest result
1	240ppm		North eastern edge of the landfill, in grass covered area	Bentonite and water		30ppm
2	380ppm		Middle of the Northern face in a grass covered area	Bentonite and water		20ppm
3	218ppm		Southern face, closer to the top edge of the face, in clay cover	Bentonite and water		35ppm

4	384ppm		Bottom edge of the final clover in southern face of the landfill	Bentonite and water		25ppm
5	662ppm		Middle of the landfill along line no.7, in final clay cover	Bentonite and water		42ppm
6	179ppm		In upper part of South Eastern face, in final cover on grass covered area	Bentonite and water		53ppm
7	340ppm		Closer to bottom of North Eastern face, in a grass covered area	Bentonite and water		24ppm

8	230ppm		Upper part of the Southern faces, in grass covered area on line no.7	Bentonite and water		78ppm
9	664ppm		Upper edge of South Eastern face, closer to main access road, in grass covered are	Bentonite and water		26ppm
10	210ppm		Bottom edge of the North Western face, closer to the side drai, alon ther lone no.3	Bentonite and water		35ppm

Appendix 2.Surface emission map



Appendix 3. Weather condition prior to the survey and during the survey

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-06-23/2024-06-23/daily

Weather History for ILEVIN75

Daily Mode | June | 23 | 2024 | View

Previous | Next

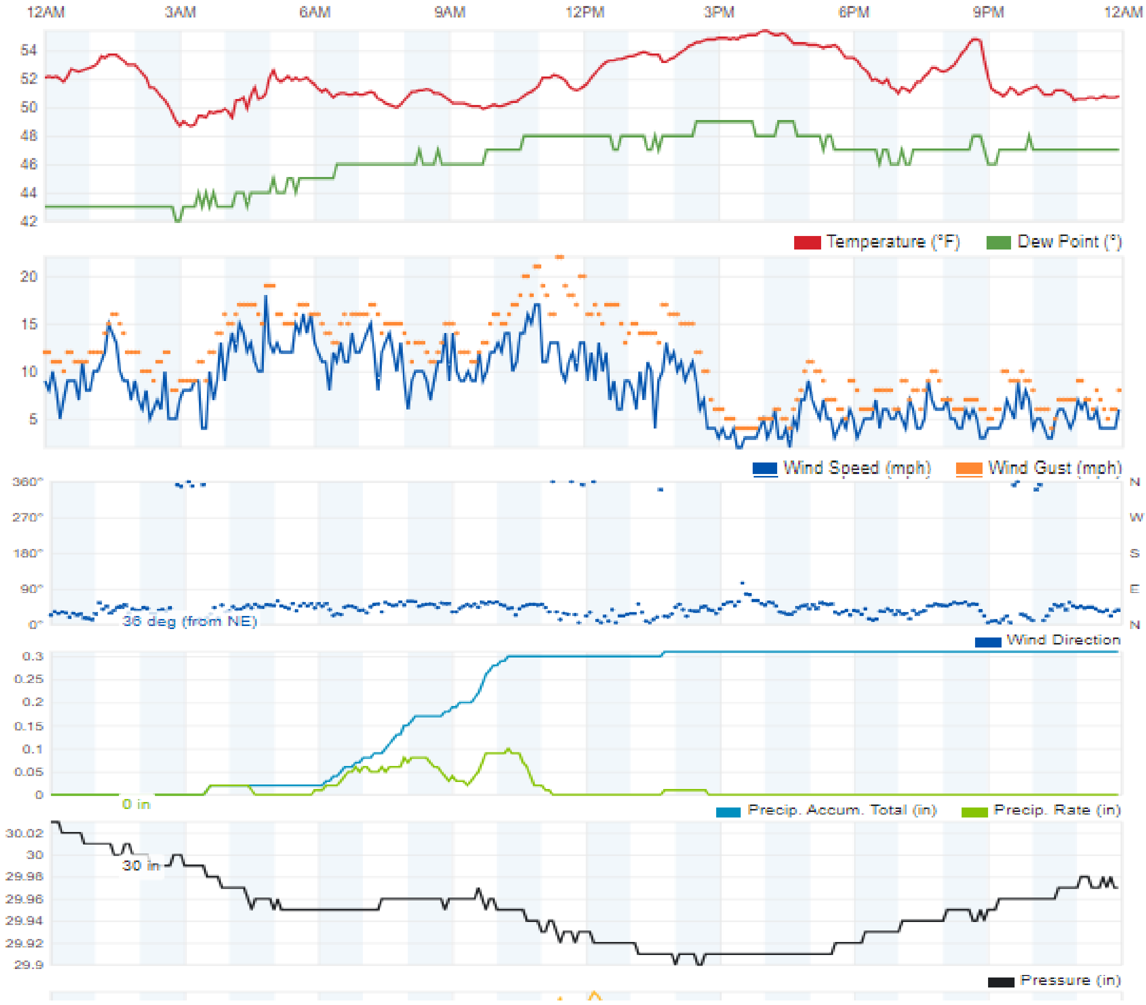
Summary
June 23, 2024

	High	Low	Average
Temperature	55.4 °F	48.7 °F	52.1 °F
Dew Point	49.0 °F	42.0 °F	46.2 °F
Humidity	89 %	66 %	81 %
Precipitation	0.31 in	--	--

	High	Low	Average
Wind Speed	18.0 mph	2.0 mph	8.3 mph
Wind Gust	22.0 mph	--	11.5 mph
Wind Direction	--	--	NE
Pressure	30.03 in	29.90 in	--

Graph | Table

June 23, 2024



Weather History for ILEVIN75

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-06-23/2024-06-23/weekly

Previous | Weekly Mode | June | 23 | 2024 | View | Next

Summary

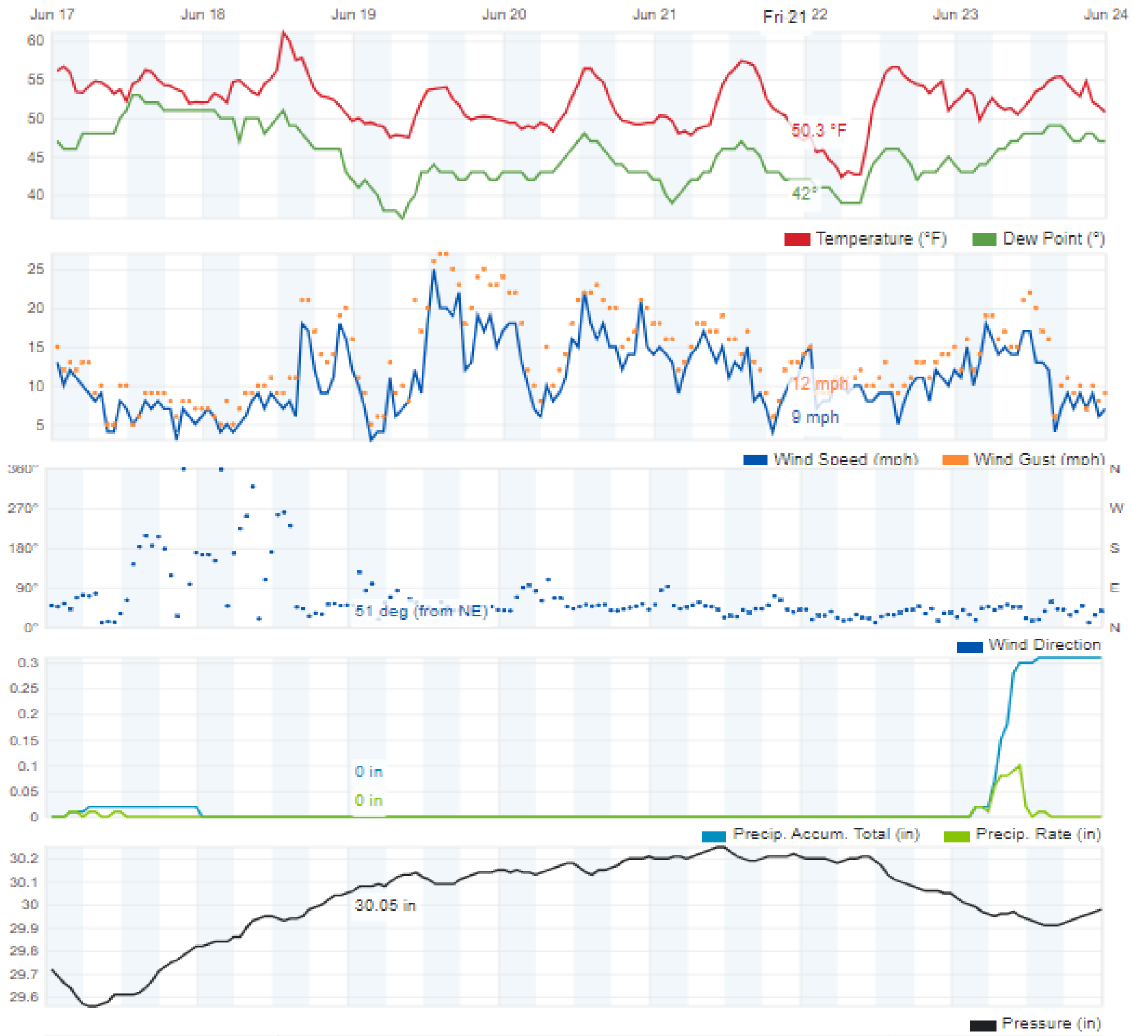
June 17, 2024 - June 23, 2024

	High	Low	Average
Temperature	61.1 °F	41.1 °F	51.3 °F
Dew Point	53.0 °F	36.0 °F	44.5 °F
Humidity	96 %	61 %	78 %
Precipitation	0.33 in	--	--

	High	Low	Average
Wind Speed	25.0 mph	0.0 mph	7.4 mph
Wind Gust	27.0 mph	--	11.1 mph
Wind Direction	--	--	ENE
Pressure	30.25 in	29.54 in	--

Graph | Table

June 17, 2024 - June 23, 2024



Weather History for ILEVIN75

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-06-29/2024-06-29/daily

Previous | Daily Mode | June | 29 | 2024 | View | Next

Summary

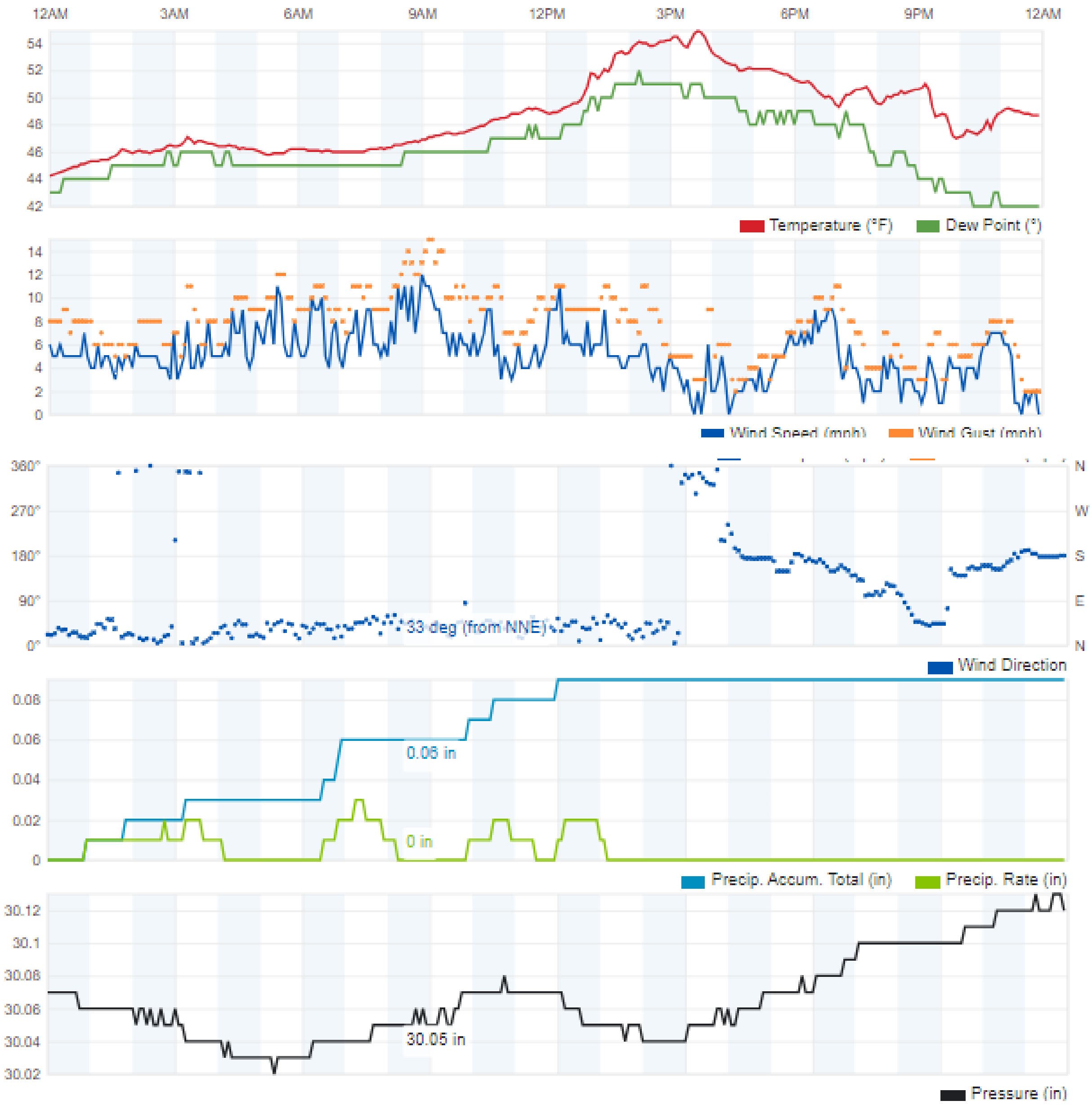
June 29, 2024

	High	Low	Average
Temperature	54.9 °F	44.2 °F	48.7 °F
Dew Point	52.0 °F	42.0 °F	46.3 °F
Humidity	97 %	76 %	92 %
Precipitation	0.09 in	--	--

	High	Low	Average
Wind Speed	12.0 mph	0.0 mph	5.2 mph
Wind Gust	15.0 mph	--	7.8 mph
Wind Direction	--	--	NE
Pressure	30.13 in	30.02 in	--

Graph | Table

June 29, 2024



Weather History for ILEVIN75

https://www.wunderground.com/dashboard/pws/ILEVIN75/graph/2024-06-29/2024-06-29/weekly

Previous | Weekly Mode | June | 30 | 2024 | View | Next

Summary

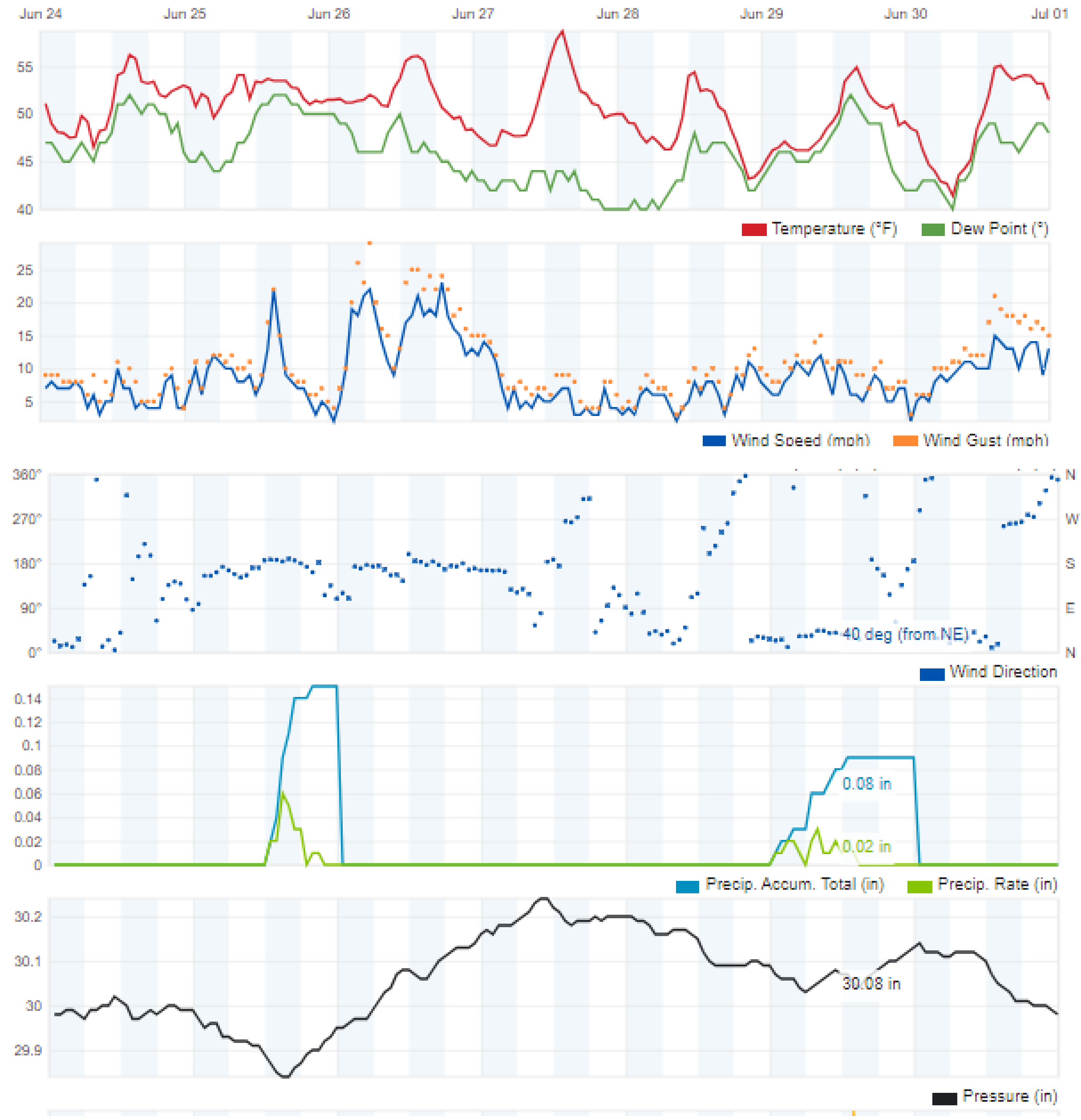
June 24, 2024 - June 30, 2024

	High	Low	Average
Temperature	58.7 °F	40.7 °F	49.7 °F
Dew Point	52.0 °F	39.0 °F	45.3 °F
Humidity	97 %	53 %	85 %
Precipitation	0.24 in	--	--

	High	Low	Average
Wind Speed	23.0 mph	0.0 mph	5.8 mph
Wind Gust	29.0 mph	--	8.6 mph
Wind Direction	--	--	SE
Pressure	30.24 in	29.83 in	--

Graph | Table

June 24, 2024 - June 30, 2024



Appendix 4. Gas monitoring results for June 2024

Well ID	DATE	CH4%	CO2%	O2%	H2S ppm	Res N %	BARO mb
LVNW-006	2/06/2024	59.1	41	0.1	251	0	1022
LVNW-007	2/06/2024	57.3	39.6	0.6	190	0.23	1022
LVNW-008	2/06/2024	55.8	44	0.2	1246	0	1022
LVNW-009	2/06/2024	58.9	41.5	0.1	868	0	1022
LVNW-010	2/06/2024	56.9	42.9	0.1	447	0	1022
LVNW-011	2/06/2024	16.9	20.9	8.7	13	20.61	1022
LVNW1-02	2/06/2024	66.5	30.9	0.3	30	1.17	1023
LVNW1-04	2/06/2024	62.2	36.9	0.1	109	0.42	1023
LVNW1-05	2/06/2024	62.9	35.1	0.1	14	1.52	1023
LVNW1-06	2/06/2024	62.2	36.9	0	105	0.9	1023
LVNW1-07	2/06/2024	59.8	30.2	0.1	15	9.52	1023
LVNW1-08	2/06/2024	60.5	37.9	0	135	1.6	1023
LVNW1-09	2/06/2024	62.1	36.9	0	119	1	1023
LVNW1-10	2/06/2024	62	37.5	0.1	89	0.02	1023
LVNW2-01	2/06/2024	60.3	40.8	0.1	173	0	1023
LVNW2-02	2/06/2024	63.7	32.8	0	21	3.5	1023
LVNW2-03	2/06/2024	60.1	40.8	0	230	0	1023
LVNW2-05	2/06/2024	60.5	40.6	0	172	0	1023
LVNW2-06	2/06/2024	0	0.2	18.9	13	9.46	1023
LVNW2-07	2/06/2024	56.3	34	1.6	26	2.05	1023
LVNW2-08	2/06/2024	63.6	37.9	0.1	253	0	1023
LVNW2-09	2/06/2024	66.4	35.3	0.1	226	0	1023
LVNW2-10	2/06/2024	66.7	34.1	0.1	183	0	1023
LVNW3-01	2/06/2024	5.2	5.2	17	51	8.34	1022
LVNW3-02	2/06/2024	56.8	42.8	0.2	273	0	1022
LVNW3-03	2/06/2024	2.3	26.2	9.7	93	25.13	1022
LVNW3-04	2/06/2024	56.5	43.4	0.1	706	0	1022
LVNW3-05	2/06/2024	55.6	44.3	0.1	590	0	1022
LVNW3-06	2/06/2024	46.8	39	2.1	43	4.16	1022
LVNW3-07	2/06/2024	29.5	26	6.6	17	12.95	1022
LVNW3-08	2/06/2024	55.2	44.3	0.1	842	0.02	1022

Well ID	DATE	CH4%	CO2%	O2%	H2S ppm	Res N %	BARO mb
LVNW-006	16/06/2024	58.9	40.6	0	230	0.5	1005
LVNW-007	16/06/2024	58.5	40.2	0.1	97	0.82	1005
LVNW-008	16/06/2024	56.2	43.5	0.1	1183	0	1005
LVNW-009	16/06/2024	58.3	41.1	0	857	0.6	1005
LVNW-010	16/06/2024	55.6	42.9	0.1	465	1.02	1006
LVNW-011	16/06/2024	16.9	21.2	6.9	28	28.92	1005
LVNW1-02	16/06/2024	63.7	35	0.1	32	0.82	1007
LVNW1-04	16/06/2024	61.7	37.1	0	127	1.2	1007
LVNW1-05	16/06/2024	8.8	4.8	16.2	17	8.96	1007
LVNW1-06	16/06/2024	61.7	36.8	0.1	119	1.02	1007
LVNW1-07	16/06/2024	60.5	31	0	16	8.5	1007
LVNW1-08	16/06/2024	60.9	37	0	76	2.1	1007
LVNW1-09	16/06/2024	61.9	36.6	0	127	1.5	1007
LVNW2-01	16/06/2024	64.8	36.4	0.5	3	0	1006
LVNW2-02	16/06/2024	64.9	38.4	0	73	0	1006
LVNW2-03	16/06/2024	58.9	39.6	0	204	1.5	1006
LVNW2-05	16/06/2024	59.3	39.5	0	187	1.2	1006
LVNW2-06	16/06/2024	27.7	20	0.1	124	51.82	1006
LVNW2-07	16/06/2024	56.9	33.7	1.5	34	2.23	1006
LVNW2-08	16/06/2024	61	39.8	0.1	352	0	1006
LVNW2-09	16/06/2024	67	34.8	0	217	0	1006
LVNW2-10	16/06/2024	66.7	34.5	0	204	0	1006
LVNW3-01	16/06/2024	1	3.3	17.2	46	13.48	1005
LVNW3-02	16/06/2024	56.6	42	0.1	285	0.92	1005
LVNW3-03	16/06/2024	2.4	26.9	10.4	27	20.99	1005
LVNW3-04	16/06/2024	55.2	43.5	0	709	1.3	1005
LVNW3-05	16/06/2024	55.3	43.5	0	474	1.2	1005
LVNW3-06	16/06/2024	54.2	44.5	0	471	1.3	1005
LVNW3-07	16/06/2024	29.9	25.7	6.7	20	12.37	1006
LVNW3-08	16/06/2024	54.5	44.1	0.1	977	0.92	1005

Well ID	DATE	CH4%	CO2%	O2%	H2S ppm	Res N %	BARO mb
LVNW-006	23/06/2024	58.3	40.8	0	245	0.9	1009
LVNW-007	23/06/2024	58.1	40.1	0.1	72	1.32	1009
LVNW-008	23/06/2024	55.4	43.8	0.2	1469	0	1009
LVNW-009	23/06/2024	58	41.3	0	841	0.7	1009
LVNW-010	23/06/2024	55.9	42.9	0.1	460	0.72	1010
LVNW-011	23/06/2024	16.7	21.2	6.9	23	29.12	1010
LVNW1-02	23/06/2024	64.5	35	0.1	32	0.02	1011
LVNW1-04	23/06/2024	63.3	36.2	0	111	0.5	1011
LVNW1-05	23/06/2024	11.8	6.2	15.4	14	8.39	1011
LVNW1-06	23/06/2024	60.7	38.4	0.1	160	0.42	1011
LVNW1-07	23/06/2024	62.4	33.2	0	16	4.4	1011
LVNW1-08	23/06/2024	60.7	38.1	0.1	132	0.72	1011
LVNW1-09	23/06/2024	60.8	38.6	0	166	0.6	1011
LVNW2-01	23/06/2024	65.8	34.9	0.4	0	0	1010
LVNW2-02	23/06/2024	65.2	38.3	0	62	0	1010
LVNW2-03	23/06/2024	62.6	38.3	0.1	159	0	1010
LVNW2-05	23/06/2024	62.9	38.2	0	155	0	1010
LVNW2-06	23/06/2024	0	0.2	18.1	10	13.28	1010
LVNW2-07	23/06/2024	56.5	33.8	1.9	25	0.62	1010
LVNW2-08	23/06/2024	60.9	40	0.1	345	0	1010
LVNW2-09	23/06/2024	67.2	34.8	0.1	218	0	1010
LVNW2-10	23/06/2024	66.9	34.2	0.1	174	0	1010
LVNW3-01	23/06/2024	0.7	2.3	17.9	50	11.44	1009
LVNW3-02	23/06/2024	56.6	42.1	0.2	273	0.34	1009
LVNW3-03	23/06/2024	2.4	27.1	10.6	25	19.83	1009
LVNW3-04	23/06/2024	55.6	43.1	0.1	690	0.82	1009
LVNW3-05	23/06/2024	55.2	43.6	0	439	1.2	1009
LVNW3-06	23/06/2024	53.4	44.1	0.1	32	2.02	1009
LVNW3-07	23/06/2024	33.2	28.6	5.6	13	11.43	1010
LVNW3-08	23/06/2024	54.8	43.8	0.2	963	0.44	1010

Well ID	DATE	CH4%	CO2%	O2%	H2S ppm	Res N %	BARO mb
LVNW2-01	29/06/2024	66.5	34.4	0.3	0	0	1015
LVNW2-02	29/06/2024	65.7	37.5	0	47	0	1015
LVNW2-03	29/06/2024	64.3	36.8	0	119	0	1015
LVNW2-05	29/06/2024	64.5	36.7	0	130	0	1015
LVNW2-06	29/06/2024	62.7	37.4	0.1	192	0	1015
LVNW2-07	29/06/2024	58.7	33.7	1.4	39	0.91	1015
LVNW2-08	29/06/2024	61.7	39.1	0	323	0	1015
LVNW2-09	29/06/2024	68	34.6	0.2	215	0	1015
LVNW2-10	29/06/2024	66.9	33.9	0.2	190	0	1015
LVNW-008	29/06/2024	55.8	43.1	0.3	1529	0	1014
LVNW-007	29/06/2024	58.7	39.6	0.1	76	1.22	1014
LVNW-006	29/06/2024	48.6	33.9	9.6	143	0	1014
LVNW-009	29/06/2024	58.1	40.8	0.1	848	0.62	1014
LVNW3-01	29/06/2024	0.9	3.4	17.4	55	12.53	1014
LVNW3-02	29/06/2024	56.3	42.2	0.2	278	0.54	1014
LVNW3-03	29/06/2024	37.3	30.2	0.5	223	30.11	1014
LVNW3-04	29/06/2024	55.9	42.8	0.1	694	0.82	1014
LVNW3-05	29/06/2024	55.4	43.3	0	414	1.3	1014
LVNW3-06	29/06/2024	54	44.1	0	38	1.9	1014
LVNW3-07	29/06/2024	0	0.2	18.8	17	9.94	1014
LVNW3-08	29/06/2024	55	43.6	0.2	992	0.44	1014
LVNW-011	29/06/2024	58.4	40.7	0	851	0.9	1014
LVNW-004	29/06/2024	36.8	25.3	6	789	9.22	1014
LVNW-010	29/06/2024	56.6	42.5	0	490	0.9	1014
LVNW1-02	29/06/2024	64.3	35	0.2	48	0	1016
LVNW1-04	29/06/2024	63.5	36.2	0	122	0.3	1016
LVNW1-05	29/06/2024	12.3	6.1	15.2	20	8.94	1016
LVNW1-06	29/06/2024	60.8	38.3	0.1	168	0.42	1016
LVNW1-07	29/06/2024	63	34.1	0	21	2.9	1016
LVNW1-08	29/06/2024	60.7	38.1	0	133	1.2	1016
LVNW1-09	29/06/2024	60.8	38.4	0	173	0.8	1016

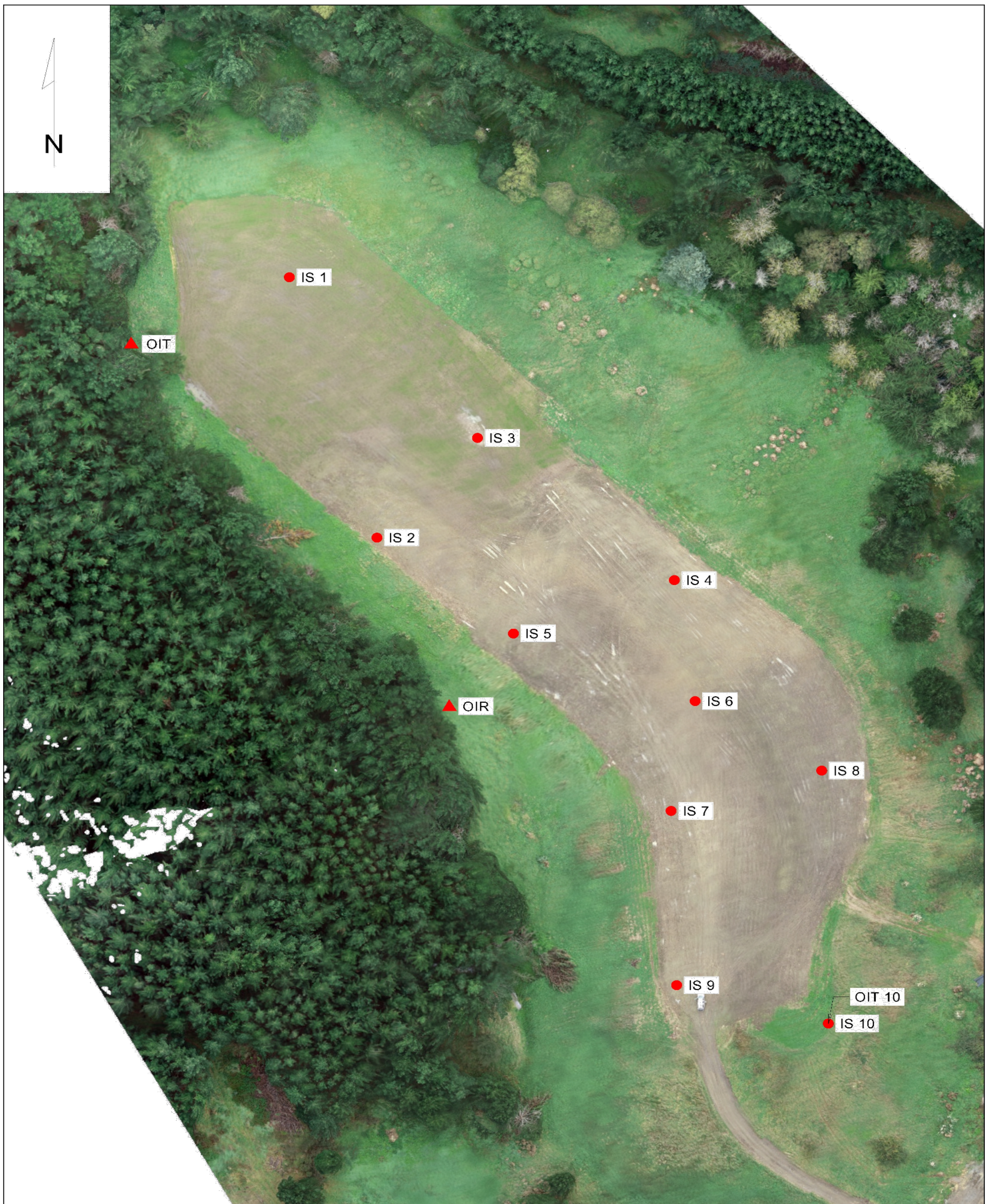
Appendix J Old landfill survey

Old Levin Landfill Monitoring Data since recapped in 2023

Survey on 11 December 2023 (Hor datum = Wang2000 Vert datum = local))

Survey Mark	Easting	Northing	Elevation	Description
IS1	376478.648	759713.597	99.857	Iron spike in conc 50mm below ground level
IS2	376503.377	759632.469	99.440	Iron spike in conc 50mm below ground level
IS3	376531.744	759663.530	101.273	Iron spike in conc 50mm below ground level
IS4	376587.312	759619.259	102.457	Iron spike in conc 50mm below ground level
IS5	376541.883	759602.603	100.525	Iron spike in conc 50mm below ground level
IS6	376593.185	759581.564	101.783	Iron spike in conc 50mm below ground level
IS7	376586.386	759547.354	101.163	Iron spike in conc 50mm below ground level
IS8	376628.900	759559.912	103.182	Iron spike in conc 50mm below ground level
IS9	376587.953	759493.063	100.917	Iron spike in conc 50mm below ground level
IS10	376630.758	759481.113	101.646	Iron spike in conc 50mm below ground level
OIT10	376630.649	759481.231	101.575	Iron tube 300mm below ground level from previous monitoring previous level = 101.619

Control Points				
OIR	376523.769	759579.650	100.000	Iron rod 200mm below ground level
OIT	376433.977	759692.587	105.026	Iron Tube 300mm above ground level



GOODMANS

OLD LEVIN LANDFILL
MONITORING POINTS
FROM DEC 2023

NOTES: PLOT NO: SHEET: REV: A
1 INITIAL SURVEY DONE ON 11 DEC 2023
2
3
4

SURVEYOR: RC
DRAWN: AW
SCALE:
DATE: 26 JAN 2024

Survey on 22 August 2024 (Hor datum = Wang2000   Vert datum = local))

Survey Mark	Easting	Northing	Elevation	Description
IS1	376478.652	759713.598	99.843	Iron spike in conc 50mm below ground level
IS2	376503.379	759632.480	99.432	Iron spike in conc 50mm below ground level
IS3	376531.749	759663.529	101.254	Iron spike in conc 50mm below ground level
IS4	376587.323	759619.267	102.442	Iron spike in conc 50mm below ground level
IS5	376541.897	759602.604	100.522	Iron spike in conc 50mm below ground level
IS6	376593.199	759581.571	101.780	Iron spike in conc 50mm below ground level
IS7	376586.386	759547.362	101.155	Iron spike in conc 50mm below ground level
IS8	376628.924	759559.916	103.170	Iron spike in conc 50mm below ground level
IS9	376587.977	759493.075	100.905	Iron spike in conc 50mm below ground level
IS10	376630.780	759481.123	101.641	Iron spike in conc 50mm below ground level
OIT10	376630.674	759481.234	101.569	Iron tube 300mm below ground level from previous monitoring previous level = 101.619

Survey Mark	E	N	Z
IS1	0.004	0.001	-0.013
IS2	0.002	0.011	-0.007
IS3	0.005	-0.001	-0.019
IS4	0.011	0.008	-0.015
IS5	0.015	0.001	-0.003
IS6	0.014	0.007	-0.003
IS7	0.000	0.008	-0.007
IS8	0.024	0.005	-0.011
IS9	0.024	0.012	-0.011
IS10	0.022	0.010	-0.004
OIT10	0.025	0.003	-0.006

Stantec is a global leader in sustainable architecture, engineering, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.