REPORT

Tonkin+Taylor

Groundwater Monitoring and Contingency Plan

WM New Zealand Landfill

Prepared for
WM New Zealand Ltd

Prepared by
Tonkin & Taylor Ltd

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Definitions

Specific terms	
Groundwater Monitoring and Contingency Plan (GWMP)	Document to confirm the monitoring requirements for groundwater related effects identified during consenting and conditions.
Landfill Management Plan (LMP)	The overarching management plan for the landfill to which the GWMP will be attached.
Landfill Commencement Date	Is the date that waste acceptance commences at the landfill, such date to be notified to Council in writing.
General terms	
Landfill footprint	The area (plan area) occupied by the landfill which has a lining system onto which waste is placed.
Project footprint	The area that includes the landfill footprint and also includes those areas outside the landfill footprint but within the WMNZ landholdings where ancillary activities are proposed to occur.
WM New Zealand Limited or WMNZ	Company name of applicant.
WM New Zealand Landfill or WMNZL	Project name, encompassing the landfill itself as well as all ancillary activities within the WMNZ landholdings.
WMNZ landholdings	The entire landholdings secured by WMNZ at Wayby Valley.
Landholding description	
Eastern Block	Area of exotic radiata pine forestry which include the Landfill Valley and Northern Valley.
Northern Valley	Forms part of the Eastern Block as an area of exotic radiata pine forestry north of the Landfill Valley.
Southern Block	Strip of land which the access road runs through until reaches the Eastern Block. This strip is mostly occupied by bush and forest plantation, within a separate valley across the southern side of the Western Block. The southern block consists of wattle plantation and regenerating native vegetation.
Landfill Valley	Forms part of the Eastern Block as a valley currently in exotic radiata pine forestry in which the landfill footprint will be located.
Landfill Footprint	The area (plan area) occupied by the landfill which has a lining system onto which waste is placed.
Western Block	The farm property previously known as Spring Hill Estate, which has some small areas of high ecological value vegetation and habitat.

1 Background

1.1 Introduction

WM New Zealand Ltd (WMNZ) proposes a new regional landfill facility, known as the WM New Zealand Landfill (WMNZL), at Wayby Valley between Warkworth and Wellsford.

The Groundwater Monitoring and Contingency Plan (GWMP) forms part of the Landfill Management Plan (LMP) and has been prepared for the WMNL project on behalf of WMNZ.

The GWMP is required to primarily fulfil or partially fulfil condition 382 of the resource consent application[1]. Other conditions that refer to the GWMP are detailed in Table 1.1. This GWMP has been prepared based on the information available at the time of writing. The GWMP will need to be reviewed and updated when more groundwater related information is available.

1.2 Purpose

This GWMP has been prepared to identify how the project will address potential adverse effects on groundwater and surrounding surface water bodies within the Landfill Valley and its immediate surrounds. This GWMP also describes the groundwater systems beneath the Landfill Valley, groundwater and surface water monitoring, and contingency responses.

1.3 Relationship to other plans

This GWMP forms part of a comprehensive suite of management plans that make up the LMP. The GWMP also has some relationship with certain aspects of the Wetland Restoration and Management Plan (WRAMP).

1.4 Consent requirements

The GWMP addresses the requirements set out in the draft resource consent conditions. The draft resource consent conditions relevant to the GWMP are indicated in numerical order in Table 1.1. Note that the conditions referred to this plan as a Groundwater Monitoring and Contingency Plan (GWMCP), however, GWMP has been adopted hereon.

Table 1.1: Draft resource consent conditions relevant to the GWMP (25 February 2025 version)

Condition number	Condition
326	If the results of samples obtained from the subsoil drains in accordance with Condition 323 and tested for the parameters listed in Condition 324 show that leachate contamination is occurring (as defined in the Groundwater Monitoring and Contingency Plan (GWMCP) required by Condition 382), then discharge from the subsoil drains to the stormwater ponds outlet shall be ceased immediately, and all discharge from the drains shall be captured and treated as leachate. The following shall then occur:
	a. Further testing of the water shall be undertaken to characterise the contamination.
	b. Downstream testing shall be conducted to determine whether any contamination has been discharged from or escaped the stormwater ponds.
	c. An investigation shall be undertaken to determine the source of the contamination.

[1] The current version of conditions is dated 25 February 2025, all references to conditions and the consent relate to this version.

Condition number	Condition
	d. If it is determined that leachate is present in the subsoil drainage then groundwater samples shall be collected from the monitoring locations immediately surrounding the Landfill. These samples shall be tested for leachate indicators set out in the GWMCP.
	e. If leachate is detected in groundwater above the groundwater trigger levels as set out in Part J then mitigation measures set out in the GWMCP shall be implemented.
	f. Measures shall also be put into place to avoid further contamination entering the subsoil drains system and/or being released to environment.
	g. Discharges of water from subsoil drains to the stormwater ponds shall not recommence until all leachate indicator parameters at the point of discharge from the subsoil drains no longer indicates that contamination is occurring.
	h. The subsoil drain outlets will be designed to allow a pump to be fitted to enable the contaminated water to be pumped to the leachate storage and treatment system while investigation and any necessary remediation is undertaken.
330	Groundwater shall be monitored on a quarterly basis or at a lesser frequency (greater intervals between readings) acceptable to Council but no less frequent than six-monthly from the Landfill Commencement Date in accordance with the Groundwater Monitoring and Contingency Plan (GWMCP) required by Condition 382.
331	Should groundwater monitoring results identify leachate contamination as defined in the GWMCP (condition 382), then the Consent Holder shall immediately notify Watercare Services Limited (WSL), Council and Tangata Whenua Executive Committee (TWEC).
382	At least three months prior to the commencement date, a final Groundwater Monitoring and Contingency Plan (GWMCP), incorporating a Groundwater Monitoring Programme (GMP), to assess the ongoing adequacy of all water quality management practices shall be developed and submitted to Auckland Council for certification. At least 30 days prior to submission to Auckland Council for certification, the Consent Holder shall provide a copy of the draft GWMCP to the TWEC and Watercare Services Limited (WSL) for feedback. The GWMCP submitted to Council shall record any feedback received from WSL and an explanation for any recommendations which have not been adopted. The GWMCP shall include, but not be limited to:
	a. Up-gradient and down-gradient groundwater monitoring bore locations and details, in line with Table 8 above at Condition 327.
	b. Methods and procedures for water quality sampling.
	c. Ongoing monitoring of water levels and water quality parameters shall be detailed in the GWMCP.
	d. Identified trigger levels for each of the parameters provided in the GWMCP (preliminary trigger levels are set out in Part J). Trigger levels for contaminants not included in the GWMCP shall be based on statistical margins from baseline results or based on a percentage of relevant guidelines.
	e. Guidelines for the determination of whether leachate contamination of groundwater is occurring.
	f. Contingency plans for remedial actions should contamination of groundwater by leachate or other pollutants associated with the landfill and activities on the Site associated with this consent be detected.
	g. Stream baseflow monitoring in adjoining catchments, trigger levels for action and contingency response approach.
	h. The methods and procedures for investigating and reporting groundwater monitoring results to Council.
	i. The response if a bore structure fails.

Condition number	Condition
383	The GWMCP shall be implemented after the Landfill Commencement Date.
383A	Contingency measures should leachate contamination in groundwater occur shall include: a. Potential expansion of the groundwater monitoring programme. b. Design and implement case-specific remediation which may include reconfiguration of daily waste placement to reduce leachate and de-watering of wells for local reversal of hydraulic gradient.

1.5 Structure

The remainder of the GWMP is structured as follows:

- Groundwater system and summary of effects.
- Monitoring requirements.
- Reporting.
- Contingency plan.

2 Groundwater system

2.1 Site geology

The ground beneath the Landfill Valley and surrounding ridges consists of the Pakiri Formation, a member of the Waitemata Group series. Weathered rock and residual soils i.e. silty sands or silty clays extend typically to depths of 0.3 m (in the valley floor) to 12.5 m (beneath the ridgelines). The Pakiri Formation bedrock comprises weak to moderately strong sandstone and weak siltstone. Fracture zones and other rock defects are present throughout the bedrock.

Northland Allochthon geology is observed on the low-lying land outside of the Landfill Valley and in the vicinity of Wetland 2A and the Kahikatea Tree Forest, towards the Hōteo River.

No geological fault lines have been mapped beneath the landfill footprint or elsewhere within the WMNZL Project Footprint.

2.2 Shallow groundwater system

The shallow groundwater is recharged by rainfall infiltration. The annual rainfall within Dome Valley is greater than the Auckland Region on average, with an annual rainfall of 1,200 to 2,000 mm/year compared to 1,200 to 1,300 mm/year for the Auckland Region.

Shallow perched groundwater layers around the Landfill Valley have been observed by encountering water in hand auger tests holes. Machine boreholes that went down to approximately 50 m depth from the ridge tops (which are approximately 140 m to 240 m above sea level) and the valley floor areas (which are 70 m to 115 m above sea level) encountered a shallow groundwater system within the Pakiri Formation bedrock.

The perched groundwater and shallow groundwater systems contribute to stream flows in the Landfill Valley.

The water levels in some wells respond quickly to rainfall, whereas others have steadier seasonal variation.

2.3 Deep groundwater system

Groundwater level data logging and deep drilling of a production bore has indicated the presence of a deeper regional groundwater system. The deeper regional water table is at 30 m to 40 m above sea level. It contributes to the stream flows in the Hōteo River which is 20 m to 25 m above sea level and in the Waitaraire Stream.

Groundwater flow directions at the Landfill Valley and the wider area reflect the topography of the site. The steep terrain around the valley will dictate groundwater flows toward the valley floor streams. Infiltration and the downward migration through the rock mass of the high elevation Pakiri Formation is expected to enter the regional groundwater table, albeit at a relatively low rate due to the low permeability of the rock mass.

The rock mass has a low hydraulic conductivity of between 1×10^{-9} and 3×10^{-6} m/s while the weathered (residual) soil has a lower hydraulic conductivity on the order of 1×10^{-10} m/s. The fractured zones have a higher hydraulic conductivity of approximately 8×10^{-6} m/s.

The hydraulic gradient between the steep valley sides in the Pakiri Formation and the Landfill Valley floor is estimated to be up to 0.25 as groundwater flows inwards towards the Landfill Valley centreline. The hydraulic gradient of the regional water table towards the Hōteo River and the Waitaraire Stream is quite gentle, between 0.005 and 0.006.

2.4 Groundwater quality

Groundwater quality samples were collected from monitoring wells during 2018 to 2019 to support the resource consent application. Results were evaluated against the ANZG maximum acceptable values and guideline values and drinking water standards to assess the ecological impact and potential effects on health.

The groundwater can be described as being moderately alkaline and tending toward a bicarbonate type (sodium and magnesium). The background groundwater has ANZG exceedances in zinc and hexavalent chromium, however these background exceedances are not at levels that would pose a risk to human health or the environment.

2.5 Municipal water supply

Potable water is pumped from the regional aquifer by Watercare (the region's municipal potable water provider). Sampling of monitoring wells provides information to assess whether the landfill is having a potential impact on the quantity or quality of the water available in the regional aquifer. In this regard, BH16 and BH18 in the schedule of monitoring wells are located:

- Between the Landfill Footprint and Watercare's existing groundwater take points.
- In consultation with Watercare.

2.6 Summary of potential groundwater related impacts

The potential effects on groundwater relate not only to the waste mass in the Landfill Valley but also the reduction of groundwater recharge and effects on stream baseflows in adjoining catchments. These potential effects and mitigation factors are set out in Table 2.1.

Similar potential effects of a reduction of groundwater recharge may also be observed following the construction of the main stockpile within the Wetland 2A surface water catchment. However, the mitigation factors are set out in the Wetland Restoration Adaptation Management Plan (WRAMP)[2].

[2] **add WRAMP reference**

Table 2.1: Potential groundwater related impacts

Effect on groundwater	Mitigation
Failure of temporary stormwater pipe under the landfill. If the stormwater pipe under the lining system crushes under the weight of waste, then the lining system could be damaged allowing leachate to reach stormwater and groundwater systems.	Design and construction to support the weight and to avoid piping erosion of backfill. Quality control during construction. Backfill/decommission the pipe when it becomes obsolete. Monitoring of subsoil drains and groundwater wells.
Blockage of the main leachate collection pipe. If blockage occurs in the leachate collection pipe that is the principal point of discharge of leachate from the landfill by gravity drainage, then leachate removal could be more difficult and leachate head on the liner could rise.	Design and construction with redundancy in the leachate collection system including a wide drainage blanket over the lining system and installation of a pump sump prior to waste placement as a backup location to remove leachate. Monitoring of leachate levels in the landfill and monitoring of discharge flow rates of leachate from the landfill.
Failure of the structural earth fill toe bund. If the structural toe bund of the landfill fails, then any free liquid leachate could escape into surface water and groundwater systems.	Proper geotechnical design and quality control during construction of the landfill's toe bund. Liner system design detailing to accommodate some differential movement of the base. Regular 'erosion and sediment control' inspections. Additional monitoring of groundwater downstream (e.g. BH7, BH16, BH19 and BH21).
Failure of the lining system – short term. If the lining system fails, then leachate could pass through into the underlying residual soils and rock mass and enter groundwater.	Lining system design including leachate drainage blanket to remove leachate off the lining system, extremely low permeability HDPE liner with protective geotextile cushion, geosynthetic clay liner (GCL) that would swell and seal up upon contact with leachate, compacted clay which has natural contaminant attenuation properties. Independent quality control of lining system during construction. Groundwater quality monitoring in the borehole network and subsoil drains.
Failure of the lining system – long term. If the lining system fails for example due to degradation over hundreds of years, then leachate could pass through into the underlying ground and groundwater.	As above, plus: Use of best available man-made technology in choice of high density poly ethylene liner, and best available natural soil materials i.e. clay and GCL to capture contaminants, if any. Waste acceptance criteria which exclude hazardous waste and chemicals that might degrade the lining system layers. Aftercare monitoring programme, with provision to define it at that time. Final capping which will seal the waste. By keeping rainfall infiltration and stormwater out of the waste mass, and by keeping the waste mass drained of leachate, there will eventually be a minimal thickness of liquid leachate to seep through the lining system, if any. Provision of buffer distance – fate and transport analyses predict that if (and only if) this scenario occurs then it may take hundreds of years for any trace to be detectable in

Effect on groundwater	Mitigation
	boreholes, streams or the river, by which time the contamination source (leachate in landfill) will have greatly weakened or ceased. Further, the traces are not predicted to reach levels that could affect food gathering or human health.
Excessive leachate generation due to poor cover. If the quality of daily and intermediate cover does not meet the specification, then rain water infiltration would increase and more leachate would be generated. Increasing head of leachate above the lining system leads to increasing risks of escape to surface water and groundwater.	Daily and intermediate cover protocols as described in the LMP Section 3.03.
Landfill instability. If the landfill waste mass slumps or slips then waste could end up outside the footprint protected by the lining system.	Geotechnical design of the permanent slopes, capping layers, and temporary slopes on the waste. Regular walkover inspections.
Subsoil drain blockage. If subsoil drains beneath the lining system block up before the weight of waste is in place, then groundwater uplift pressures could damage the lining system and groundwater inflows into the waste could increase leachate amounts.	Design of subsoil drains to be flushable. Programming of construction and waste placement to avoid long periods that might allow uplift pressures to develop. Monitoring of flowrates and water quality in subsoil drains and leachate drains.
Lining system damage caused by fire. If a fire occurs deep in the waste or near the edge of the waste, then heat could damage the lining system and potentially affect the containment of leachate and contamination of groundwater.	Proper waste placement procedures that reduce risk of fire e.g. diligent placement of daily cover and regular monitoring of gases that might indicate fire. Composite lining system that has non-flammable natural material i.e. clay to back up manufactured materials. Emergency management plan that includes de-brief to assess damage if any.
Oil/leachate spill. If oil or hydrocarbon fuel spills onto the ground, then some could migrate and reach stormwater or groundwater depending on clean-up. The same applies to leachate stored in tanks ready for treatment or removal.	Bunded and certified fuel and oil facilities. Spill response plan. Perpetual presence of machinery and staff that can respond quickly to a spill emergency.
Fall in groundwater level. The landfill lining system will reduce groundwater recharge from rainfall. This could reduce groundwater levels below the ridgelines, which could affect baseflow on streams in the surrounding catchments and cause stream flows to fall below the mean annual low flow (MALF).	Ongoing monitoring of groundwater levels and stream flows to observe potential effects. Augment stream flows in affected catchment using water from an alternative source. These sources could include groundwater, rainwater storage or water carted onto site.

3 Monitoring requirements

At the time of writing this version of the GWMP (v1.0), monitoring to assess potential groundwater related effects after the Landfill Commencement Date is in the initial baseline phase. Ongoing monitoring requirements are summarised in the following sub-sections and described in more detail in the Consolidated Monitoring Plan[3].

3.1 Monitoring parameters and schedule

The groundwater and subsoil drain ongoing monitoring chemistry parameters are attached as Appendix A. The ongoing/operational monitoring programme for the groundwater boreholes, streamflow points and subsoil drains are summarised in Table 3.1.

Table 3.1: Ongoing monitoring programme summary

Location/event/topic	Parameter	Frequency
Schedule One boreholes	Groundwater chemistry samples	Quarterly
Schedule Two boreholes	Groundwater level measurements	Quarterly
Schedule Two boreholes relevant to stream baseflow (BH20, BH4, BH5)	Groundwater level measurements	Quarterly
Stream baseflow	Stream water level	Continuously
Stream baseflow	Streamflow	Quarterly
Subsoil drains beneath Landfill Footprint	Groundwater chemistry samples	Quarterly
Subsoil drains beneath landfill lining system	Electrical conductivity	Continuously
Subsoil drains beneath Landfill Footprint	Flow rate	Quarterly

3.2 Monitoring locations

3.2.1 Groundwater boreholes

The groundwater, monitoring locations along with the streamflow and subsoil drain monitoring locations are illustrated on the groundwater monitoring location plan attached as Appendix B. The lists of Schedule One and Schedule Two groundwater monitoring boreholes are attached as Appendix C.

3.2.2 Streams

Stream levels and stream flows are recorded at several locations surrounding the Landfill Valley. These locations are also illustrated on the monitoring location plan attached as Appendix B. The location, parameter and purpose of monitoring at the stream locations are summarised in Table 3.2.

[3] T+T July 2024. Consolidated Monitoring Plan. Ref: 1234567.p002 vS2.

Table 3.2: Stream monitoring locations

Location	Parameter	Purpose
SF1 Near the mouth of the Northern Valley stream	Water levels and streamflows	Baseflow monitoring of the Northern Valley stream to assess potential effects relating to the landfill footprint.
SF2 Downgradient of the confluence between the Northern Valley stream and the Landfill Valley stream	Water levels and streamflows	Baseflow monitoring of the stream downgradient of the confluence between the Northern Valley stream and the Landfill Valley stream to assess potential effects relating to the landfill footprint.
SF3 Near the mouth of an Upper Waitaraire stream	Water levels and streamflows	Baseflow monitoring of the Upper Waitaraire stream to assess potential effects relating to the landfill footprint.

3.2.3 Subsoil drains

The monitoring frequency requirements for the subsoil drains beneath the landfill footprint are set out in Table 3.1. At the time of writing the GWMP v1.0 the subsoil drains had not been designed. This section will be updated with the monitoring locations following construction.

3.3 Monitoring procedures

Separate detailed step-by-step procedures will be prepared by WMNZ and used for monitoring events (variously known as work instructions, standard operating procedures, and safe work method statements). Only the key features of those procedures are highlighted in Table 3.3.

Table 3.3: Summary of monitoring procedures

Procedure	Key steps
Groundwater sample	• Boreholes listed in Schedule One. • Purging protocol (currently non-purge approach using Hydrasleeves). Traditional method as follows, unless replaced by alternative technology with Council approval: • Pre-ordered bottles. • Field filtering. • Field parameter measurements. • Field preservative and handling precautions. • Avoidance of cross-contamination. • Chain of custody documentation.
Groundwater levels	• Boreholes listed in Schedule Two. • Clean equipment. • Locking and unlocking of well heads. • Collection of manual groundwater level readings before retrieval and prior to re-installation. • Downloading data from recording device.

Procedure	Key steps
Laboratory test methods and Limits of Detection	• Listed in the laboratory data sheets attached as Appendix D.
Subsoil drain sample	• Pre-ordered bottles. • Clear and safe access, and technique that retrieves undisturbed flow sample. • Field parameter measurements. • Chain of custody documentation.
Subsoil drain flow rate measurement	• Identification of pipe outlets. • Direct method (jug and stopwatch) v flow meter. • Downloading data from recording device.
Annual Environmental Report	• Groundwater monitoring results. • Evaluation against trigger levels. • Objective assessment of results.
Groundwater supply well water take volume measurement	• Check for any tampering. • Check of well head assembly and seal. • Check of water meter calibration status. • Water level measurement (device able to read to 200 m). • Flow volume meter reading. • Entry of readings into Council's online system.
Stream levels and flows	• Check of monitoring equipment. • Download of non-telemetered level-loggers, reset and re-deploy. • Manual stream level readings from stream bed to calibrate continuous level monitoring. • Manual stream flow measurements using a digital velocimeter or other suitable technique to calibrate and correlate levels with flowrates.

4 Reporting

The reporting requirements for monitoring groundwater related effects are set out in

Table 4.1.

Table 4.1: Groundwater monitoring reporting requirements

Location/event/topic	Report to	Method	Frequency
Groundwater monitoring and Contingency Plan to be submitted prior to Landfill Commencement Date	Auckland Council	E-mail	At least three months before
Groundwater contamination detected	Auckland Council, Watercare Services and TWEC	E-mail	Within five days
Post Closure Management Plan to be submitted prior to ceasing waste disposal	Auckland Council	E-mail	At least 12 months before

Location/event/topic	Report to	Method	Frequency
Environmental report	Auckland Council	E-mail	Annually
Environmental report	Community Liaison Group	E-mail to advise of its availability	Annually

5 Contingency plan

5.1 Groundwater trigger levels – explanation

Response limits (or trigger levels) are values for the monitoring parameters which, if exceeded, require a course of action to be taken. Upon completion of a monitoring event, the results will be checked against the pre-specified trigger levels. In most cases, the trigger levels are based on baseline data that are being collected prior to Landfill Commencement.

If no trigger level is exceeded, the monitoring event will be routinely reported in due course. If any trigger level is exceeded, action will be taken immediately as described in this contingency plan.

Trigger levels are set at two limits and are referred to as Trigger Level 1 (TL1) and Trigger Level 2 (TL2). These levels are described more broadly in the following sub-sections.

Groundwater trigger levels have been derived for the following leachate indicator parameters including indicators provided by WasteMINZ[4]:

- Ammoniacal nitrogen.
- Boron.
- Chloride.
- Chemical Oxygen Demand.
- Electrical conductivity.
- pH.
- Iron.
- Nitrate.
- Sulphate.
- Zinc.

At the time of writing the GWMP v1.0 groundwater trigger levels have been calculated by using an unfinished baseline monitoring data period. These trigger levels shall be updated on completion of the baseline monitoring period.

5.1.1 Trigger Level 1 (lower response limit)

Exceedance of TL1 warns of potential adverse effects, warns of potential future non-compliance with the resource consent conditions, requires investigation and reporting, and may require remedial action.

TL1 values for groundwater boreholes have been calculated using the mean plus three standard deviations of the available baseline data. These groundwater TL1 values for the leachate indicators are presented in Table Appendix E.1 in Appendix E.

[4] WasteMINZ, September 2023. Technical Guidelines for Disposal to Land. Revision 3.1.

5.1.2 Trigger Level 2 (upper response limit)

Exceedance of TL2 is a firm indication that significant adverse effects and breaches of consent conditions are either already occurring, or could have occurred, or are about to occur. The upper limit is typically set at the limit specified in the resource consent, so exceedance of the upper limit typically indicates non-compliance. In this case, the groundwater TL2 values are based on the mean plus four standard deviations. The TL2 values are also included in Table Appendix E.1 in Appendix E.

Exceedance of TL2 will require the following actions:

- Notify authorities.
- Implement mitigative actions, which will be agreed with Auckland Council and could include:
  - Low flow pumping from the affected monitoring location to induce drawdown and draw leachate impacted groundwater toward the monitoring location.
  - Installation of a dedicated bore to continue low flow pumping up-gradient of the affected monitoring location.
- Engage a specialist adviser (a qualified person or consultancy with experience in environmental management).
- Prompt instigation of investigations to identify the source of the leachate contamination in groundwater.

5.1.3 Emergency

A significant exceedance of the groundwater TL2 may require reference to the site emergency plan.

5.1.4 Flowchart

The procedure to be followed upon receipt of the groundwater quality monitoring results is illustrated in Figure 5.1.

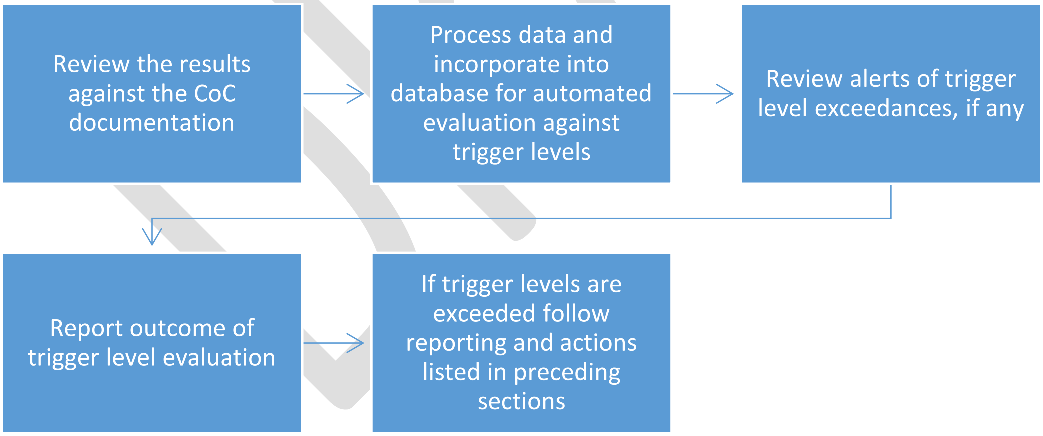

Figure 5.1: Process following receipt of groundwater quality results.

5.1.5 Definition of leachate contamination of groundwater

For the purposes of this GWMP 'leachate contamination' is defined as:

- The groundwater TL2 has been exceeded in monitoring.
- Independent specialist advice has confirmed that a significant change has occurred to the quality of the groundwater in a borehole (or subsoil drain) likely due to leachate.

This definition aims to encompass all events for which the regulator expects notification and liaison regarding response actions. If investigation of a monitoring result or observation subsequently reaches a different conclusion from the first, i.e. that leachate either was or was not the cause, then the event may be re-rated retrospectively accordingly.

With reference to groundwater, leachate contamination may be detected in either the sampling wells or in subsoil drain flows.

5.1.6 Watercare Services Ltd

If TL2 is exceeded in groundwater monitoring wells located between the landfill footprint and any Watercare production well for municipal potable water supply then Notification to Auckland Council shall also be copied to Watercare Services Limited.

5.2 Stream flow trigger levels – explanation

The stream flow trigger levels are values specifically for stream baseflow, which, if triggered, require a course of action to be taken. In this case, action will be required if surface water flow falls below the calculated trigger levels. The trigger levels will be based on the baseline stream flow data that are being collected prior to the Landfill Commencement Date.

If no trigger level is exceeded, the monitoring event will be routinely reported in due course. If any trigger level is exceeded, action will be taken immediately as described in this contingency plan.

Trigger levels for stream flows are set at two limits and are referred to as Stream Flow Trigger Level 1 (SFTL1) and Stream Flow Trigger Level 2 (SFTL2). These levels are described more broadly in the following sub-sections.

5.2.1 Stream Flow Trigger Level 1

The stream flow trigger levels have not been calculated for this version of the GWMP because the baseline monitoring period is in progress at the time of writing. However, SFTL1 will be based on an agreed percentage above the mean annual low flows (MALF) of the stream downgradient of the Landfill Valley and the stream in the Upper Waitaraire catchment. This GWMP proposes SFTL1 to be 150% of the MALF.

Exceedance of the SFTL1 warns of potential adverse effects from reduced groundwater baseflows, warns of potential future non-compliance with the resource consent conditions, requires investigation and reporting, and may require remedial action.

5.2.2 Stream Flow Trigger Level 2

The SFTL2 will be based on the MALF’s calculated from the stream water level and stream flow data being collected from the stream downgradient of the Landfill Valley and the stream in the Upper Waitaraire catchment.

Exceedance of the streamflow TL2 will require one or more of:

- Urgent mitigative actions including augmentation of streamflow to maintain 85% of the MALF.
- Notification of authorities.

5.3 Response guidelines

Response guidelines for groundwater and streamflow management are set out in Table 5.1.

Table 5.1: Summary of response guidelines

Contingency triggering event	Response guidelines
Leachate contamination in groundwater or subsoil drain flow identified by exceedance of TL2	• Confirm that the steps in the contingency plan flowchart have been followed. • Expand the monitoring programme which might include more locations, more parameters and more often. • In the case of the subsoil drains, if the continuous monitoring of electrical conductivity has exceeded the trigger level, then a grab sample of the subsoil drainage will be taken at the outlet and analysed for the parameters set out in Appendix A. • Ensure that the contaminant is also measured in leachate (conversely if a contaminant concentration in leachate rises significantly, then consider adding that contaminant to the monitoring parameter list for groundwater and/or subsoil drain flow). • Design and implement any case-specific remediation e.g. de-watering wells for local reversal of hydraulic gradient, liner redesign, subsurface grout curtains, reconfiguration of daily waste placement to reduce leachate.
Stream flow falls below 85% of the MALF	• Visually observe the streams being monitored. • Augment stream flows using water sources that could include rainwater collection tanks, diversion of groundwater from the potable supply bore or import of water by using water tankers.

5.4 Bore failure

Condition 327 indicates that should any of the monitoring bores be damaged or become inoperable then a replacement monitoring bore shall be drilled at a nearby location in consultation with Council. The replacement bore shall be to the same depth or greater.

To support consultation with Council, they shall be provided with a brief description of the cause of the bore failure, the bore log of the failed bore and a proposed location and preliminary bore construction design for the replacement bore.

6 Task lists

6.1 Tasks and scheduled maintenance

The monitoring tasks relating to groundwater boreholes, subsoil drains and streamflow for ongoing/ operational monitoring are set out in Table 6.1.

Table 6.1: Scheduled monitoring and maintenance

Role	Task	Frequency
Monitoring Technician	Collect groundwater samples (Schedule One).	Quarterly
Monitoring Technician	Measure groundwater levels (Schedule Two).	Quarterly
Monitoring Technician	Download groundwater level data and stream level data from remote (non-telemetry) monitoring devices including leveloggers.	Monthly

Role	Task	Frequency
	Check battery and memory space at the same time.	
Monitoring Technician	Backup groundwater data collected by the web-based (telemetry) monitoring service.	Monthly
Landfill Engineer	Prepare the annual Environmental Report, including groundwater and streamflows.	Annually
Monitoring Technician	Inspect and maintain pneumatic and/or electric groundwater pumping equipment.	Quarterly

7 Applicability

This report has been prepared for the exclusive use of our client WM New Zealand Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that WM New Zealand Ltd, will submit this report as part of an application for resource consent and that the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:	Report Reviewed by:
....	....
Leon Pemberton Senior Hydrogeologist	Tony Reynolds Project Director

Authorised for Tonkin & Taylor Ltd by:

....

Simonne Eldridge
Project Director

LP
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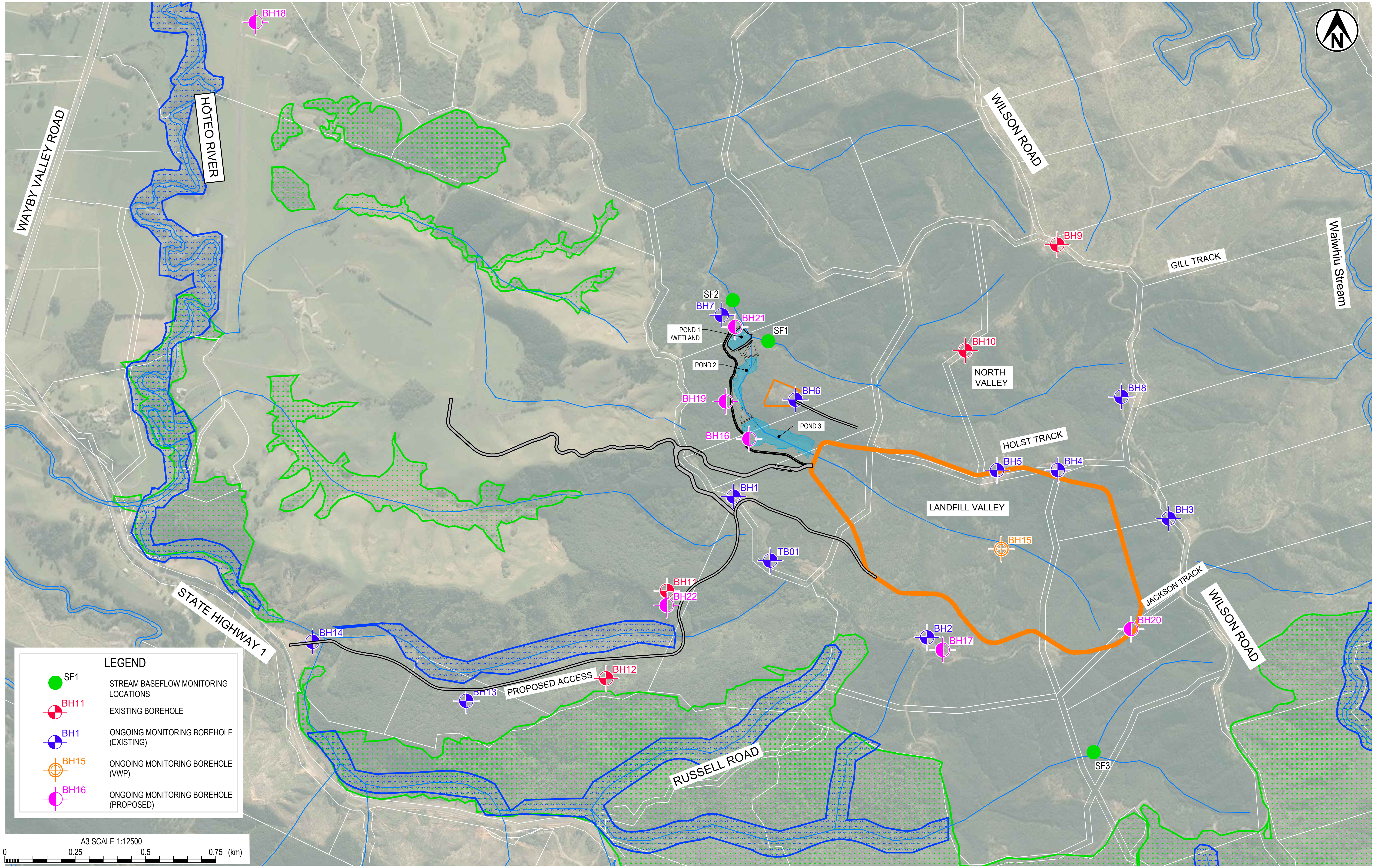
Appendix A Ongoing monitoring parameters

Table Appendix A.1 : Ongoing groundwater monitoring parameters (post Landfill Commencement Date)

PARAMETER	UNITS	Quarterly sampling	Annual sampling
Temperature	°C	Y	Y
Sodium	g Na/m3		Y
pH			Y
Chloride	g Cl/m3	Y	Y
Conductivity	mS/m	Y	Y
Potassium	g K/m3		Y
Total Ammoniacal Nitrogen	g N/m3	Y	Y
Total Hardness	g CaCO3/m3		Y
Zinc (soluble)	g Zn/m3	Y	Y
Manganese (soluble)	g Mn/m3		Y
COD	g O2/m3		Y
Arsenic (soluble)	g As/m3	Y	Y
Copper (soluble)	g Cu/m3	Y	Y
Lead (soluble)	g Pb/m3	Y	Y
Nitrate Nitrogen	g N/m3		Y
Sulphate	g SO4/m3		Y
Alkalinity	g CaCO3/m3		Y
Boron	g B/m3	Y	Y
Nickel (soluble)	g Ni/m3	Y	Y
Calcium	g Ca/m3		Y
Iron (soluble)	g Fe/m3		Y
Magnesium (soluble)	g Mg/m3		Y
Cadmium (soluble)	g Cd/m3	Y	Y
Chromium (soluble)	g Cr/m3	Y	Y
Semi Volatile Organic Compounds	g/m3		Y
Total Petroleum Hydrocarbons	g/m3		Y
Polycyclic Aromatic Hydrocarbons	g/m3		Y

Appendix B Monitoring location plan



Tonkin+Taylor

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Aerial photo sourced from Auckland Council GIS Website.
Property boundaries sourced from Land Information New Zealand data as at 16-Feb-2017 (Crown Copyright Reserved).

PROJECT No.	1017284	
DESIGNED	LP	Dec.20
DRAWN	RBS	Dec.20
CHECKED		
APPROVED		DATE

CLIENT **WASTE MANAGEMENT NZ**

PROJECT **AUCKLAND REGIONAL LANDFILL PROJECT**

TITLE GROUNDWATER MONITORING & CONTINGENCY PLAN
MONITORING LOCATIONS

DRAFT

SCALE (A3) 1:12,500 FIG No. 1017284-F1 REV 1

Appendix C Schedule One and Schedule Two Boreholes

LMP Section 3.24

Schedule One

Boreholes for monitoring of groundwater chemistry (marked by *)

Borehole	**Groundwater Chemistry** **ONGOING**	**Groundwater Chemistry** **BASELINE ONLY**
BH1		*
BH2		*
BH3	*	*
BH4		
BH5	*	*
BH6	*	*
BH7	*	*
BH8	*	*
BH9		*
BH10		*
BH11		
BH12		
BH13	*	*
BH14	*	*
BH15		
TB01 (potable)	*	*
BH16 (downstream of landfill in vicinity of toe of landfill)	*	
BH17 (between southern landfill and tributary of Waiteraire Stream)	*	
BH18 (downstream of landfill in vicinity of Spindler Rd)	*	
BH19 (down-gradient of Pond 3, to shallow depth)	*	
BH20		
BH21 (down-gradient of Pond 1, to shallow depth)	*	
BH22 (between south western landfill and tributary of Waiteraire Stream)	*	

LMP Section 3.24

Schedule Two

Boreholes for monitoring of groundwater levels (marked by *)

Borehole	**Groundwater Level** **ONGOING**	**Groundwater Level** **BASELINE ONLY**
BH1	*	*
BH2	*	*
BH3	*	*
BH4	*	*
BH5	*	*
BH6	*	*
BH7	*	*
BH8	*	*
BH9		*
BH10		*
BH11		*
BH12		*
BH13	*	*
BH14	*	*
BH15 (until removed for landfill footprint)	* (VWPs)	* (VWPs)
TB01 (potable)		
BH16 (downstream of landfill in vicinity of toe of landfill)	*	
BH17 (between southern landfill and tributary of Waiteraire Stream)	*	
BH18 (downstream of landfill in vicinity of Spindler Rd)	*	
BH19 (down-gradient of Pond 3, to shallow depth)	*	
BH20 (between south eastern landfill and tributary of Waiteraire Stream)	*	*
BH21 (down-gradient of Pond 1, to shallow depth)	*	
BH22 (between south western landfill and tributary of Waiteraire Stream)	*	

Appendix D Laboratory data sheets

SUMMARY OF METHODS

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

Sample Type: Ground Water

Test	Method Description	Default Detection Limit
Individual Tests		
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) 23rd ed. 2017.	-
Preparation for filtered dissolved metals analysis	Preparation for dissolved metals analysis. APHA 3030 B 23rd ed. 2017.	-
Dissolved Arsenic	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0053 g/m^3
Total Calcium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.053 g/m^3
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3
Dissolved Lead	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.053 g/m^3
Total Sodium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.021 g/m^3
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m^3
Chemical Oxygen Demand (COD), screen level	Dichromate/sulphuric acid digestion, colorimetry. Screen Level method. APHA 5220 D 23rd ed. 2017.	25 g O_2/m^3
Anion / Cation profile, dissolved metals trace level		
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E 23rd ed. 2017.	0.07 meq/L
Total cations for anion/cation balance check	Sum of cations as mEquiv/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H^+) also included in calculation if available. APHA 1030 E 23rd ed. 2017.	0.05 meq/L
pH	pH meter. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D 23rd ed. 2017.	1.0 g/m^3 at 25°C
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House	0.0010 g/m^3

RELIABLE SUPPORTIVE RESPONSIVE LOCAL TRUSTED

Sample Type: Ground Water		
Test	**Method Description**	**Default Detection Limit**
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3

This Laboratory is accredited by International Accreditation New Zealand (IANZ).

The tests quoted herein will be performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Appendix E Groundwater trigger levels

Table Appendix E.1 : Groundwater trigger levels

	BH01 -3 std dev	BH01 -4 std dev	BH2 -3 std dev	BH2 -4 std dev	BH3 -3 std dev	BH3 -4 std dev	BH5 -3 std dev	BH5 -4 std dev	BH6 -3 std dev	BH6 -4 std dev	BH7 -3 std dev	BH7 -4 std dev
	TL1	**TL2**	**TL1**	**TL2**	**TL1**	**TL2**	**TL1**	**TL2**	**TL1**	**TL2**	**TL1**	**TL2**
Electrical Conductivity (EC)-mS/m	26	27	162	194	105	116	38	41	249	277	38	38
Total Boron-g/m3	0.026	0.027	0.136	0.155	0.377	0.4	0.038	0.042	0.11	0.127	0.22	0.237
Dissolved Iron-g/m3	0.11	0.14	0.09	0.11	0.02	0.02	2.52	2.98	0.15	0.17	0.13	0.16
Dissolved Zinc-g/m3	0.172	0.214	0.01	0.012	0.045	0.051	0.084	0.1	0.529	0.678	0.17	0.202
Chloride-g/m3	22.6	23.1	39	43	40	41	33	37	23	26	36	37
Total Ammoniacal-N-g/m3	0.01	0.01	1.91	2.28	2.59	2.79	0.09	0.11	4.15	4.49	0.06	0.073
Nitrate-N-g/m3	18.41	23.75	20.47	26.37	1.25	1.61	4.66	5.95	0.08	0.1	0.12	0.15
Sulphate-g/m3	8.7	9.2	8.3	9.5	27.7	31.9	11.8	13.7	16	18.4	21.3	21.9

	BH9 -3 std dev	BH9 -4 std dev	BH10 -3 std dev	BH10 -4 std dev	BH13 -3 std dev	BH13 -4 std dev	BH14 -3 std dev	BH14 -4 std dev	TB01 -3 std dev	TB01 -4 std dev
	TL1	**TL2**	**TL1**	**TL2**	**TL1**	**TL2**	**TL1**	**TL2**	**TL1**	**TL2**
Electrical Conductivity (EC)-mS/m	95	115	40	41	41	46	48	50	147	157
Total Boron-g/m3	0.079	0.097	0.228	0.239	0.077	0.092	0.062	0.065	1.02	1.07
Dissolved Iron-g/m3	3.9	5.05	0.15	0.18	6.23	7.67	0.29	0.36	0.29	0.36
Dissolved Zinc-g/m3	0.174	0.221	0.231	0.291	0.13	0.163	0.027	0.033	0.185	0.229
Chloride-g/m3	48	59	46	47	34	38	31	32	30	32
Total Ammoniacal-N-g/m3	0.52	0.672	0.031	0.036	0.019	0.022	0.052	0.057	4.1	4.39
Nitrate-N-g/m3	0.86	1.02	0.52	0.6	4.21	5.33	14.82	19.23	0.021	0.025
Sulphate-g/m3	11.8	14.2	18.1	18.7	60.4	75.9	8.3	8.8	44.1	51.6