PLANZ CONSULTANTS
PLANNING AND RESOURCE MANAGEMENT

Waste Management NZ Limited

Fairfield Closed Landfill – Renewal of Regional Resource Consents

Resource Consent Application to the Otago Regional Council

February 2024

Planz Consultants

Quality Assurance Statement:

Application Prepared By:

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APPLICATION FOR RESOURCE CONSENT

SECTION 88 OF THE RESOURCE MANAGEMENT ACT 1991

To: the Otago Regional Council

1. We, **Waste Management NZ Limited**[1] (**Waste Management**) (318 East Tamaki Road, East Tamaki, Auckland 2013) is seeking all necessary resource consents for the aftercare period of the Fairfield closed landfill. The specific requirements for the resource consents are:

   (a) A discharge permit to discharge landfill gas, and associated odour, to air from the Fairfield closed landfill, in accordance with Rule 7.6.1.3 (discretionary activity) of the Regional Plan: Waste for Otago (Waste Plan)[2].

   (b) A discharge permit to discharge landfill leachate to groundwater, by seepage, through the 21 hectare base of the Fairfield closed landfill which is bounded by the leachate interception drain:

      a. in accordance with Rule 7.6.1.1 (discretionary activity) of the Waste Plan; and

      b. in accordance with Regulation 45B(5) (discretionary activity) the Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-F) where the discharge occurs within 100m of the Kaikorai Lagoon Swamp[3].

   (c) A water permit to take groundwater containing leachate and other groundwater, for the purpose of controlling landfill leachate and to maintain groundwater within the area bounded by the Fairfield closed landfill's leachate interception drain:

      a. in accordance with Rule 10A.3.2.1 (non-complying activity) and Rule 12.2.4.1(i) (discretionary activity) of the Regional Plan: Water for Otago (Water Plan); and

      b. in accordance with Regulation 45B(4) (discretionary activity) of the NES-F for the groundwater that is taken within 100m of the Kaikorai Lagoon Swamp.

   (d) A discharge permit to discharge stormwater runoff diverted from the Fairfield closed landfill into the Kaikorai Stream and Kaikorai Lagoon Swamp, after treatment through the North and Weighbridge stormwater retention ponds:

      a. in accordance with Rule 7.6.1.2 (discretionary activity) of the Waste Plan; and

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[1] Consent 95008, as contained in **Appendix 1,** refers to the consent holder as 'Waste Management Limited', previously known as 'Transpacific Industries Group New Zealand Limited'. Waste Management NZ Limited is the entity that was formerly known as Transpacific Industries Group New Zealand Limited, not Waste Management Limited, and is therefore considered to be the consent holder of this resource consent. It is acknowledged that Consents 93540 to 93542 correctly refer to Waste Management NZ Limited as the consent holder.

[2] The Waste Plan rules, rather than the rules of the Regional Plan: Air for Otago (as stated in Section 16.2.2 of the Regional Plan: Air for Otago), apply to the discharges to air from the closed landfill.

[3] The 'Kaikorai Lagoon Swamp' is a 'Regionally Significant Wetland' as identified in Schedule F of the Water Plan (Map F57).

b. **in accordance with Regulation 45B(5) (discretionary activity) of the NES-F as the discharge is into the Kaikorai Lagoon Swamp.**

A consent term of 30 years is sought for all of the above resource consents. This time period reflects the expected aftercare time period for the closed landfill and the fact that the activities for which consent are being sought are interlinked (i.e., the water permit to take groundwater is the directly connected to the need to manage the discharge of landfill leachate to groundwater, by seepage, through the base of the landfill).

Finally, the reason the above consent term is also being sought for the groundwater take, which is to be allocated as a surface water take in accordance with Policy 6.4.1A(b) of the Water Plan, is discussed in Sections 4.3 and 8.7 (Table 3 – refer to Policy 10A.2.3) of this application.

The overall activity status of the application is non-complying.

2. The activity to which the application relates (the activity) is as follows:

Tartan Industries Limited, a subsidiary of Waste Management, own the site associated with the Fairfield closed landfill, with Waste Management managing activities within the closed landfill. While the landfill is closed, and therefore no longer receiving waste material for disposal (waste disposal ceased in 2017), a number of activities, currently authorised by regional resource consents granted by the Otago Regional Council (ORC), will continue during the landfill's aftercare period as the material in the landfill continues to slowly decompose. These activities are as follows:

- **The discharge of landfill gas, and associated odour, to air. The landfill gas, from part of the site, is currently flared (i.e., collected and combusted with a flame). This discharge is currently authorised by Consent 95008 as contained in Appendix 1 of this application.**
- **The discharge of landfill leachate to groundwater by seepage. This discharge is currently authorised by Consent 93540 as contained in Appendix 1 of this application.**
- **The taking of underground water containing leachate and other groundwater. This take is currently authorised by Consent 93541 as contained in Appendix 1 of this application. The leachate and groundwater, taken in accordance with this water permit, is discharged into Dunedin's wastewater network in accordance with a trade waste consent.**
- **The discharge of treated stormwater into the Kaikorai Stream and Kaikorai Lagoon Swamp. This discharge is currently authorised by Consent 93542 as contained in Appendix 1 of this application. Stormwater from the site's North Pond is discharged into the Kaikorai Stream, while the overflow discharge from the Weighbridge Pond is discharged into the Kaikorai Lagoon Swamp.**

Consents 95008 and 93540 to 93542 expire on 1 September 2024. Waste Management are seeking to 'renew' these resource consents as the discharge and take activities currently authorised by these resource consents will continue during the closed landfill's aftercare period. That is, leachate and gas will continue to be generated as the waste in the landfill decomposes, although over time the levels of leachate and gas will reduce, and ultimately cease (i.e., when the organic material in the landfill has decomposed).

The activity for which resource consents are being sought by this application are more fully described in the attached AEE which forms part of this application.

3. The site at which the proposed activity is to occur is as follows:

Address: **Fairfield, adjacent to the Kaikorai Stream and Kaikorai Lagoon Swamp, approximately 1km off Old Brighton Road, Fairfield, Dunedin. The access into the landfill is at 125/127 Old Brighton Road.**

Legal Description: **Tartan Industries Limited, which is a subsidiary of Waste Management, landholding consists of the following land parcels - Lot 2 DP566541 (RT 1021375 (prior to subdivision in March 2023, part of Part Lot C DP1685 (RT OT13B/390)), Part Lot B DP685 (RT OT8D/1045) and Part Section 41 Block VIII Dunedin & East Taieri Survey District and DP7227 (RT OT352/110). Copies of the Records of Title are provided in Appendix 9.**

Area: **Tartan Industries Limited's, which is a subsidiary of Waste Management, total land holding is 65.6ha. The area covered by the Fairfield closed landfill is 21ha.**

The location of the Fairfield closed landfill is identified in Figures 1 and 2 contained in the attached AEE which forms part of this application and in the figures and plans contained in the Aftercare Management Plan contained in Appendix 2 of this application.

4. The full name and address of each owner and occupier (other than the applicant) of the site to which the application relates are as follows:

Tartan Industries Limited, a subsidiary of Waste Management, is the owner of that land associated with the closed landfill site. Waste Management manage, and thus occupy, the closed landfill.

5. There are no other activities that are part of the proposal to which this application relates.

6. No additional resource consents are needed for the proposal to which this application relates.

The Resource Management (National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat) Regulations 2023 came into effect on 27 July 2023. However, while landfill gas is a greenhouse gas, these regulations do not apply to the discharge of landfill gas to air, including the products of combustion from the flaring of the landfill gas, from the site, as these regulations only apply to industrial activities generating thermal energy as part of its processing operations.

7. We attach an assessment of the proposed activity's effect on the environment that—

    (a) includes the information required by clause 6 of Schedule 4 of the Resource Management Act 1991; and

    (b) addresses the matters specified in clause 7 of Schedule 4 of the Resource Management Act 1991; and

    (c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

8. We attach an assessment of the proposed activity against the matters set out in Part 2 of the Resource Management Act 1991.

9. We attach an assessment of the proposed activity against any relevant provisions of a document referred to in section 104(1)(b) of the Resource Management Act 1991, including the information required by clause 2(2) of Schedule 4 of that Act.

10. The value of the investment of the existing consent holder is:

    As this application has been lodged six months prior to the expiry of Consents 95008 and 93540 to 93542 (Appendix 1), section 124 of the Resource Management Act 1991 (RMA) applies. As an application affected by section 124, section 104(2A) of the RMA requires the consent authority to have regard to the value of investment of the existing consent holder. In accordance with these provisions of the RMA, an overview of the value of Waste Management's investment at the site is outlined in Section 5.3 of the attached AEE.

11. We attach the following further information required to be included in this application by the district plan, the regional plan, the Resource Management Act 1991, or any regulations made under that Act:

    The statutory planning documents, assessed in the attached AEE and relevant to this application, are the National Policy Statement for Freshwater Management 2020, the New Zealand Coastal Policy Statement 2010, the Resource Management (National Environmental Standards for Air Quality) Regulations 2004, the Resource Management (National Environmental Standards for Freshwater) Regulations 2020, the Proposed Otago Regional Policy Statement 2021, the Partially Operative Otago Regional Policy Statement 2019, the Regional Plan: Waste for Otago, the Regional Plan: Water for Otago and the Regional Plan: Coast for Otago.

The deposit of $2,450 (incl. GST) (non-notified and limited notified multiple application which consists of $2,300 plus $150 compliance administration fee[4]) has been paid by Waste Management, on 19 February 2024, using the ORC's Datacom secure credit card payment page (payment references are OTH240232488 / RCT240205300).

C Taylor

Carmen Taylor (Consultant Planner (Partner))

Planz Consultants Limited
On behalf of **Waste Management NZ Limited**

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[4] https://www.orc.govt.nz/media/13997/orc-schedule-of-fees-and-charges-23-24.pdf

Address for Service (Electronic and Postal):	**Address for Billing:***
Planz Consultants Limited C/o PO Box 1845 **CHRISTCHURCH 8140** Attention: Carmen Taylor Consultant Planner (Partner) DDI: 03 929 1414 Mobile: 021 312 781 Email: carmen@planzconsultants.co.nz	Waste Management NZ Limited PO Box 11337 Sockburn **CHRISTCHURCH 8443** Attention: David Fitzmaurice Senior Project Engineer South Island – Operational & Technical Services Mobile: 021 507 031 Email: dfitzmaurice@wastemanagement.co.nz

* Planz Consultants Limited accepts no liability for any Council costs or charges. Invoices for all such work are to be sent to the Applicant's address above for billing.

Form 1 – Application for Resource Consent

This application is made under Section 88 of the Resource Management Act 1991 (RMA).

The purpose of this Form 1 and the relevant activity form(s) is to provide applications with guidance on information that is required under the Resource Management Act 1991. Please note that these forms are to act as a guide only, and Otago Regional Council reserves the right to request additional information or to reject the application as incomplete under Section 88 of the RMA if the provisions of the fourth schedule of the RMA are not provided (refer to page 6 of this form, which details these requirements).

PLEASE NOTE: You must have Adobe Acrobat Reader installed onto your computer to use this editable version, which you can download for free from the Adobe website. This form cannot be filled in on your internet browser. REMEMBER to save the form to your computer after completing then attach and send via email along with the other relevant application forms/information to consents.applications@orc.govt.nz. The form can also be printed and completed manually.

1(a). Applicant's details:

- The full names or Company name or Trust (including full names of all Trustees) of the consent holder who will be responsible for the consent and any associated costs.
- A resource consent can only be held by a legal organisation or fully named individual(s). A legal organisation includes a registered limited company, incorporated group or registered trust. If the application is for a Trust, the full names of all Trustees are required. If the application is not for a limited company, incorporated group or rust, then you must use fully named individual(s).
- All invoices will be made out to and sent to the applicant.

Full name(s): ____________________

OR

Registered company: Waste Management NZ Limited

OR

Trust (include all Trustees full names) ____________________

Postal address: C/o PO Box 11337, Sockburn
Christchurch Post code: 8443

and

Physical address: (not a PO Box number) 318 East Tamaki Road, East Tamaki
Auckland Post code: 2013

Phone number: Business: ________ Private: ________
Mobile: C/o 021 507 031

Email address: C/o dfitzmaurice@wastemanagement.co.nz / David Fitzmaurice, Senior Project Engineer South Island

Please provide a valid and clear email address. Otago Regional Council has adopted a paperless consenting process – therefore any correspondence including decision documents and consent (if granted) will be sent via email, unless you request a paper copy.

Please tick if you do not prefer contact by electronic means ☑

1(b). Key contact for applicant details (if applicable):

Only complete if the applicant consists of multiple parties (e.g. multiple consent holders, Trust etc). Please outline who the key contact for the consent will be, if granted:

Full name: ______________________

Phone number: Business: ____________ Private: ____________

Mobile: ____________

Email address: ______________________

2. Consultant details (if applicable):

Contact person: Carmen Taylor, Consultant Planner (Partner)

Company: Planz Consultants Limited

Phone number: Mobile: 021 312 781 Business: 03 929 1414

Email address: carmen@planzconsultants.co.nz

3. Consents required in relation to this proposal:

Water

☐ Take surface water ☒ Take groundwater ☐ Divert

☐ Dam

Discharge onto or into:

☐ Land ☒ Water x 2 ☒ Air

Land use:

☐ Bore construction ☐ Bore alteration ☐ Disturbance of contaminated

☐ Activities in or on beds of lakes or rivers or floodbanks

Coastal

☐ Activities in the coastal marine area (i.e. below mean high water spring tide)

Where you have indicated the type of consent that is required, you must complete the appropriate application form before your application can be processed. Application forms can be found on the Council's website: www.orc.govt.nz/consents/ready-to-apply-for-a-consent

4. For what purpose is/are the consent(s) required (e.g. gravel extraction, water for irrigation etc):

Aftercare activities at the Fairfield closed landfill.

5. Location of proposed activity:

Address: 125/127 Old Brighton Road, Fairfield, Dunedin

Legal description(s): Refer to Form 9 contained in the application documentation.

Map reference(s) (NZTM 2000): E ____ N ____

Please include location details on separate documentation if there are multiple sites or activities.

Note: Certificate(s) of Title less than three months old for the site to which this application relates are required.

6. Are there any current or expired Resource Consents relating to this proposal:

☒ Yes ☐ No

If yes, give consent number(s), description and expiry date(s):

Consents 95008 and 93540 to 93542. These consents expire on 1 September 2024.

Refer to the application documentation for a description of these existing resource consents.

(a) Do you agree to your current consent automatically being surrendered should a replacement consent be issued?

☒ Yes ☐ No

(b) Has there been a previous application for this activity that was returned as incomplete?

☐ Yes ☒ No

(c) Have you lodged a pre-application with Council for this activity?

☒ Yes ☐ No

(d) Have you spoken to a Council staff member about this application prior to lodging this application?

☒ Yes ☐ No

If yes, please state name of staff member: Brittany Watson (and others). Pre-app reference is RM22.380.

7. What is the term of consent you are seeking and reason for this term:

30 years. Please refer to the application documentation for the reason for this term.

8. Territorial Local Authority in which activity is situated:

☒ Dunedin City Council ☐ Clutha District Council ☐ Central Otago District Council

☐ Queenstown Lakes District Council ☐ Waitaki District Council

9. Do you require any other resource consent from any local authority for this activity:

☐ Yes ☒ No

If yes, please give the date applied for or issued:

10. For the land on which the activity occurs, is the applicant (tick one):

If the applicant does not own the land to which this application relates, unconditional written approval from the land owner/affected party will be required.

☒ The owner ☐ The lease holder ☒ The occupier

☐ Prospective purchaser

If the applicant is not the land owner, who is the owner of the land on which the activity occurs/is to occur:

Name of land owner: Tartan Industries Limited, which is a subsidiary of Waste Management Limited

Phone number: Mobile: Not applicable Business: Not applicable

Email address: Not applicable

11. Site visit from the Consents Team:

Consents staff are able to meet with you, visit your site and see what you are proposing to do. We find that this is beneficial to everyone involved. The cost of the visit will be included in the total cost of processing your consent. However, we find that applications that have an on-site visit are processed with less congestion and at a similar or lesser overall cost. Please let us know below if you would like us to come and see your site.

I would like a member of the Consents Team to visit my site:

☐ Yes ☐ No

Consents team members are welcome to visit the site. However, it is requested that access arrangements are made through Waste Management, who will accompany team members around the site.

12. Processing Officer:

Due to high workloads or the complex nature of your application, it could be assigned to a consultant processing officer. Having your application assigned to an external officer should not greatly affect the processing costs. However, if you would like your application to be assigned to an internal officer then please advise. This may mean that your application enters a waiting line to be allocated and may not be processed straight away. If this is the case we will ask for a timeframe extension to cover the waiting time. There may be situations where we cannot accommodate this request but will let you know why this is.

I would like my application to only be processed by an internal staff member:

☐ Yes ☐ No

N/A - No preference.
However, it is understood, as discussed at a pre-hearing meeting, that Brittany Watson would be assigned to this application.

13. How to pay:

A deposit **must** accompany this application (see **page 9** for amounts and ways to pay). The applicant will be invoiced for all costs incurred in processing this application that exceed the deposit.

If the required deposit does not accompany your application, staff will contact you on the email address provided on this form to request payment, and after 3 working days your application will returned as incomplete if no payment is made for the required deposit.

When paying online, please use the word '**Consent**' followed by the name of the applicant as a reference.

Method of payment:

☐ Online bank transfer ☐ In person ☒ Credit card

Date of payment: 19 February 2024

Amount paid: $2,450 (incl. GST)

Payment reference: OTH240232488 / RCT240205300

Please note: Your deposit may not cover the entire cost of processing your application. At the end of the application process you will be invoiced for any costs that exceed the deposit. Interim invoices may be sent out for applications, where appropriate. We will communicate processing costs to you at key stages through the process. If you would like this, then please let us know and we can see if this is an option for you.

If your application is returned to you, you will still be charged for the cost of processing the application up to the point it was returned or withdrawn. **Therefore, it is recommended that you have your application checked before it is lodged. This is a free service.**

Information regarding costs can be found via the following link:
www.orc.govt.nz/consents/ready-to-apply-for-a-consent/fees-and-charges

Checklist

Before signing the declaration below, in order to provide a complete application have you remembered to:

- ☒ Fully complete this Form 1, including signed declaration
- ☑ Completed the necessary application forms relating to the activity
  Application forms can be found on Council's website via the following link:
  www.orc.govt.nz/consents/ready-to-apply-for-a-consent

– Form 9 of the RMA regulations contained in the application

- ☒ Payment of the required deposit (see page 8 for fees schedule)
- ☐ Written approvals from all potentially affected parties Not applicable
  "Written Approval of an Affected Party" forms are available from Councils website
- ☒ An assessment of effects on the environment
- ☒ An assessment against the relevant objectives, policies and rules from Regional Council Plans, Regional Policy Statement (including proposed and partially operative versions), and relevant Regulations, National Policy Statements, National Environmental Standards and iwi management plans
- ☒ Site and location plans
- ☒ Certificate(s) of Title less than three months old for the site to which this application relates
  Certificates of Title can be obtained via the Land Information New Zealand website: www.linz.govt.nz

Declaration

I/we hereby certify that to the best of my/our knowledge and belief, the information given in this application is true and correct.

I/we undertake to pay all actual and reasonable application processing costs incurred by the Otago Regional Council.

Name(s): Carmen Taylor

Signature(s):*
(or person authorised to sign on behalf of applicant)

* **Ensure you use the "fill and sign" function of Adobe Acrobat when signing this form. Either draw your signature or add an image. Council cannot accept typed signatures.**

Designation: Consultant
(e.g. owner, manager, consultant)

Date: 28 Febuary 2024

Council can accept electronic lodgement of applications if sent to consents.applications@orc.govt.nz.

Alternatively, applications can be posted or delivered to:
Otago Regional Council
Private Bag 1954
70 Stafford Street
Dunedin 9054

Consultation

(consultation is not compulsory, but it can make a process easier and reduce costs)

Under Section 95E of the Resource Management Act 1991 (the Act), the Council will identify affected parties to an application and if the application is to be processed on a non-notified basis the unconditional written approval of affected parties will be required. Consultation with potentially affected parties and interested parties can be commenced prior to lodging the application.

Consultation may be required with the appropriate Tangata Whenua for the area. The address of the local Iwi office is: Aukaha, 258 Stuart Street, P O Box 446, Dunedin, Fax (03) 477-0072, Phone (03) 477-0071, Email info@aukaha.co.nz. If you are in the Clutha River area you may need to talk to Te Ao Marama Inc, Phone (03) 931 1242. If you require further advice, please contact the Otago Regional Council.

Good consultation practices include:

- Giving people sufficient information to understand your proposal and the likely effects it may have on them
- Allowing sufficient time for them to assess and respond to the information
- Considering and taking into account their responses

Written approval forms are available on Council's website.

Information Requirements

In order for any consent application to be processed efficiently in the minimum time and at minimum cost, it is critical that as much relevant information as possible is included with the application.

Resource Management Act 1991
FOURTH SCHEDULE – ASSESSMENT OF EFFECTS ON THE ENVIRONMENT
(Below are the provisions of the fourth schedule of the Act, which describes what must be in an application for resource consent, as amended in 2015)

1. Information must be specified in sufficient detail

Any information required by this schedule, including an assessment under clause 2(1)(f) or (g), must be specified in sufficient detail to satisfy the purpose for which it is required.

2. Information required in all applications

(1) An application for a resource consent for an activity (the **activity**) must include the following:
  (a) a description of the activity; and
  (b) a description of the site at which the activity is to occur; and
  (c) the full name and address of each owner or occupier of the site; and
  (d) a description of any other activities that are part of the proposal to which the application relates; and
  (e) a description of any other resource consents required for the proposal to which the application relates; and
  (f) an assessment of the activity against the matters set out in Part 2; and
  (g) an assessment of the activity against any relevant provisions of a document referred to in section 104(1)(b) *("document" includes regional and district plans, regulations, national policy statements, iwi plans)*.

(2) The assessment under subclause (1)(g) must include an assessment of the activity against:
  (a) any relevant objectives, policies, or rules in a document; and
  (b) any relevant requirements, conditions, or permissions in any rules in a document; and
  (c) any other relevant requirements in a document (for example, in a national environmental standard or other regulations).

(3) An application must also include an assessment of the activity's effects on the environment that:
  (a) includes the information required by clause 6; and
  (b) addresses the matters specified in clause 7; and
  (c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

3. Additional information required in some applications

An application must also include any of the following that apply:

(1) if any permitted activity is part of the proposal to which the application relates, a description of the permitted activity that demonstrates that it complies with the requirements, conditions, and permissions for the permitted activity (so that a resource consent is not required for that activity under section 87A(1))

(2) if the application is affected by section 124 or 165ZH(1)(c) (which relate to existing resource consents), an assessment of the value of the investment of the existing consent holder (for the purposes of section 104(2A))

(3) if the activity is to occur in an area within the scope of a planning document prepared by a customary marine title group under section 85 of the Marine and Coastal Area (Takutai Moana) Act 2011, an assessment of the activity against any resource management matters set out in that planning document (for the purposes of section 104(2B).

4. (relates to subdivisions – *not included here as subdivisions are not within ORC's jurisdiction)*

5. Additional information required in application for reclamation

An application for a resource consent for reclamation must also include information to show the area to be reclaimed, including the following:

(1) the location of the area; and
(2) if practicable, the position of all new boundaries; and
(3) any part of the area to be set aside as an esplanade reserve or esplanade strip.

Assessment of environmental effects

6. Information required in assessment of environmental effects

(1) An assessment of the activity's effects on the environment must include the following information:
  (a) if it is likely that the activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity
  (b) an assessment of the actual or potential effect on the environment of the activity
  (c) if the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment that are likely to arise from such use
  (d) if the activity includes the discharge of any contaminant, a description of:
    (i) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and
    (ii) any possible alternative methods of discharge, including discharge into any other receiving environment.
  (e) a description of the mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect
  (f) identification of the persons affected by the activity, any consultation undertaken, and any response to the views of any person consulted
  (g) if the scale and significance of the activity's effects are such that monitoring is required, a description of how and by whom the effects will be monitored if the activity is approved
  (h) if the activity will, or is likely to, have adverse effects that are more than minor on the exercise of a protected customary right, a description of possible alternative locations or methods for the exercise of the activity (unless written approval for the activity is given by the protected customary rights group).

(2) A requirement to include information in the assessment of environmental effects is subject to the provisions of any policy statement or plan

(3) To avoid doubt, subclause (1)(f) obliges an applicant to report as to the persons identified as being affected by the proposal, but does not:
  (a) oblige the applicant to consult any person; or
  (b) create any ground for expecting that the applicant will consult any person.

7. Matters that must be addressed by assessment of environmental effects

(1) An assessment of the activity's effects on the environment must address the following matters:
  (a) any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects
  (b) any physical effect on the locality, including any landscape and visual effects
  (c) any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity
  (d) any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations
  (e) any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants
  (f) any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations.

(2) The requirement to address a matter in the assessment of environmental effects is subject to the provisions of any policy statement or plan.

Set out below are details of the amounts payable for those activities to be funded by fees and charges, as authorised by s36(1) of the Resource Management Act 1991.

Resource Consent Application Fees (from 1 July 2020)

Note that the fees shown below are a **deposit** to be paid on lodgement of a consent application and applications for exemptions in respect of water metering devices. This deposit will not usually cover the full cost of processing the application, and further costs are incurred at the rate shown in the scale of charges. GST is included in all fees and charges.

If you wish to make a payment via internet banking, or online, the details are below. Please note the applicants name and 'consent application' should be used as reference when paying the deposit.

For ways to pay, visit: www.orc.govt.nz/consents/ready-to-apply-for-a-consent

Pre-Application Work
Fees payable for pre-application work carried out before a consent application is lodged with Council will be incurred at the rates shown in the scale of charges.

Publicly Notified Applications: [3]	**$**
First application	5,000.00
Non-Notified Applications and Limited Notification Applications: [3]	**$**
First application (except those below)	1,750
Multiple Applications [1]	2,300
Variation to Conditions – s127	1,750
Administrative Variation – s127	1,750
Fixed Fees	**$**
Exemptions from water metering regulations	400
Bores	600
Hearings	Per Note 2 below
Payment for Commissioner request – s100A	Per Note 4 below
Objections	
Payment for Commissioner request – s357AB	Per Note 4 below
Transfer of Consent Holder and Certificates Deposits:	**$**
Transfer of permits and consents	200
Priority Table	200
Section 417 Certificate	500
Certificate of Compliance	1,750
All Other Costs As per Scale of Charges	
Scale of Charges:	**$**
Staff time per hour:	
• Management	190
• Team Leader/Principle	170
• Senior Technical	135
• Technical	115
• Field staff	115
• Administration	85
Disbursements	Actual
Additional site notice	Actual
Advertisements	Actual
Vehicle use per kilometre	0.70
Travel and accommodation	Actual
Testing charges	Actual
Consultants	Actual
Commissioners	Actual
Photocopying and printing	Actual

Councillor Hearing fees per hour:	$
• Chairperson	$100
• Member	$80
• Expenses	Actual

Notes:

1. For additional permits in respect of the same site, activity, applicant, time of application, and closely related effect as the first application.

2. The deposit payable shall be 90% of the cost of a hearing as calculated by Council in accordance with information contained in the application file and using the scale of charges. The amount payable will be due at least 10 working days before the commencement of the hearing. If the amount is not paid by the due date, then the Council reserves the right under S36(7) of the Resource Management Act to stop processing the application. This may include cancellation of the hearing.

   Should a hearing be cancelled or postponed due to the non-payment of the charge, the applicant will be invoiced for any costs that arise from that cancellation or postponement.

   Following completion of the hearing process, any shortfall in the recovery of hearing costs will be invoiced, or any over recovery will be refunded to the applicant.

3. Where actual and reasonable costs are less than the deposit paid, a refund will be given.

4. Where an applicant requests under s100A (for a consent hearing) or under s357AB (for the hearing of an objection) an independent commissioner(s); the applicant will be required to pay any increase in cost of having the commissioner(s).

   Where a submitter(s) requests under s100A an independent commissioner(s) any increase in cost that is in addition to what the applicant would have paid shall be paid by the submitter. If there is more than one submitter who has made such request the costs shall be evenly shared.

Review of consent conditions

Following the granting of a consent, a subsequent review of consent conditions may be carried out at either the request of the consent holder, or as authorised under Section 128, as a requirement of Council. Costs incurred in undertaking reviews requested by the consent holder will be payable by the consent holder at the rates shown in the Scale of Charges above.

Reviews initiated by Council will not be charged to consent holders.

Compliance Monitoring Charges

Compliance charges may also be applied to any granted consent(s). These can be found via Council's website at: https://www.orc.govt.nz/media/8679/annual-plan-2020-21_digital.pdf

Resource Management Act 1991
Fourth Schedule
Assessment of Effects on the Environment

1 Introduction

1.1 Background

Tartan Industries Limited (**TIL**), a subsidiary of Waste Management NZ Limited (**Waste Management**), own the site associated with the Fairfield landfill (**the landfill**, or **the site**). Waste Management have operated the landfill/s at the site since 2008.

Landfilling activities have occurred at the site for some time. This application concerns the landfills known as the '**Western Landfill**' which closed in 1996 and the '**Eastern Landfill**', which ceased waste acceptance in 2017 (**Figure 1** in **Section 2.1**).

The Fairfield landfill is now closed and therefore no longer receiving any waste material for disposal. Waste Management also completed, in August 2022, the final phases of site engineering to meet the closure requirements. These requirements are specified in the discharge permit (Consent RM18.066.01, previously Consent 95007), granted by the Otago Regional Council (**ORC**) that authorised the discharge of waste material at the landfill, and the Closure Management Plan prepared in accordance with the discharge permit. Key closure activities included landfill capping and revegetation of the site, as well as the installation of the landfill gas flares.

While the landfill is now closed, a number of activities, currently authorised by regional resource consents granted by the ORC which expire in September 2024, will continue during the landfill's aftercare period as the material in the landfill continues to slowly decompose. Waste Management are therefore seeking new regional resource consents for these ongoing activities from the closed Western and Eastern Landfills. The activities for which resource consents are being sought are as follows:

- The discharge of landfill gas, and associated odour, to air. This discharge is currently authorised by Consent 95008. The discharge of dust is also authorised by this consent, but as the landfill is now closed this aspect of the discharge will no longer occur at the site.
- The discharge of landfill leachate to groundwater by seepage. This discharge is currently authorised by Consent 93540.
- The taking of underground water containing leachate and other groundwater. This take is currently authorised by Consent 93541. The leachate and groundwater taken in accordance with this water permit is discharged into Dunedin's wastewater network in accordance with a trade waste consent.
- The discharge of treated stormwater. This discharge is currently authorised by Consent 93542. Stormwater from the landfill's North Pond is discharged into the Kaikorai Stream, and the overflow discharge from the Weighbridge Pond is discharged into the Kaikorai Lagoon Swamp.

Copies of Consents 95008, and 93540 to 93542 are provided in **Appendix 1** of this application.

Accordingly, this document is an application, and an Assessment of Effects on the Environment (**AEE**), in accordance with the Resource Management Act 1991 (**RMA**), seeking resource consents for the above discharge and take activities that will continue during the closed landfill's aftercare period. The overall activity status of this application is **non-complying**.

As this application has been lodged at least six months prior to the expiry of the closed landfill's existing resource consents, Waste Management will continue to operate under the existing resource consents (Consents 95008, and 93540 to 93542 – **Appendix 1**) until a final decision on this application is made.

1.2 Purpose of this Report

The purpose of this report is to provide the ORC with the information required to consider this resource consent application for the continued discharges and take of underground water associated with the aftercare period at the Fairfield closed landfill.

1.3 Structure of this Report

This report is divided into twelve sections as follows:

Section 1:	provides an introduction to the background for the application and identifies the purpose and structure of the report.
Section 2:	provides a brief description of the closed landfill site and surrounding environment.
Section 3:	provides a detailed description of the closed landfill and the continued discharges and take of underground water for which resource consents are being sought by this application.
Section 4:	assesses the rules and regulations of the Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (**NES-AQ**), the Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (**NES-F**), the Regional Plan: Waste for Otago (**Waste Plan**) and the Regional Plan: Water for Otago (**Water Plan**) that apply to the continued discharges and take of underground water from the Fairfield closed landfill.
Section 5:	identifies the relevant statutory framework under the RMA in such detail as is commensurate with the activity for which resource consents are being sought.
Section 6:	evaluates the proposal in terms of its actual and potential effects on the environment and outlines the mitigation measures and monitoring to be implemented.
Section 7:	describes the alternatives for the discharges associated with Waste Management's closed landfill at Fairfield.
Section 8:	identifies the relevant objectives and policies of the National Policy Statement for Freshwater Management 2020 (**NPS-FM 2020**), the New Zealand Coastal Policy Statement 2010 (**NZCPS**), the Proposed Otago Regional Policy Statement 2021 (**PORPS 2021**), the Partially Operative Otago Regional Policy Statement 2019 (**PORPS 2019**), the Waste Plan, the Water Plan,the Regional

Plan: Coast for Otago (**Coastal Plan**) and the Regional Plan: Air for Otago (**Air Plan**), and evaluates the activities for which resource consents are being sought against the relevant policy framework of these statutory planning documents.

Section 9: identifies that the Kai Tahu ki Otago Natural Resource Management Plan (**Kāi Tahu MP**) is relevant to this application, while noting that an assessment of relevant provisions will form part of the Cultural Impact Assessment (**CIA**) that is being prepared by Aukaha on behalf of Te Rūnanga o Otakou (**Te Rūnanga**). The policy framework of Dunedin City Council's (**DCC**) Waste Minimisation and Management Plan 2020 / Te Mahere Whakamimiti Para (**WMM Plan**) is also considered in this section of the application.

Section 10: outlines the consultation undertaken and basis for notification of the application.

Section 11: briefly discusses the nature of the proposed consent conditions, with the proposed consent conditions for each of the resource consents being sought by this application provided in **Appendix 8** of this application.

Section 12: provides a summary and conclusion.

The appendices at the end of the report contains relevant information to support this application.

2 Site Description

2.1 Application Site

The landfill is located on the edge of the suburb of Fairfield in Dunedin. It is located to the south of Walton Park, an area of residential development that lies on the southern side of SH1, and to the east of the Walton Park Recreational Reserve. Kaikorai Stream[5] is located to the east of the landfill with the northern extent of the Kaikorai Lagoon Swamp adjoining the landfill site's southern boundary. The location of the Western and Eastern Landfills are shown in **Figure 1**.

Access into the site is at 125/127 Old Brighton Road, with access to the landfill via an approximately 1km long access road. A locked gate at the entrance to the site restricts unauthorised access. The landfill leachate interception drain runs along the eastern and southern side of the Western and Eastern Landfill, with stormwater treatment ponds located on the northern and western side of the Eastern Landfill.

Christies Creek and Coal Creek both pass through the site before entering the Kaikorai Lagoon Swamp and then the Kaikorai Estuary (refer to **Figure 4** below). Christies Creek flows across the site entering near the northern boundary at the site's western end, before traversing the site at the western end of the Western Landfill prior to entering the Kaikorai Lagoon Swamp. Coal Creek runs along the southern boundary of the site.

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[5] It is acknowledged that some, not all, online map systems label the part of the stream that flows past the landfill as 'Abbotts Creek'. A review of the NZTopo50 maps labels Abbotts Creek as being associated with the creek that flows into the Kaikorai Stream just south of State Highway 1. Throughout this application the part of the stream that flows past the landfill will be referred to as Kaikorai Stream.

Figure 1: Fairfield Closed Landfill – Site Location (Figure 1 of the Groundwater, Surface Water & Ecological Assessment (Appendix 5))

The aerial photograph contained in **Figure 2** below, shows the nature of vegetation at the site. The site, which is generally flat except for the Eastern Landfill, is covered in pastoral grasses. Landscaping, established in accordance with landscape plans approved in accordance with resource consent conditions while the landfill was operating, has been established between the landfill and the existing residential area associated with Walton Park.

TIL's (which is a subsidiary of Waste Management) total landholding at the site, following the subdivision and sale of land to the north of the Eastern Landfill (as now contained in Lot 1, DP566541 (RT 1021374)), is approximately 65.6ha. The land parcels associated with TIL's landholding, as shown in **Figure 2** below, are Lot 2 DP566541 (RT 1021375)[6], Part Lot B DP1685 (RT OT8D/1045) and Part Section 41 Block VIII Dunedin & East Taieri Survey District and DP7227 (RT OT352/110). The Eastern Landfill is located solely in Lot 2 DP566541, while the eastern end of Western Landfill is located in Lot 2 DP566541 and its western end is located in Part Lot B DP1685.

It is noted that a boundary adjustment, between Lots 1 and 2 DP566541, where all of the North Pond and associated infrastructure (i.e., pipes and outfall) would fall back within Waste Management's landholding, has been agreed with the owner of Lot 1 and is intended to be progressed.

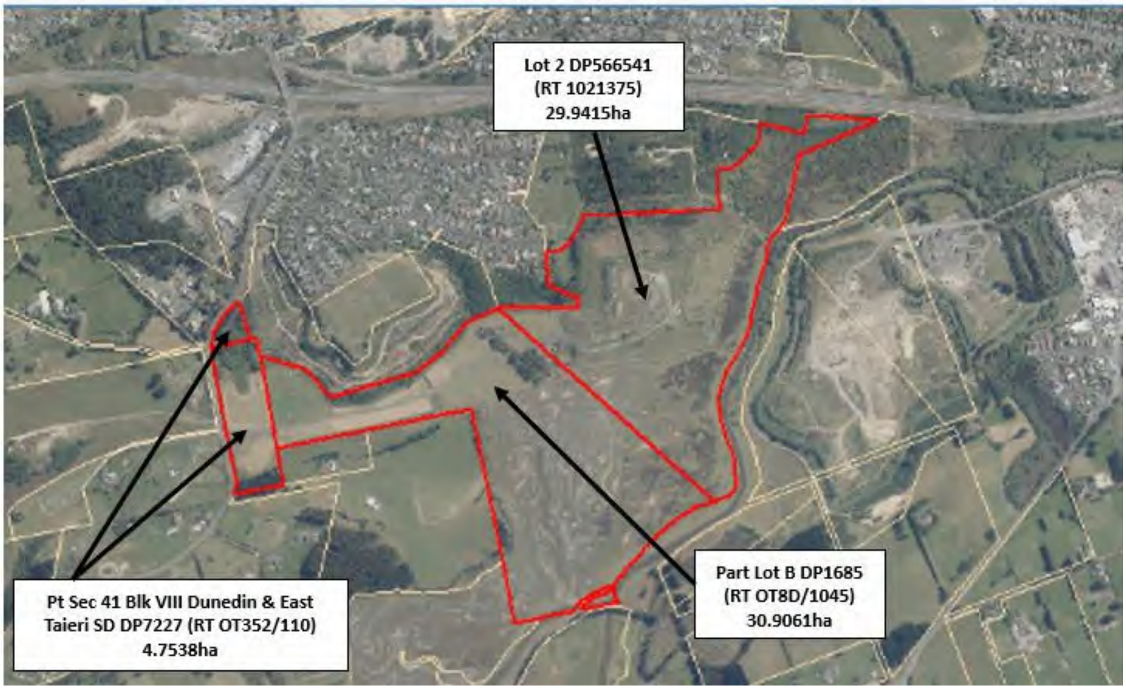

Figure 2: Fairfield Closed Landfill – Land Parcels (Source: Prover.co.nz)

As is evident from **Figure 2** above, the southern parts of TIL's landholding (i.e., the southern parts of Lot 2 DP566541 and Part Lot B DP1685 (**Figure 2**)), is an area of 'land' associated with the Kaikorai Lagoon Swamp. The 'Kaikorai Lagoon Swamp' is classified as a Regionally Significant Wetland under the Water Plan (Schedule F and Map F of the Water Plan. The extent of the Kaikorai Lagoon Swamp is in **Figure 4** and discussed further in **Section 2.2** below.

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[6] Prior to subdivision, which was completed in March 2023, Lot 1 DP566541 (RT 1021374) and Lot 2 DP566541 (RT 1021375) were contained in Part Lot C DP1685 (RT OT13B/390).

Under the Proposed Second Generation Dunedin City District Plan[7] (**the 2GP**), the site is zoned Rural (Coastal) (grey shading in **Figure 3** below). A 'Hazard 2 (flood) Overlay Zone'[8] (blue horizontal lines) lies over the western part of the site and around the southern and eastern edge of the site (i.e., associated with the Kaikorai Stream, Wetland and Estuary). The northwestern corner of the site, beside the 'Recreation Reserve', is subject to a 'Hazard 2 (land instability) Overlay' (area with brown diagonal lines). Christies Creek is denoted as being within an 'Esplanade Reserve and Strips Mapped Area' (blue dotted line). Other overlays and values associated with the estuary part of the site include an 'Area of Significant Biodiversity Value' (within the green line), an 'Archaeological Alert Layer' (area with pink diagonal lines) and 'Wāhi Tupuna Mapped Area' (area denoted within the red triangle boundary). These zones, overlays and values are identified in **Figure 3** below.

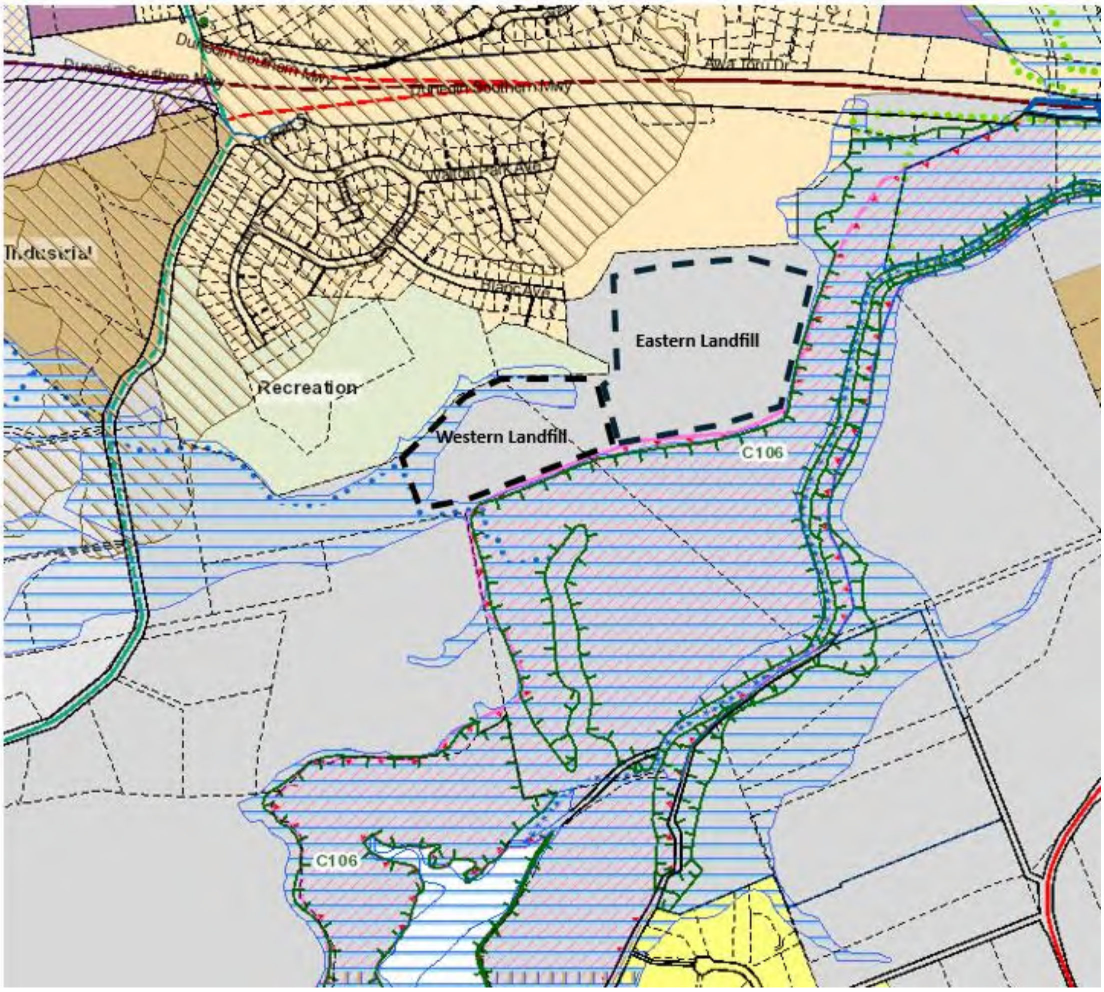

Figure 3: Fairfield Closed Landfill – Site Zoning and Overlays (Source: 2GP Planning Maps)

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[7] The zoning and overlays that apply to the site under the 2GP are not subject to appeal and therefore can be deemed to be operative.

[8] ORC's Natural Hazards Portal also identifies this overlay area as being a flood hazard area.

2.2 Surrounding Area

As identified in **Section 2.1** above, residential development associated with Walton Park lies to the north of the Western Landfill, and to the northwest of the Eastern Landfill.

Immediately to the north of the Eastern Landfill, on the southern side of SH1 is an area of land, that is currently vacant, which is zoned General Residential 1 under the 2GP (cream shading in **Figure 3** above). The residentially zoned land to the north of the Eastern Landfill has recently been subdivided from TIL's landholding and sold.[9] Waste Management understands that the new owner of this 13ha piece of land intends to subdivide the land for residential development consistent with the land's zoning. The Dunedin City Council's Hazard Register identifies that part of this site is subject to land stability issues (subsidence) associated with past coal mining in the area.

The Walton Park Recreation Reserve is located to the west of the Eastern Landfill and to the north of the Western Landfill (zoned 'Recreation' under the 2GP – refer to **Figure 3** above). Land to the south of the site, on the western side of the Wetland-Estuary, predominantly consists of farmland and is zoned appropriately in the 2GP. The Green Island landfill, to the southeast of the site, is located on the other side of the Wetland-Estuary.

The site's eastern and southern boundary adjoins both the Kaikorai Stream and the Kaikorai Lagoon Swamp (refer to **Figures 1 and 4**). Christies Creek and Coal Creek, as well as Kaikorai Stream and the Wetland-Estuary complex, are associated with areas identified as 'Hazard 2 (flood) Overlay Zone' in the 2GP (**Figure 3**).

As shown as **Figure 3** above, the Wetland-Estuary is identified as an Area of Significant Biodiversity Value (**ASBV**) (C106) in the 2GP. Schedule A1.2 of the 2GP identifies the values associated with the ASBV as being: regionally significant; included in the WERI Database as a wetland; and, possessing ecological values which include an estuary mudflat, salt marsh and reed swamp as well as succulent herb swamp. The Kaikorai Lagoon Swamp, which includes the main stem of the Kaikorai Stream that flows past the eastern side of the landfill, is also classified as a Regionally Significant Wetland under the Water Plan (the extent of the Kaikorai Lagoon Swamp is shown in **Figure 4** below).

As shown in **Figure 4** below, the wetland area (the Kaikorai Lagoon Swamp which is a Regionally Significant Wetland), adjoins and flows into the Kaikorai Estuary (also referred to as the Kaikorai Lagoon Estuary). The Kaikorai Lagoon Estuary constitutes the parts of the broader waterbody that are located below mean high water springs, and thus within the coastal marine area (**CMA**). As the Kaikorai Lagoon Swamp is not located within the CMA, it is also classified as a natural inland wetland.

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[9] The legal description for the new allotment associated with the residentially zoned land is Lot 2 DP566541 (RT 1021375). The new title was issued on 1 March 2023.

Figure 4: Kaikorai Lagoon Swamp (green shading) and the Kaikorai Lagoon Estuary (grey hatching) (Source: Figure 4 of the Groundwater, Surface Water & Ecological Assessment (Appendix 5))

Given the different categorisations that apply to the waterbody located to the south and east of the Fairfield closed landfill, throughout the remainder of this application the following terms has been used:

- Kaikorai Stream or Stream. This term has been applied to the part of the stream that flows past the eastern side of the landfill. In applying this terminology, it is acknowledged that this part of the Stream is located within the Kaikorai Lagoon Swamp, and thus is also a natural inland wetland.
- Wetland. This term has been applied to the Kaikorai Lagoon Swamp, but generally (but not always) excluding the Kaikorai Stream which flows past the eastern side of the landfill. The Wetland is classified as both a Regionally Significant Wetland under the Water Plan and is a natural inland wetland in accordance with the definition contained in the NPS-FM 2020.
- Estuary. This term has been applied to the southern parts of the waterbody that lies within the CMA, and which are labelled 'Kaikorai Lagoon Estuary' in **Figure 4** above.
- Waterbody. This term refers to the Kaikorai Stream, the Wetland and the Estuary collectively.

Under the 2GP, the Wetland-Estuary is also located within an 'Archaeological Alert Layer' and 'Wāhi Tupuna Mapped Area' (A4.51 – Kaikorae). Schedule A4 of the 2GP, which identifies the values associated with Wāhi Tupuna Mapped Area, identifies the following values as being associated with Kaikorae (the Kaikorai Estuary):

> ***A4.51.1 Description of area***
> *A mahika kai for adjacent coastal settlements, providing eels, waterfowl, birds and kai moana. The first known site to be named in Dunedin ('Kaikarae' - where a seabird was cooked and eaten) by Rakaihautu, a Waitaha chief who first explored the southern coast.*
> *This site has linkages to the beach north of the Kaikorai estuary.*
>
> ***A4.51.2 Values to be protected***
> *Historical mahika kai. Of less value now due to pollution.*
> *Archaeological remains.*

Other identified classifications and values associated with the Kaikorai estuary include:

- Statutory Acknowledgement Area (**SAA**). The estuary, where it is located within the CMA (refer to **Figure 4** above), is part of the Te Tai o Arai Te Uru (Otago CMA) SAA under the Ngai Tahu Claims Settlement Act 1988.
- Schedule 2 of the Coastal Plan (operative in 2001), and associated maps, classifies the estuary as a Coastal Protection Area (i.e., CPA 22). The values associated with CPA22 are described as:

> ***Kāi Tahu cultural and spiritual values.*** *Estuarine values such as a diversity of species and communities which support a diverse bird population. Up to 50 bird species have been identified in the estuary. There is a wide variety of estuarine plants such as tall rushland and saltmarsh ribbonwood. Juvenile rearing area for whitebait and breeding area for yellow belly flounder.*

It is acknowledged that the CIA, which is currently being prepared by Aukaha on behalf of Te Rūnanga, may identify additional cultural values associated with the area, or expand on the above information.

The ORC's Natural Hazards Portal identifies that the following natural hazards are associated with the broader area:

- The Kaikorai Stream, Christies and Coal Creek, and Wetland-Estuary, and some adjoining land, are located within a flood hazard area (i.e., generally consistent with the flood overlay in the 2GP – refer to **Figure 3** above). The Natural Hazard & Climate Assessment, contained in **Appendix 6** of this application, identifies that as a result of climate change flood risks, in this area, will increase (i.e., by 5 to 10% by 2050 and 20 to 50% by 2100 – based on 'high risk' scenarios (RCP8.5)).
- In relation to coastal hazards, the Kaikorai Stream and Wetland-Estuary, are also located in a storm surge affected area of greater than 50cm above current mean sea level and tsunami affected area (i.e., mean high water springs plus 50cm). The Natural Hazard & Climate Assessment identifies that sea level rise is projected to increase in the area by 0.25m by 2050, and 0.81m by 2100, using 'high risk' scenarios, while noting that water levels in the Wetland-Estuary are largely depended on whether the outlet to the sea is open or not.
- Parts of the Walton Park residential area is located in an inactive alluvial fan.
- Relatively small areas of the hillside located to the north of the site, and associated with the Walton Park Recreation Reserve, are identified as being a likely or possible landslide risk.

The Natural Hazard & Climate Assessment also describes a range of other potential hazards, including those that will arise from climate change. These hazards are identified in the Natural Hazard & Climate Assessment to provide context for the assessment of natural hazard implications for the landfill, as assessed in **Section 6.5** of this application. For this reason, the identified hazards are not listed within this section of the application.

3 Fairfield Closed Landfill

3.1 Background

Landfill operations at the site commenced in 1967 by Walton Park Sand Company, a subsidiary of Fulton Hogan whose Dunedin office is still located in Fairfield.

The Western Landfill closed in 1996, which is when the Eastern Landfill, located at the eastern end of the site, commenced operations. In July 2017 Waste Management stopped accepting material for disposal at the Eastern Landfill, with Waste Management then commencing landfill closure activities (i.e., capping, installing gas flares, revegetating the landfill etc) which were completed in August 2022.

Throughout the operational life of the site, ownership and day to day management of the site has changed with TIL acquiring ownership in 1996 (then a subsidiary of Fulton Hogan) and Waste Management, trading as Otago Waste Services (**OWS**) in Otago, taking over management in 2008. A history of the site is provided in Section 1.2 of the draft Aftercare Management Plan (**AMP**) provided in **Appendix 2** of this application.

3.2 Resource Consent History

Since the RMA came into effect, landfilling activities at the site have taken place in accordance with existing use rights, permitted activity rules of various district plans, as well as a number of resource consents issued by the ORC. It is also noted that in 2005 and 2006 respectively, the DCC issued land use resource consents for the development of the landfill stormwater system and the relocation of soil stockpiles[10].

The regional resource consents, which authorised the development and subsequent operational activities associated with the Eastern Landfill, as well as the ongoing discharges at the Western Landfill, were issued in 1995[11]/1996. The ORC consents issued for the landfilling activities are:

- A discharge permit (Consent 95007) to **discharge a mixed stream of domestic, commercial and industrial waste and cleanfill to land** at the Eastern landfill. This consent limited the rate of discharge to 1,800m^3 per week of compacted waste and prohibited the discharge of hazardous substances. The original discharge permit for the waste disposal activities at the site expired on 1 September 2018 (with waste disposal activities actually ceasing in July 2017). However, as Consent 95007 also provided for landfill closure activities, a new discharge permit, to authorise the **discharge of cleanfill and capping material to land for the purpose of landfill closure** was sought in February 2018. The closure discharge permit (Consent RM18.066.01) was issued in March 2018 and expired on 1 March 2023. The conditions of this later consent were changed in August 2022 to reflect the actual final landform at the site.
- A discharge permit (Consent 95008), which expires on 1 September 2024, to **discharge landfill gas, odour and dust to air**.
- A discharge permit (Consent 93540), which expires on 1 September 2024, to **discharge landfill leachate to groundwater by seepage** from the base of the landfill.
- A water permit (Consent 93541), which expires on 1 September 2024, to **take underground water containing leachate and other groundwater** in order to control landfill leachate and maintain groundwater within the landfill area at a lower level than the surrounding land. Leachate (and associated groundwater) from the landfill is taken (collected) by a gravity fed 1km long leachate interception drain located at 'toe' of the landfill. The drain runs along the eastern and southern sides of the Eastern and Western Landfills. Manholes and a pump station associated with the interception drain pump the leachate out of the drain. The landfill leachate and groundwater taken in accordance with this water permit is discharged into the Dunedin's wastewater network in accordance with a Trade Waste Consent.
- A discharge permit (Consent 93542), which expires on 1 September 2024, to **discharge up to 3,400m^3 per day of stormwater** runoff from the non-working areas of the landfill into the Kaikorai Stream[12] after treatment through silt retention ponds.

While the landfill is now closed, the activities currently authorised by Consents 95008 and 93540 to 93542 will continue during the landfill's aftercare period as the material in the landfill

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[10] These land use consents were required as these activities were located outside of 'Landfill' area identified in in Appendix 6A of the operative Dunedin City District Plan (2006). Under Rule 6.5.8(v) of the Dunedin City District Plan (2006), *'landfilling and activities associated with the operation of the landfill situated'* in the area shown in Appendix 6A were a 'Scheduled Permitted Activity' and thus permitted by Rule 6.5.2(v).

[11] While Consents 93540 to 93442 were issued in 1995, the applications for these resource consents were lodged with the ORC in 1993.

[12] The site directly discharges stormwater from the North Pond to the Kaikorai Stream, and overflows from the Weighbridge Pond into the Kaikorai Swamp Lagoon. While Consent 93542 only refers to the Kaikorai Stream, the consent does authorise stormwater discharges from the site pond**s** (emphasis added). It has been assumed that the reference to Kaikorai Stream in this consent effectively includes the Kaikorai Swamp Lagoon.

continues to slowly decompose. Waste Management are therefore seeking, through this application, to 'renew' these four resource consents as the discharge and take activities currently authorised by these resource consents will continue during the closed landfill's aftercare period. That is, leachate and gas will continue to be generated as the waste in the Western and Eastern Landfills continues to decompose, although over time the levels of leachate and gas will reduce, and ultimately cease (i.e., when the organic material in the landfill has completely decomposed). It is also anticipated that stormwater from the landfill, albeit from vegetated surfaces, will continue to be periodically discharged to the Kaikorai Stream/Kaikorai Lagoon Swamp after 'treatment', and attenuation, in the North and Weighbridge Ponds.

3.3 Closed Landfills – Aftercare Activities

The draft AMP, which is contained in **Appendix 2**, is an update of the Closure Management Plan required by Consent RM18.066.01. As noted within the AMP, the AMP will be updated to reflect the conditions of the new resource consents being sought by this application, once the resource consents have been granted (as required by the proposed conditions provided in **Appendix 8** of this application i.e., the proposed conditions require Waste Management to submit an AMP, for certification, within three months of the resource consents being granted, or rather, when they are first exercised). However, as part of this application, the proposed conditions, as provided in **Appendix 8**, have been reflected within the appended draft AMP, as they identify the approach to controlling, managing and monitoring the activities for which resource consents are being sought.

The draft AMP (**Appendix 2**) describes the aftercare activities, anticipated to be a minimum of 30-years, associated with the closed landfill. As a brief overview the aftercare activities include: ongoing site maintenance; site responsibilities; the monitoring and reporting regime for leachate, groundwater, landfill gas and the Kaikorai Stream and estuary; site inspections; and, complaint and contingency (emergency) procedures. The AMP also outlines the potential future use of the site.

Consistent with the proposed consent conditions, the AMP, which will be updated after the grant of the resource consents being sought by this application, will identify the criteria, or trigger levels, for changing from active to passive management of landfill leachate and landfill gas at the closed landfill. This change will be determined by an assessment of the relevant monitoring data and consideration that the adverse effects associated with the discharges at the closed landfill are now minimal or non-existent.

4 Rule and Regulation Assessment

4.1 Introduction

The discharge activities associated with the Fairfield closed landfill, namely the discharge of landfill gas (and associated odour) to air[13], the discharge of landfill leachate to underground water via seepage and the discharge of stormwater into the Kaikorai Stream and Kaikorai Lagoon Swamp, are regulated by the Waste Plan. The take of landfill leachate and groundwater

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[13] As the Waste Plan regulates the discharges to air from landfills, the Air Plan rules are not applicable to the closed landfill, as stated in Section 16.2.2 of the Air Plan, and therefore do not need to be assessed.

is subject to the rules of the Water Plan. The applicability of the Waste Plan and Water Plan rules are therefore assessed in **Sections 4.2 and 4.3** below.

Given that the site adjoins a Regionally Significant Wetland, the Kaikorai Lagoon Swamp (i.e., with the parts of the wetland adjoining the landfill also classified as a natural inland wetland), and given that there is a discharge of landfill gas to air, regulations contained in the NES-F and the NES-AQ are also relevant to this application. The applicability of the regulations, contained in these national environmental standards, are assessed in **Sections 4.4 and 4.5** below.

As the landfill does not adjoin the Estuary (refer to **Figure 4** and **Section 2.2** of this application), the Coastal Plan rules are not triggered by this application. However, for completeness, and given the proximity to the CMA, the objectives and policies of the NZCPS and Coastal Plan are assessed in **Section 8** of this application.

It is also noted that the regulations contained in the National Environmental Standards for Sources of Human Drinking Water (**NES-DW**) and the National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat (**NES-GHG**) are not relevant to this application and therefore have not been assessed below. The NES-DW regulations are not relevant to this application as there are no registered water supplies, or water permits to take surface or groundwater, downstream of the site. The NES-GHG regulations are not relevant as the discharge of landfill gas to air, including the products of combustion from the flaring of the landfill gas, are not industrial activities generating thermal energy as part of an industrial activities' processing operations.

4.2 Regional Plan: Waste for Otago

The Waste Plan, which became operative in 1997, establishes the resource management framework for waste minimisation and the management of landfills, contaminated sites, hazardous substances and wastes in the Otago region. Proposed Plan Change 1, which amended Waste Plan provisions related to the use of waste oil as a dust suppressant and the landfill policy framework, became operative in July 2022.

Chapter 7 of the Waste Plan contains rules in relation to landfills, including solid waste landfills, cleanfill landfills, offal pits, farm landfills, greenwaste landfills, composting and discharges from silage production. Rule 7.6.1 of the Waste Plan applies to both the Western and Eastern Landfills given that these landfills closed after 1994 (Section 7.1.3 of the Waste Plan). Rule 7.6.1 states:

> *New or operating landfills [excluding cleanfill landfills, offal pits, farm landfills and greenwaste landfills] (discretionary activities)*
> *1 The discharge of any contaminant into or onto land: or*
> *2 The discharge of any contaminant or water into water: or*
> *3 The discharge of any contaminant into air,*
>
> *As a result of the operation of any landfill (except for a cleanfill landfill, offal pit, farm landfill, or greenwaste landfill covered by Rules 7.6.3 to 7.6.11) are discretionary activities, providing that no burning of waste is undertaken.*

Given the post-closure discharges that will continue during the aftercare period at the Western and Eastern Landfills, the following **discretionary activity** rules trigger the need to seek resource consents, as sought by this application, for the following discharges from the Western and Eastern Landfills:

- **Rule 7.6.1.1** applies to the continued discharge of landfill leachate to underground water by seepage through the base of the landfills.

- **Rule 7.6.1.2** applies to the continued discharge of stormwater, into the Kaikorai Stream and Kaikorai Lagoon Swamp, after treatment through the North and Weighbridge stormwater retention ponds.
- **Rule 7.6.1.3** applies to the continued discharge of landfill gas, and any associated odour, to air.

4.3 Regional Plan: Water for Otago

4.3.1 Introduction

The Water Plan, which became operative in 2004, has also been subject to a number of plan changes and amendments since 2004. All plan changes and variations are fully operative, with the most recent, Plan Change 8 (Omnibus Plan Change), having been made operative in September 2022.

The purpose of the Water Plan is to promote the sustainable management of the region's resources. This is to be achieved through the Water Plan's resource management framework which provides for the use, development and management of the region's freshwater resources.

4.3.2 Values and Attributes

The schedules and maps attached to the Water Plan identify a range of values and attributes associated with the Kaikorai Stream and the Wetland. They include the following:

- Schedule 1D identifies Kāi Tahu values associated the region's waterbodies. Of relevance to this application is that the values associated with the Kaikorai Stream which include:
    - The following beliefs, values and uses – kaitiakitanga (MA1), mauri (MA2), waahi tapu and/or waiwhakahere (MA3) and waahi taoka (MA4).
    - The following access and customary use interests – mahika kai (MB1), kohanga (MB2), trails (MB3) and cultural materials (MB4).
- Schedule 9 and Map Series 9 identify the region's Regionally Significant Wetlands and Wetland Management Areas. As stated in **Section 2.2,** and illustrated in **Figure 4** of this application, the Kaikorai Stream and the Wetland are classified as a Regionally Significant Wetland, called the 'Kaikorai Lagoon Swamp'.
- Schedule 12 identifies the CMA boundaries that apply to the region's freshwater bodies, including the Kaikorai Stream.
- Schedule 15 contains good water quality limits and targets for the region's lakes and rivers. The limits applied from 31 March 2012 where the waterbody achieves the limit, and where the limit is not achieved a target date for achieving the limit is provided. The Kaikorai Stream is included in 'Receiving Water Group 1' of the schedule. The limits, that applied to the Stream (from 31 March 2012), include nitrate-nitrite nitrogen (0.444mg/L), dissolved reactive phosphorus (0.026mg/L), ammoniacal nitrogen (0.1mg/L) and turbidity (5NTU). Under the schedule, from a target date of 31 March 2025, an *E.Coli* limit (260cfu/100mL) also applies to the Stream[14].

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[14] It is anticipated that the new/amended water quality limits and targets which are to be contained in region's new freshwater planning instrument, which Council has advised is to be notified by 30 June 2024, will in effect replace the limits and targets contained in Schedule 15 of the Water Plan. It is also recognised that the new government are

- Schedule 16 contains permitted activity discharge thresholds for water quality that are to apply from 1 April 2026. Given this timeframe, and the fact that Otago's new freshwater planning instrument is currently due to be notified prior to this date, the provisions of this schedule are not relevant to this application[15].

4.3.3 *Relevant Rules*

Introduction

As stated in **Section 4.1** above, as the Waste Plan regulates the consent renewals for the discharges to land, air and the Kaikorai Stream from the site, the Water Plan rules only apply to the take of landfill leachate and associated groundwater associated with the landfill's aftercare activities.

Although the water permit is for a take of landfill leachate and associated groundwater, Policy 6.4.1A of the Water Plan is relevant to this aspect of the landfill's aftercare activities. Policy 6.4.1A is as follows:

> ***6.4.1A*** *- A groundwater take is allocated as:*
> *(a) Surface water, subject to a minimum flow, if the take is from any aquifer in Schedule 2C; or*
> *(b) Surface water, subject to a minimum flow, if the take is within 100 metres of any connected perennial surface water body; or*
> *(c) Groundwater and part surface water if the take is 100 metres or more from any connected perennial surface water body, and depletes that water body most affected by at least 5 litres per second as determined by Schedule 5A; or*
> *(d) Groundwater if (a), (b) and (c) do not apply.*

The landfill's groundwater take is not from an aquifer listed in Schedule 2C of the Water Plan and therefore Clause (1) of the above policy does not apply. However, as described previously in this application, the purpose of the interception drain, which runs along the eastern and southern edge of the Eastern and Western Landfills, is to create a hydraulic depression to prevent the outward flow of leachate impact groundwater from the landfill into the Kaikorai Stream and Wetland-Estuary system. As outlined in Section 10.2 of the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), as the interception drain is located within 100m of the Stream and Wetland, the groundwater take is to be considered and assessed as a surface water take under the Water Plan provisions. While the take is to be allocated as a surface water take (as required by the above policy), the Groundwater, Surface Water & Ecological Assessment (refer to Section 10.2), outlines that:

- The application of a minimum flow restriction on the take would be detrimental to the receiving environment (as discussed further in **Section 6.2.2** of this application).
- The average take of groundwater is small (0.6 to 1.4L/s), and any associated actual take of surface water associated with the site's 'connected surface water' would be a very small portion of the groundwater take.

Chapter 10A of the Water Plan contains rules that apply to the 'replacement water take & use permit', with this chapter of the plan applying to replacement Deemed Permits and water permits that expire prior to 31 December 2025. The landfill's water permit expires prior to 31 December 2025 (i.e., on 1 September 2024), and although there is no use of water associated

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intending to extend the deadline for the freshwater planning instruments from 31 December 2024 to 31 December 2027. However, at the time of lodgement of this application, Council's webpage continues to identify 30 June 2024 as the notification timeframe for the region's new freshwater planning instrument.

[15] The Kaikorai Stream is located in a 'Discharge Threshold Area 1 Catchment' (Schedule 16A and May J5).

with the groundwater take (as explained in the paragraph below), an assessment of Chapter 10A rules is provided below where it is considered the Rule 10A.3.2.1 is the relevant rule applicable to the activity.

In addition, the rules in Chapter 12 of the Water Plan that apply to the take, use and management of water have also been assessed below. This assessment has been included in order to provide a robust assessment of potentially applicable rules. This approach has been taken as the groundwater take does not include any water use (i.e., the water is 'disposed' of into DCC's wastewater network for treatment and discharge) and therefore the groundwater take does not necessarily sit solely within the Chapter 10A rule framework.

Chapter 10A – Objectives, Policies & Rules for Replacement Water Take & Use Permits

This chapter of the Water Plan contains four rules that apply to the take and use of surface water, including groundwater allocated as surface water in accordance with Policy 6.4.1A(a) to (c), where the activity is currently authorised by a Deemed Permit or a water permit that expires prior to 31 December 2025. While there is no 'use' associated with the landfill's water permit (Consent 93541), given the take is for leachate and associated groundwater and it is discharged to the wastewater network, an assessment of the rule applicability has been carried out below.

Rule 10A.3.1.1 provides for any take and use of surface water, including groundwater takes allocated as a surface water take under Policy 6.4.1A(b) (as applies to the take being sought by this application), as a controlled activity, subject to compliance with Conditions (i) to (vii). Rule 10A.3.1A.1 then provides for the take and use, as a restricted discretionary activity, where Conditions (iv) and (vi) of the controlled activity rule (Rule 10A.3.1.1) are not complied with and provided a water meter has been installed, or an exemption to metering has been granted, in accordance with Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 (**Water Take Regulations**). Rule 10A.3.1B.1 (restricted discretionary activity) applies to hydro-electric generation activities (and therefore is not relevant to this application). Rule 10A3.2.1 then provides for the take and use of surface water, and connected groundwater takes, as a non-complying activity, despite any other rules in the Water Plan, where Rules 10A.3.1.1, 10A.3.1A.1 and 10A.3.1B.1 are not met.

The conditions attached to Rule 10A.3.1.1 (controlled activity), and an assessment of applicability to the landfill's leachate and associated groundwater take, is provided as follows:

- The consent duration sought is no more than six years (Condition (i)). This condition is not complied with as Waste Management are seeking a 30-year consent term. This consent term is being sought for the very specific reasons. In terms of the closed landfill's ongoing discharge and take activities, 30-years reflects the likely aftercare period associated with the landfill (i.e., when leachate and gas will continue to be generated, albeit at levels that reduce over time). Throughout this aftercare period, the take of landfill leachate and groundwater, and thus any connected surface water, is a vital component of the site's leachate management system (i.e., the take of groundwater is the directly connected to the need to manage the discharge of landfill leachate to groundwater, by seepage, through the base of the landfill). If the take does not occur, then leachate from the landfill is not captured and removed, resulting in the discharge of leachate into the surrounding environment, which includes the Kaikorai Stream and the Wetland-Estuary. The take must operate as long as the active management of the leachate being generated at the landfill is required, which is throughout the aftercare period.
- The water permit is a valid permit (Condition (ii)). Consent 93541 (**Appendix 1**) is a valid permit as: it does not expire until 1 September 2024; this application has been lodged

six-months prior the expiry of the Consent 93541 and therefore Waste Management can continue to exercise the water permit in accordance with section 124 of the RMA; and, the water permit has not been surrendered, cancelled and has not lapsed.

- Condition (iii) applies to the use of the water for the purpose of irrigation and therefore is not relevant to this application.
- Condition (iv), except where Condition (vii) applies, requires the annual 'rate of take limit' to be no more than that which was taken prior to 30 June 2020, where water meter data is available. The landfill's leachate and groundwater take is not metered, although the volume of the take is calculated based on pumping rates at the pump station (and reported to ORC within monitoring reports). Consent 93541 limits the rate of take to 72,000L/hr (i.e., the consented take limit), with the typical volume of the take, over recent years, ranging from around 48 to 120m^3/day (or 2,000 to 5,000L/hr)[16]. As the landfill is closed, the rate of leachate generation within the landfill will decrease, and thus the required rate of take will also decrease and at some time in the future the take will no longer be required. On this basis, the intent of this condition will be complied with. It is noted that a condition, requiring the monitoring and recording of the instantaneous abstraction rate is proposed, as contained in **Appendix 8** of this application.
- Condition (v) requires any residual flow, minimum flow or take cessation condition, where applicable, to be included in the application for the new resource consent. This condition is not applicable to the take of landfill leachate and groundwater as there are no such conditions attached to Consent 93541.
- Condition (vi) is similar to Condition (iv) except that it relates to the daily, monthly and annual volume of the take, rather than the rate of take. For the same reason as outlined above in relation to Condition (iv), the intent of the condition is considered to be complied with.
- Condition (vii) identifies that where takes are not required to be monitored by the existing consent, or in accordance with the Water Take Regulations, the rate and volume of water sought is no more than the existing consented rate and/or volume of take. For the reasons outlined above in relation to Condition (iv), this condition will be complied with.
- Condition (viii) does not apply to this application.

As this application is seeking a consent term that exceeds six years, for the reasons discussed above in relation to Condition (i), Rule 10A.3.1.1 does not apply to the landfill's take of leachate and associated groundwater (and any connected surface water).

Rule 10A.3.1A.1 (restricted discretionary) then provides for the take and 'use' of surface water, including groundwater allocated as surface water under Policy 6.4.1.A, subject to complying with conditions, including compliance with Condition (i) of Rule 10A.3.1.1. As already stated above, this application is seeking a consent term that exceeds 6-years and therefore Condition (1) of Rule 10A.3.1.1 is not complied with, and thus the conditions of Rule 10A.3.1A.1 are also not complied with.

Rule 10A.3.2.1 (non-complying) then provides for the take and 'use' surface water, including groundwater allocated as surface water under Policy 6.4.1.A, despite any other rule or rules in the Water Plan, where the conditions of Rules 10A.3.1.1, 10A.3.1A.1 and 10A.3.1B.1 are not complied with. As the take of landfill leachate and associated groundwater (and any connected

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[16] Refer to the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**).

surface water) does not comply with the conditions of Rules 10A.3.1.1 and 10A.3.1A.1, primarily due to the fact that a consent term that exceeds six-years is being sought (as discussed above), Rule 10A.3.2.1 (non-complying activity) applies to the take of landfill leachate and groundwater at the closed Fairfield landfill.

Chapter 12 – Rules: Water Take, Use and Management

The take of landfill leachate and groundwater is not prohibited by general Rules 12.0.1.1 to 12.0.1.5[17], or Rules 12.2.1.1 and 12.2.1.2 which specifically relate to the take and use of groundwater. In relation to the remainder of groundwater take and use rules:

- The non-complying activity rules do not apply as the take at the landfill is not directly from within a Regionally Significant Wetland (Rule 12.2.1A.1), nor is it from the Waitaki catchment (Rule 12.2.1A.2) or a new consumptive take (Rule 12.2.1A.3).
- The following permitted activity rules do not apply as: there is no use associated with the take (Rule 12.2.2.0); the take is not for domestic needs (Rule 12.2.2.1); the take occurs within 100m of a wetland (thus Condition (c) of Rule 12.2.2.2 is not complied with); the take is not for a pump test (Rule 12.2.2.3); the take is not from within 100m of the water bodies listed in Rule 12.2.2.4; and, the take occurs for more than 3 days in any one month period (Rule 12.2.2.5). Rule 12.2.2.6 is assessed in more detail below where it is concluded that it also does not apply to this application.
- The controlled activity rule (Rule 12.2.2A.1) does not apply as the take is not for a community water supply.
- The restricted discretionary activity rules do not apply to this application:
  - Rule 12.2.3.1A does not apply as the take is not from a Schedule 2C aquifer.
  - Rule 12.2.3.2A does not apply as Schedules 4 and 5 of the Water Plan are not relevant to the site and nature of the take of landfill leachate and groundwater.

Permitted activity Rule 12.2.2.6, which permits the take (and use) of groundwater states that:

> *Except as provided for by Rules 12.2.1.1 to 12.2.2.5, the taking and use of groundwater from:*
> *(i) Any aquifer listed in Schedule 2C; or*
> *(ii) Within 100 metres of any wetland, lake or river,*
>
> *is a **permitted activity**, providing:*
>
> *(a) There is no change to the water level range or hydrological function of any Regionally Significant Wetland; and*
> *(b) There is no damage to fauna, or New Zealand native flora, in or on any Regionally Significant Wetland; and*
> *(c) No lawful take of water is adversely affected as a result of the taking; and*
> *(d) No take is for a volume greater than 25,000 litres per day at any landholding; and*
> *(e) …*
> *(f) No back-flow of contaminated water occurs to the water body; and*

Consent 93541 (**Appendix 1**), which authorises the site's existing take of landfill leachate and other groundwater, authorises the take *"at a rate of 20,000 litres per hour (and not exceeding 72,000 litres per hour)"*. The current maximum rate of take, based on pump station pump rates,

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[17] Rule 12.0.1.1 does not apply, as while Policy 6.4.2(b) applies to the groundwater take, Waste Management hold an existing consent to take the groundwater (Consent 93541). Rule 12.0.1.2 does not apply as the 'groundwater' take from the site was already consented in 2010, the take can be considered to fall within the primary allocation (under Policy 6.4.2), and also as the landfill is in the aftercare period, the volume of water being taken has reduced, and will continue to reduce, below the rate authorised by Consent 93541.

is around 2,000 to 5,000L/hr (which is less than the current consented rate of take), or 48,000 to 120,000L/day. Although this rate of take will reduce during the consent period, the current rate of take exceeds 25,000L/day and therefore Condition (d) of Rule 12.2.2.6 is not complied with. Therefore, Rule 12.2.2.6 does not provide for the take of groundwater, or any connected surface water (i.e., within 100m of a wetland, lake or river), as a permitted activity.

Rule 12.2.4.1(i) (discretionary activity) of the Water Plan then provides for the take and use of groundwater, and any connected surface water, as follows:

> *Except as provided for by Rules 12.2.1.1 to 12.2.3.5 the taking and use of groundwater is a discretionary activity.*

As outlined above, Rules 12.2.1.1 to 12.2.3.5 do not apply.

Summary

Therefore, based on the above assessment, the continued take of landfill leachate and associated groundwater from the site, as well as any connected surface water, requires a water permit, as sought by this application, in accordance with **Rule 10A.3.2.2** (**non-complying activity**) and **Rule 12.2.4.1(i)** (**discretionary activity**) of the Water Plan.

4.4 Resource Management (National Environmental Standards for Air Quality) Regulations 2004

The NES-AQ came into force in 2004, with amendments having come into force since then, most recently in 2011. The NES-AQ contains mandatory national regulations in relation to air quality.

The NES-AQ prohibits or restricts discharges from specific activities, namely: lighting of fires and burning of waste at landfills; burning of tyres, bitumen, coated wires and oil; incinerators; wood burners; and, domestic solid-fuel burning open fires. Also, as discussed below, greenhouse gas emissions from landfills are subject to control in accordance with NES-AQ regulations (Regulations 25 to 27).

The NES-AQ (Regulation 13 and Schedule 1) also establishes national ambient air quality standards, that apply in an airshed, for PM_{10} (particulate matter less than 10 micrometres in diameter), carbon monoxide (**CO**), oxides of nitrogen (**NO_x**), ozone, volatile organic compounds and sulphur dioxide (**SO_2**). Regulations 13 to 21 of the NES-AQ then places restrictions on the granting of discharge permits which discharge these contaminants, dependent on whether or not ambient air quality will continue to comply with the standards.

Regulation 17 of the NES-AQ is of particular relevance to this application as the landfill site is within a polluted airshed. The Air Plan identifies that the site is located within the 'Air Zone 2 (Green Island)' airshed, which was gazetted in January 2006 as 'Otago 2 airshed', and also includes 'Air Zone 2' airsheds associated with Palmerston, Mosgiel, South Dunedin and Milton. As described in the Air Quality Assessment (Section 4.6 - **Appendix 4**), monitoring data from Mosgiel and Milton, which are in the 'Otago 2 airshed', has shown that an average of one exceedance of the NES-AQ PM_{10} 50µg/m^3 24-hr average ambient air quality standard has occurred most years between 2011 and 2021 (Figure 4.6 of the Air Quality Assessment). Given these exceedances within the gazetted airshed as whole, under Regulation 17(4) of the NES-AQ the airshed is classified as 'polluted'. This includes the 'Air Zone 2 (Green Island)' part of the airshed even through there is no PM_{10} ambient air quality monitoring available for the Green Island part, nor the nearby South Dunedin part, of the gazetted airshed[18]. As the airshed

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[18] ORC currently monitors ambient air quality at a 'Central Dunedin' monitoring site which is located within the 'Otago 3 airshed' (and 'Air Zone 2' under the Air Plan) and therefore this monitoring site is not relevant to the

associated with the closed landfill's discharges to air is polluted, Regulation 17 of the NES-AQ then requires the consent authority to decline a resource consent application to discharge PM_{10} to air, if the discharge would result in an increase of average hourly PM_{10} concentrations of 2.5µg/m^3 or more (and subject to some specific exclusions provided for by Regulation 17(2) and (3)).

The Air Quality Assessment describes the nature of the discharges to air from the site (i.e., landfill gases and the products of combustion arising from the flaring of the gas) and the environmental setting within which the discharges from the site occur. The Air Quality Assessment then assesses the discharges from the landfill against the NES-AQ ambient air quality standards that are relevant to this application, namely the discharge of PM_{10} from the combustion of landfill gas (via the flares). In relation to the discharge of CO, NO_x and SO_2, the Air Quality Assessment does not model the effects of these combustion products due to the very low level of these contaminants in the discharge and expected negligible off-site effects[19] meaning that the relevant NES-AQ ambient air quality standards for these parameters will be complied with (and therefore Regulations 20 and 21 do not apply to this application).

In relation to the discharge of PM_{10} from the combustion of landfill gas at the site, the dispersion modelling, which the Air Quality Assessment states is 'very conservative', identified that the maximum off-site 24-hr average PM_{10} concentration (immediately to the north of the Eastern Landfill) is predicted to be 0.4µg/m^3. The Air Quality Assessment then outlines that this is well below the 2.5µg/m^3 criterion of Regulation 17. Therefore, Regulation 17 does not place any barriers on granting the air discharge permit being sought by this application.

Regulations 25 to 27 are also potentially relevant to this application as they relate to the control of gas to air from landfills and the control and flaring of landfill gas. Regulation 25 is set out below:

> ***25 Application of regulations 26 and 27***
>
> *(1) Regulations 26 and 27 apply to a landfill if—*
> *(a) the landfill—*
> *(i) has a total capacity of not less than 1 million tonnes; and*
> *(ii) contains not less than 200,000 tonnes of waste; and*
> *(iii) is or is likely to be accepting waste; and*
> *(b) the waste in or to be included in the landfill is likely to consist of 5% or more (by weight) of matter that is putrescible or biodegradable.*
>
> *(2) However, regulations 26 and 27 do not apply to a landfill until 8 October 2007 if the landfill—*
> *(a) has a total capacity of not less than 1 million tonnes of waste; and*
> *(b) on 8 October 2004—*
> *(i) contains not less than 200 000 tonnes of waste; and*
> *(ii) is accepting waste; and*
> *(c) does not operate a gas collection system.*
>
> *(3) Regulations 26 and 27 do not apply to a cleanfill.*

Regulation 26 then states that the discharge of gas from a landfill is not allowed, except where the landfill has a gas collection system that is designed and operated to ensure that the

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gazetted airshed that applies to the landfill site. Monitoring has been carried out at a 'North Dunedin' (also within the 'Otago 3 airshed') and 'South Dunedin' ('Otago 2 airshed') site in the past, but these sites are now inactive with no monitoring data being collected (refer to - https://www.lawa.org.nz/explore-data/otago-region/air-quality/dunedin/)

[19] As stated in Section 3.1 of the Air Quality Assessment.

discharge of gas from the landfill does not exceed 5,000 parts of methane per million parts of air, and where the gas is flared in accordance with Regulation 27 or used as fuel or generating electricity. Regulation 27 of the NES-AQ then outlines how landfill gas flares are to operate in order to 'destroy' the landfill gas.

The Fairfield closed landfill (Eastern Landfill) does not contain more than 1 million tonnes of waste,[20] and is also not currently accepting waste. For both these reasons Regulations 25 to 27 of the NES-AQ do not apply to the site. However, Waste Management, in accordance with recognised best practice, have installed a gas collection system and gas flares within the Eastern Landfill in order to 'destroy' the landfill gas generated at the site. The gas flares have been designed, where relevant, to meet the requirements of Regulation 27. As discussed in **Section 3.3** of this application, once gas generation levels reduce below the identified criteria or trigger levels to be identified in the updated and certified AMP, then management of landfill gas will transfer to a passive management and treatment system (i.e., when insufficient quantities of landfill gas is being generated for the gas to be flared).

Therefore, based on the above assessment, there are no barriers to granting the discharge permit being sought by Waste Management arising from the NES-AQ.

4.5 Resource Management (National Environmental Standards for Freshwater) Regulations 2020

4.5.1 Introduction

The NES-F, which came into effect in September 2020, has been amended a number of times since coming into effect, with the most recent amendments coming into force on 21 September 2023. The NES-F contains regulations that apply to farming activities (Regulations 8 to 36 (Part 2)), other activities that relate to freshwater (Regulations 37 to 74 (Part 3)) and identifies that local authorities may charge for monitoring (Part 4). Sub-part 1 of Part 3 (Regulations 37 to 56) of the NES-F relates to a range of activities within 'natural inland wetlands', or within specified setbacks from natural inland wetlands. Sub-part 2 of Part 3 (Regulations 56A and 57) relates to the reclamation of rivers and Sub-part 3 of Part 3 (Regulations 58 to 74) relate to the passage of fish affected by structures (i.e., culverts, weirs, flap gates, dams and fords).

Given that the Kaikorai Lagoon Swamp, which is classified as a Regionally Significant Wetland in the Water Plan, is located alongside the site, Regulations 37 to 56 of the NES-F are potentially relevant to this application. These regulations apply to activities located within and near natural inland wetlands, with a 'natural inland wetland' defined in Clause 3.21 of the NPS-FM 2020 (Regulation 3 of the NES-F states that the NPS-FM 2020 meaning applies to natural inland wetlands) as follows:

> ***natural inland wetland*** *means a wetland (as defined in the Act) that is not:*
>
> *(a) in the coastal marine area; or*
>
> *(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or*
>
> *(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or*
>
> *(d) a geothermal wetland; or*
>
> *(e) a wetland that:*
> *(i) is within an area of pasture used for grazing; and*

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[20] Waste Management have advised that the capacity of the Eastern Landfill was 850,000 tonnes.

> (ii) *has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology (see clause 1.8)); unless*
>
> (iii) *the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply.*

Given the above definition, the Kaikorai Stream and Wetland, where they adjoin the landfill (refer to **Figure 4** and the discussion in **Section 2.2** of the application), are classified as a natural inland wetland. On this basis, the NES-F wetland regulations apply to the landfill activities adjoining the Kaikorai Stream and Wetland. For clarity, the regulations apply to the activities taking place at the landfill, which are located to the west of the Stream and to the north of the Wetland. The relevance of the wetland regulations to this application and the activities taking place at the closed landfill are assessed further below.

Regulations 38 to 51, but not including Regulation 45B, provide for a range of activities within and adjacent to natural inland wetlands that are not associated with the activities occurring at the closed landfill. The activities provided for by these regulations include: the restoration, wetland maintenance and biosecurity of natural inland wetlands; scientific research; construction and maintenance of wetland utility structures; construction, maintenance and operation of specified infrastructure and other infrastructure; quarrying activities; urban development; extraction of minerals and ancillary activities; sphagnum moss harvesting; arable and horticultural land uses; and, natural hazard works. The activities listed above are not expected to occur at the closed landfill, and therefore the above regulations of the NES-F are not relevant to this application.

Regulations 45B and 52 to 54 are potentially relevant to this application. The applicability of these regulations to the discharge and take activities associated with the closed landfill are assessed in the following sections of this application.

4.5.2 Regulation 45B – Landfills and Cleanfill Areas

Regulation 45B, which came into effect on 5 January 2023, provides a discretionary activity consenting pathway for various activities associated with the operation of landfills and cleanfill areas. Regulation 3 of the NES-F identifies that a 'landfill' has the meaning given in the National Planning Standards 2019 (**NPS 2019**) which defines landfill as follows:

> ***Landfill*** *- means an area used for, or previously used for, the disposal of solid waste. It excludes cleanfill areas.*

In the context of the closed landfill's discharges and take, and the fact that the landfill adjoins a 'natural inland wetland', Regulation 45B(4) to (6) are potentially relevant to this application. This regulation states:

> ***45B Discretionary activities***
>
> (1) *Vegetation clearance …*
>
> (2) *Earthworks or land disturbance …*
>
> (3) *Earthworks or land disturbance …*
>
> (4) *The taking, use, damming, or diversion of water within, or within a 100 m setback from, a natural inland wetland is a discretionary activity if—*
>
> (a) *the activity is for the purpose of constructing or operating a landfill or a cleanfill area; and*
>
> (b) *there is a hydrological connection between the taking, use, damming, or diversion and the wetland; and*

> - *(c) the taking, use, damming, or diversion will change, or is likely to change, the water level range or hydrological function of the wetland.*
>
> *(5) The discharge of water into water within, or within a 100 m setback from, a natural inland wetland is a discretionary activity if—*
>   - *(a) the discharge is for the purpose of constructing or operating a landfill or a cleanfill area; and*
>   - *(b) there is a hydrological connection between the discharge and the wetland; and*
>   - *(c) the discharge will enter the wetland; and*
>   - *(d) the discharge will change, or is likely to change, the water level range or hydrological function of the wetland.*
>
> *(6) A resource consent for a discretionary activity under this regulation must not be granted unless the consent authority has first—*
>   - *(a) satisfied itself that the landfill or cleanfill area—*
>   - *(i) will provide significant national or regional benefits; or*
>   - *(ii) is required to support the quarrying activities regulated under regulation 45A; or*
>   - *(iii) is required to support urban development regulated under regulation 45C; or*
>   - *(iv) is required to support the extraction of minerals regulated under regulation 45D; and*
>   - *(b) satisfied itself that—*
>   - *(i) there is no practicable alternative location for the landfill or cleanfill area in the region; or*
>   - *(ii) every other practicable alternative location in the region would have equal or greater adverse effects on a natural inland wetland; and*
>   - *(c) applied the effects management hierarchy.*

It is considered that Regulation 45B(4) and (5) applies to the entire Fairfield closed landfill area, given that the NPS 2019 definition specifically refers to areas previously used for a landfill. Also, although Clauses (4)(a) and (5)(a) of this regulation specifically refer to 'constructing or operating a landfill', it is considered that the ongoing decomposition of waste material contained within a closed landfill constitutes the ongoing operation of a landfill. In addition, as assessed more fully in **Section 4.5.4** in relation to Regulation 54 of the NES-F, it is considered likely that there is a hydraulic connection with the Wetland associated with the take and discharges, there is the potential that water levels in the Wetland could change as a result of the take and discharges, and also it is acknowledged that a small percentage of the landfill leachate is likely to enter the Wetland and the Estuary. Thus, the conditions contained in Regulation 45B(5)(a) to (d) are met.

On that basis, it is considered that Regulation 45B does apply to the site's take and discharges. Therefore, subject to meeting the requirements of Clause (6) of Regulation 45B, as assessed below, the aftercare discharge and take activities at the closed landfill, are a discretionary activity.

Clause (6) of Regulation 45B states that a resource consent for a discretionary activity under this regulation must not be granted unless the consent authority is satisfied that the requirements of (a) to (c) of this clause of the regulation have been met. An assessment of the relevant Clause (6) requirements, in the context of the closed landfill and its ongoing discharge and take activities is provided as follows:

- **The landfill provides a significant national or regional benefit (Clause (6)(a)(i)).**

  At the time that the landfill was receiving waste it provided a significant regional benefit in that it provided a location for the safe and efficient disposal location for solid waste generated in Dunedin and from nearby communities. The landfill also provided an economically viable option for the disposal of waste materials. While the landfill is now closed, the benefits that derived from it while operational are not lost during the landfill's aftercare period. For this reason, it is considered that the activities associated with the closed landfill, given that it adjoins a natural inland wetland, meets the requirements of this clause of Regulation 45B.

- **There is no practicable alternative location, or every other practicable alternative location would have equal or greater adverse effects on a natural inland wetland (Clause (6)(b)(i) and (ii)).**

  An assessment of alternatives, including alternative locations for the closed landfill, is contained in Section 7 of this application. That assessment outlines that while it may be feasible, on a theoretical basis, to remove the waste material contained in the site's closed landfills and relocate this material elsewhere, it is considered that this alternative is fanciful. It is also considered this alternative, if it were to be adopted, would result in significant economic and environmental costs or effects. For these reasons, an alternative location, or locations, are not viable and thus retaining the closed landfill at its present location is the only practicable option.

- **The effects management hierarchy has been applied (Clause (6)(c)).**

  The definition of 'effects management hierarchy' is contained in Clause 3.21 of the NPS-FM 2020. The hierarchy outlines a stepwise approach to managing the adverse effects of activities on the extent or values of a wetland (or river). The key elements of the steps entail:

  (a) avoiding adverse effects where practicable;

  (b) minimising adverse effects where practicable;

  (c) remedying adverse effects where practicable;

  (d) then, where more than minor residual effects remain, aquatic offsetting is to be provided where possible;

  (e) where aquatic offsetting is not possible, aquatic compensation is provided; and,

  (f) then, if aquatic compensation is not appropriate, the activity itself is avoided (f).

  An assessment of the effects associated with the continued discharges and take of landfill leachate (and associated groundwater) at the site is provided in **Section 6** of this application, where it is concluded that the continued effects of the activities, for which resource consents are being sought, while not being avoided are being effectively managed so that adverse effects on the receiving environment are minimised, in accordance with the second step of the effects management hierarchy. In addition, over the term of the resource consents, decomposition of the waste in the landfill will slow and ultimately cease, meaning that in that point in time, adverse effects from the landfill will be avoided. On this basis, the discharge and take activities associated with the closed landfill meets the requirements of Clause (b) of the effects management hierarchy, and in time, will meet the requirements of Clause (a).

Given this activity meets the gateway under Regulation 45B(6), it is considered that Regulation 45B applies to the ongoing discharge and take activities at the closed landfill. Accordingly, discretionary activity resource consents are being sought by this application to discharge of leachate and stormwater within 100m of the Wetland (Kaikorai Lagoon Swamp) (Regulation 45B(5)) and to take leachate and associated underground water (Regulation 45B(4)).

4.5.3 *Regulations 52 and 53 – Drainage of Natural Inland Wetlands*

For completeness, as there is a 'take' associated with the landfill, it is also appropriate to consider the applicability of Regulations 52 and 53 which relate to the 'drainage of natural inland wetlands'. These two regulations state:

> ***52 Non-complying activities***
>
> *(1) Earthworks …*
>
> *(2) The taking, use, damming, or diversion of water outside, but within a 100 m setback from, a natural inland wetland is a non-complying activity if it—*
> *(a) results, or is likely to result, in the complete or partial drainage of all or part of a natural inland wetland; and*
> *(b) does not have another status under any of regulations 38 to 51.*
>
> ***53 Prohibited activities***
>
> *(1) Earthworks …*
>
> *(2) The taking, use, damming, or diversion of water within a natural inland wetland is a prohibited activity if it—*
> *(a) results, or is likely to result, in the complete or partial drainage of all or part of a natural inland wetland; and*
> *(b) does not have another status under any of regulations 38 to 51.*

The take of landfill leachate and groundwater that is associated with the operation of the closed landfill (i.e., until it moves to a passive management system) has been occurring at the site since around 1996 which is when the Eastern Landfill and the leachate interception drain was developed. While the interception drain is designed to capture the leachate (and associated groundwater) upgradient of the interception drain (i.e., from the landfill site), it is also acknowledged that due to the maintenance of the phreatic depression in the interception drain, and the pumping that occurs as part of this system, a small portion of water downgradient of the interception drain may also be taken. However, since 1996 when operation of the interception drain, and the associated take, commenced, there has been no evidence that the take results in the partial or complete drainage of the Kaikorai Lagoon Swamp. For this reason, it is considered that Regulations 52 and 53 do not apply to the site's take of landfill leachate and associated groundwater which is the subject of this application.

4.5.4 *Regulation 54 – Other Activities*

While it is considered that Regulation 45B of the NES-F applies to the ongoing discharge and take activities at the Fairfield closed landfill, for completeness, the implications of Regulation 54 have also been considered (i.e., in case it is determined that Regulation 45B does not apply to closed landfills).

Regulation 54 applies where activities do not have status under Part 3 Sub-part 1 of the NES-F. Regulation 54 states:

> ***54 Non-complying activities***
>
> *The following activities are non-complying activities if they do not have another status under this subpart:*

> *(a) vegetation clearance …*
>
> *(b) earthworks …*
>
> *(c) the taking, use, damming, or diversion of water within, or within a 100 m setback from, a natural inland wetland if—*
> *(i) there is a hydrological connection between the taking, use, damming, or diversion and the wetland; and*
> *(ii) the taking, use, damming, or diversion will change, or is likely to change, the water level range or hydrological function of the wetland:*
>
> *(d) the discharge of water into water within, or within a 100 m setback from, a natural inland wetland if—*
> *(i) there is a hydrological connection between the discharge and the wetland; and*
> *(ii) the discharge will enter the wetland; and*
> *(iii) the discharge will change, or is likely to change, the water level range or hydrological function of the wetland.*

In relation to Regulation 54 and the ongoing activities at the site, the following assessment of regulation applicability has been carried out:

- **The take of landfill leachate and associated groundwater within 100m of the Kaikorai Lagoon Swamp.** Regulation 54(d) is potentially relevant to this activity. As noted above in relation to Regulations 52 and 53, the leachate interception drain is designed to intercept leachate and groundwater from under the landfill which would otherwise flow outward from the drain. Therefore, while the take should not result in hydraulically connected water in the Stream or Wetland being taken, it is recognised that the take is potentially hydrologically connected to the stream (Clause (c)(i)). Also, the take is in effect stopping some groundwater potentially reaching the Kaikorai Stream and Wetland, and therefore it is possible that the take is also changing the potential 'natural' water level range of the Stream and Wetland (Clause (c)(ii)). On this basis, it is considered that Regulation 54(c) does have the potential to apply to this aspect of the closed landfill's activities.
- **The discharge of treated stormwater directly into the Kaikorai Stream and/or Kaikorai Lagoon Swamp.** Stormwater from the site is periodically discharged direct to the Stream and the Wetland and therefore the discharge is hydrologically connected to the Wetland (Clause (d)(i)) and is direct to the Wetland (including the Kaikorai Stream) (Clause (d)(ii)). Given the area's topography, the stormwater, if not intercepted and treated at the site prior to discharge, would have ended up in the area's groundwater or adjoining surface water bodies. Therefore, the direct discharge is not necessarily changing longer term water levels or hydrological function (Clause (d)(iii)). However, it is acknowledged that the temporary capture of this stormwater is a change in the area's 'natural' stormwater runoff. On this basis, it is considered that Regulation 54(d) does have the potential to apply to the site's stormwater discharge.
- **The discharge of landfill leachate to land via seepage within 100m of the Kaikorai Lagoon Swamp**. As discussed above in relation to the take of landfill leachate (and groundwater), the leachate interception drain (and associated take) are designed to capture this discharge before it migrates 'off-site' into the Kaikorai Stream and the Wetland. However, as assessed within the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), it is acknowledged that a small portion of the leachate may be being discharged into the Stream and the Wetland (Clauses (d)(i) and (ii)). While it is unlikely that this portion of the discharge will give rise to a change in the water level

range or hydrological function of the Stream or the Wetland (Clause (d)(iii)), for the sake of robustness, it is considered pertinent to acknowledge that there is the potential for this occur. On this basis, it is considered that Regulation 54(d) also has the potential to apply to the site's leachate discharge.

However, given that Regulation 45B applies to the closed landfill's take and discharge activities, these activities have another status under the NES-F subpart, and therefore Regulation 54 is not applicable to this application.

4.5.5 Summary

Based on the above assessment, which has adopted a conservative approach to the assessment of the applicability of the NES-F regulations, it is considered that **Regulation 45B (discretionary activity)** applies to this application. **Regulation 45B(4)** applies to the take of landfill leachate and associated groundwater within 100m of the Kaikorai Lagoon Swamp (Kaikorai Stream and the Wetland), while **Regulation 45B(5)** applies to the discharge of landfill leachate to land within 100m of the Kaikorai Lagoon Swamp and the discharge of treated stormwater periodically into the Kaikorai Lagoon Swamp.

4.6 Summary

Based on the assessment provided above in **Sections 4.2 to 4.5** of this application, the following resource consents are required from the ORC, as sought by this application, for the ongoing discharges and takes associated with the closed Western and Eastern Landfills:

- A **discharge permit** to discharge landfill gas, and associated odour, to air in accordance with **Rule 7.6.1.3** (**discretionary activity**) of the **Waste Plan**.
- A **discharge permit** to discharge landfill leachate to groundwater, by seepage, through the base of the landfill:
  - in accordance with **Rule 7.6.1.1** (**discretionary activity**) of the **Waste Plan**; and
  - in accordance with **Regulation 45B(5) (discretionary activity)** of the **NES-F** where the discharge occurs within 100m of the Kaikorai Lagoon Swamp.
- A **water permit** to take groundwater containing leachate and other groundwater, for the purpose of controlling landfill leachate and to maintain groundwater:
  - in accordance with **Rule 10A.3.2.2** (**non-complying activity**) and **Rule 12.2.4.1(i)** (**discretionary activity**) of the **Water Plan**; and
  - in accordance with **Regulation 45B(4) (discretionary activity)** of the **NES-F** for the groundwater that is taken within 100m of the Kaikorai Lagoon Swamp.
- A **discharge permit** to discharge stormwater runoff, after treatment through the North and Weighbridge stormwater retention ponds, into the Kaikorai Stream and Kaikorai Lagoon Swamp:
  - in accordance with **Rule 7.6.1.2** (**discretionary activity**) of the Waste Plan; and
  - in accordance with **Regulation 45B(5) (discretionary activity)** of the **NES-F** as the discharge is into the Kaikorai Lagoon Swamp.

The overall activity status of the resource consents being sought by this application is **non-complying**.

In addition, as assessed above, there are no barriers or restrictions on granting the resource consents being sought by this application arising from the regulations of the NES-AQ.

5 Statutory Framework

5.1 Introduction

Part 2 of the RMA contains sections 5 to 8 which define the purpose and principles of the RMA, while section 104 identifies the matters that should be considered in relation to any resource consent application. In addition, as the overall activity status of this application is non-complying, section 104D of the RMA is relevant to this application. Also, as this application is seeking to authorise discharges and the take at the closed landfill which are currently provided for by four resource consents (as contained in **Appendix 1**), sections 105, 107 and 124 also apply to this application.

An assessment of these provisions of the RMA, where relevant to this application, is provided below.

5.2 Part 2 of the RMA

Part 2 of the RMA sets out the purpose and principles of the Act, being *"to promote the sustainable management of natural and physical resources"* which is defined to mean:

> *managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while –*
>
> *(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *(b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
>
> *(c) Avoiding, remedying or mitigating any adverse effects of activities on the environment.*

This application has been prepared following the Court of Appeal's decision in *R J Davidson Family Trust v Marlborough District Council* [2018] NZCA 316. This decision means that recourse to Part 2 of the RMA is appropriate under section 104 of the RMA, particularly in circumstances where the relevant higher order policy documents are unclear or outdated in addressing the matters pertinent to the application. However, recourse to Part 2 cannot subvert regional or district plans.

The statutory planning documents that trigger the need to seek resource consents for the landfill's ongoing discharges and take are the Waste Plan, which became operative in 1997, the Water Plan, which became operative in 2004, and the NES-F, which came into effect in September 2020. Higher order policy documents relevant this application, are the NPS-FM 2020, the PORPS 2019 and the PORPS 2021. As the Waste Plan and the Water Plan have not fully given effect to the NPS-FM 2020, the PORPS 2019 or the PORPS 2021, an assessment of Waste Management's discharges and take, in the context of Part 2 of the RMA, has been carried out below.

The discharges to air, groundwater and the Kaikorai Stream-Kaikorai Lagoon Swamp from the Fairfield closed landfill and the taking of landfill leachate, and associated groundwater, are directly associated with Waste Management's continued aftercare operations at the site. Therefore, the activities for which resource consent is being sought play an important role in ensuring that the closed landfill continues to be managed in a safe and efficient manner, thus ensuring that the well-being of the local community is being provided for. Failing to authorise these ongoing activities, given the management measures in place for the active management of leachate and landfill gas during the landfill's aftercare period, will have detrimental effects on environmental, social and cultural values, and thus would not provide for the sustainable management of the area's natural resources. In addition, as assessed in **Section 6** of this application, given the nature of the discharges and take, the management and treatment systems that are in place, and the fact that over time the discharges will diminish and thus the take will no longer be required, the actual and potential effects of the aftercare activities at the landfill are appropriately avoided or mitigated such that any effects on people and the environment are minimal. Therefore, adverse effects on the environment will continue to be avoided, remedied or mitigated such that the existing life-supporting capacity of the environment surrounding the site, Kaikorai Lagoon Swamp and Estuary are safeguarded and sustained for future generations, if not improved.

Section 6 sets out matters of national importance. The section 6 matters which are relevant to this application are:

> *(a)* *the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands … and the protection of them from inappropriate subdivision, use, and development:*
>
> *(c)* *the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
>
> *(e)* *the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:*
>
> *(h)* *the management of significant risks from natural hazards.*

Section 7 requires particular regard to be had to 'other matters'. Of relevance to this application are:

> *(a)* *kaitiakitanga:*
>
> *(aa)* *the ethic of stewardship:*
>
> *(c)* *the maintenance and enhancement of amenity values:*
>
> *(d)* *intrinsic values of ecosystems:*
>
> *(f)* *maintenance and enhancement of the quality of the environment:*
>
> *(i)* *the effects of climate change:*

Section 8 requires the principles of Te Tiriti of Waitangi (the Treaty of Waitangi) to be taken into account, in relation to managing the use, development and protection of natural and physical resources.

The natural character of the Wetland- Estuary as it now exists, will not be affected by the activities associated with this application as landfilling, and thus landform modification and/or reclamation of the Wetland, or Estuary, is not associated with this application (section 6(a)). For the same reason, the area's existing visual amenity will not be affected by this proposal (section 7(c)). In the context of other amenity values, there is the potential for odour to be associated with the landfill gas. However, given the present flaring of the gas, and the fact that the generation of landfill gas will diminish during the aftercare period to a level whereby the site transfers to a passive system (when gas levels are minimal), it is considered that the amenity values of the area's air resource will be at least maintained, if not improved during the term of the resource consents being sought (section 7(c)).

As outlined in **Section 2.2** of this application and the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), the Stream, and the Wetland-Estuary complex are recognised as areas with high and very ecological values, respectively. Under section 6(c) of the RMA, these values are to be protected. As assessed in the Groundwater, Surface Water & Ecological

Assessment, the broader Stream, Wetland and Estuary is recognised as degraded, with the degradation associated with the past and continuing use of the immediate area and past use and development in the upstream catchment. It is also acknowledged that past landfilling activities at the site is likely to have contributed to some of the degradation of these waterbodies. However, in the context of this application, the site's landfilling activity has ceased, the landfill leachate is controlled and managed such that the discharge of landfill leachate is minimised and, as the landfill is closed, over time the volume of leachate generated will be reduced and ultimately cease. On this basis, it is considered that existing biodiversity values associated with the Stream, Wetland and Estuary are not being adversely by the continued discharges and take activities associated with the closed landfill, and that the intrinsic values of ecosystems are also being provided for (sections 6(c) and 7(d)).

In relation to sections 6(e), 7(a), 7(aa) and 8, Waste Management has, as outlined in **Sections 6.6 and 10** of this application, consulted with Te Rūnanga, through Aukaha, in relation to the closed landfill and its discharge and take activities, to ensure that the matters of importance to Te Rūnanga are recognised and provided for, had regard to and/or taken into account as part of this application. As a result of this engagement, Aukaha are in the process of preparing a CIA, on behalf of Te Rūnanga. As outlined in the Aukaha Letter (**Appendix 3**), the CIA is still being prepared.

The risks to the site from natural hazards (section 6(h)), including those arising from, or exacerbated by, climate change influences (i.e., increased temperatures and dry periods, increased intense rainfall events and flood risks and sea level rise), have been assessed in the Natural Hazard & Climate Assessment contained in **Appendix 6**. The assessment outlines a range of recommended responses, management and monitoring actions in order to manage and mitigate the potential risks from natural hazards. The actions identified have all been incorporated into the proposed conditions contained in **Appendix 8** of this application. On this basis, the significant risks to the site as a whole from natural hazards, including those influenced or arising from climate change, will continue to be effectively managed.

In relation to section 7(f) of the RMA, as the landfilling activities at the site have ceased, discharge and take controls and management mechanisms that are in place, and the fact that over time the generation of landfill leachate and gas will diminish and ultimately cease, it is considered that the quality of the existing environment is being at least maintained, and in the future, will be enhanced.

As a result of the repeal of section 70A of the RMA in November 2022, consideration can now be given to the effects of a resource consent application on climate change under section 7(i) of the RMA. Accordingly, an assessment of the effects on climate change from the discharge of greenhouse gases (methane and carbon dioxide), which is a component of the site's discharge of landfill gas, is provided in **Section 6.4** of this application. The findings of that assessment are that the potential effects on climate change from the landfill are being effectively mitigated and reduced as landfill gas from the Eastern Landfill is being captured and flared (thus destroying methane in the gas) and, as the landfill is closed, the volume of gas generated will reduce over time.

Therefore, the continued discharges and take associated with Waste Management's closed landfill site are considered to promote sustainable management and be consistent with Part 2 of the RMA.

5.3 Section 104 of the RMA

Section 104 of the RMA provides the statutory requirements for the assessment of the application and sets out those matters that ORC must have regard to when considering the application. Subject to Part 2 of the RMA, section 104 matters for the assessment within this application include:

- Any actual or potential effects on the environment of allowing the activity (section 104(1)(a));
- Any measure proposed or agreed by the applicant for the purpose of ensuring positive effects to offset or compensate any adverse effect on the environment (section 104(ab));
- The relevant objectives, policies, rules and other provisions of national environmental standards, other regulation, national policy statements, regional policy statements (proposed and operative), proposed plans and plans (section 104(1)(b)); and
- Any other matter that the Council considers relevant and reasonably necessary to determine the application (section 104(1)(c)).

The effects of the activities for which resource consents are being sought by this application, have been assessed in the assessments contained in **Appendices 4** to **6** and **Section 6** of this application (section 104(1)(a)). Based on the assessment of effects, as overviewed in **Section 6** of this application, offsetting or compensation of adverse effects is not required or needed (section 104(ab)). Given the requirements of section 104(1)(b), the relevant statutory and regulatory planning documents are identified in **Section 1.3** of this application, with the rules and regulations of the relevant planning documents assessed in **Section 4**. The relevant objectives and policies of the relevant statutory documents are assessed in **Section 8**. In relation to other matters, **Section 9** of this application identifies that the Kāi Tahu MP is relevant to this application (section 104(1)(c)).

Section 104(2A) requires ORC to have regard to the value of the investment of the existing consent holder when considering applications affected by section 124 of the RMA (as discussed below in **Section 5.5**). As a closed landfill, the value of investment in the site's operations is not directly connected to the ability to continue to operate the landfill as an operational landfill. Rather, the value of investment needs to be considered in the context of ongoing aftercare obligations associated with the site's past landfilling activities. In this context, the value of investment associated with landfill closure and the ongoing operation of the landfill leachate and gas management system has been, to date, in the order of $600,000. In addition, in continuing to manage the site during the aftercare period, Waste Management is committed to budgeting operational funding for the site, including contractors working at the site (i.e., contractors carrying out monitoring in accordance with consent conditions). Finally, while the development potential of the site is acknowledged as being restricted, the capital value of the site is around $2.030 million.

5.4 Section 104D of the RMA

As the overall activity status of this application is non-complying, section 104D of the RMA is relevant to this application. Section 104D sets out particular restrictions for non-complying activities, whereby a consent authority may grant a resource consent for a non-complying activity only if it is satisfied that either:

> *(a) the adverse effects of the activity on the environment (other than any effect to which section 104(3)(a)(ii) applies) will be minor; or*
>
> *(b) the application is for an activity that will not be contrary to the objectives and policies of—*
>
> *(i) the relevant plan, if there is a plan but no proposed plan in respect of the activity; or*

> *(ii)* *the relevant proposed plan, if there is a proposed plan but no relevant plan in respect of the activity; or*
>
> *(iii)* *both the relevant plan and the relevant proposed plan, if there is both a plan and a proposed plan in respect of the activity.*

An assessment of the effects associated with the continued discharges and take of landfill leachate (and associated groundwater) at the site, on the basis of the information provided in the technical assessments appended to this application, is provided in **Section 6** of this application. This assessment concludes that the continued effects of the activities, for which resource consents are being sought, are being effectively controlled and managed, and thus minimised. The findings of the effects assessment, as contained in **Section 6**, recognises the fact that landfilling activities have ceased and that active management of landfill leachate and gas will be ongoing until such time as decomposition of the waste in the landfill slows or ceases, resulting in the volume of leachate and landfill gas also diminishing. On this basis, it is considered that the continued effects associated with the landfill are less than minor. Accordingly, the first 'gateway test' of section 104D of the RMA is satisfied.

In addition, an assessment of the relevant objectives and policies of the relevant plans is provided in **Section 8** (as are other statutory plans), where it is concluded that the activities for which resource consents are being sought by this application are not contrary to (and/or are consistent with) the relevant objectives and policies.

Therefore, the continuing discharges and take associated with the closed landfill at Fairfield for which Waste Management are seeking resource consents, passes both tests of section 104D of the RMA. On this basis, there is no barrier to granting the resource consents being sought by this application arising from section 104D of the RMA.

5.5 Sections 105 and 107 of the RMA

As this application is seeking discharge permits for the discharge of landfill leachate, landfill gas and the discharge of treated stormwater directly to the Kaikorai Stream and Kaikorai Lagoon Swamp, the requirements of sections 105 and 107 of the RMA are relevant to this application.

Section 105 (as well clause 6(1)(d) of Schedule 4 of the RMA) identifies that where an application is for a discharge permit to something that would contravene sections 15 or 15B of the RMA, a description of the nature of the discharge, the sensitivity of the receiving environment to adverse effects, the applicant’s reasons for the proposed choice and alternative discharge methods and locations is required. The nature of the continued discharges associated with the site is described in **Section 3** of this application, as well as the Groundwater, Surface Water & Ecological Assessment (**Appendix 5)** and the Air Quality Assessment (**Appendix 4**). The sensitivity of the receiving environment, namely the Kaikorai Stream and Wetland-Estuary and the area’s air resource are also assessed in the Groundwater, Surface Water & Ecological Assessment and Air Quality Assessment and summarised in **Section 6** of this application. While the continued discharges associated with the site are directly connected to past decisions to undertake landfilling activities at the site, and associated past decisions in relation to landfill development approaches that at the time reflected engineering best practice, an overview of the discharge options or alternatives potentially applicable to the site’s continued discharges is provided in **Section 7** of this application. The alternatives assessment contained in **Section 7** concludes that the approach to the site’s continued discharges, as outlined within this application, continues to represent the best practicable option.

Section 107(1) of the RMA specifies that a discharge permit to discharge to water or land is not to be granted if, after reasonable mixing, the discharge gives rise to any of the following effects:

(c) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:

(d) any conspicuous change in the colour or visual clarity:

(e) any emission of objectionable odour:

(f) the rendering of fresh water unsuitable for consumption by farm animals:

(g) any significant adverse effects on aquatic life.

As assessed in the Groundwater, Surface Water & Ecological Assessment and the Air Quality Assessment, and as overviewed in **Section 6** of this application, given the nature of the discharge activities and the active management controls that will continue to be in place until no longer needed (i.e., once the generation of landfill leachate and gas reduces to the criteria, or 'trigger levels' to be identified in the updated and certified AMP required by the proposed consent conditions (**Appendix 8**)) the discharges which are the subject of this application will not give rise to any of the above effects.

While reaching the above conclusion, Waste Management acknowledges that the Stream, Wetland and Estuary are degraded and the discharges from the closed landfill have, and are continuing, at least while leachate is continuing to be generated at the landfill, to contribute to this degradation. The Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), in relation to effects on aquatic live, recognised the past and current activities have resulted in the degradation of the Estuary, but while degraded, water quality is stable (with the landfill being a contributor). In addition, parts of the Wetland-Estuary complex support nationally vulnerable bird and fish species. While the assessment does not reach a conclusion in relation to the significance of effects on aquatic life (given for additional monitoring in the Wetland-Estuary), the assessment states the degradation of the Wetland-Estuary complex, from all sources, is likely to be contributing to negatively affect the aquatic community. The assessment acknowledges that the operation of the interception drain is critical for the ongoing management of the leachate, and now that the landfill is no longer receiving waste the volume of leachate generation will be expected to reduce with time and concentration levels will also be expected to reduce.

5.6 Section 124 of the RMA

Section 124 of the RMA also applies to this application for the continued discharges and take that are occurring at the closed landfill. Section 124 outlines, that where a resource consent is due to expire and a consent holder applies for a new consent/s for the same activity at least six months prior to the expiry of the consent, then the consent holder can continue to operate under its existing consent/s until the new resource consent application is fully determined.

The existing consents (Consents 95008 and 93540 to 93542 – **Appendix 1**) expire on 1 September 2024. This application for the renewal of the consents for the ongoing discharges and take associated with the closure of the Fairfield landfill has been lodged in advance of the six-month timeframe before the expiry of the existing resource consents. Therefore, Waste Management can continue to carry out the activities authorised by Consents 95008, and 93540 to 93542 until a final decision is made on this application.

6 Assessment of Effects on the Environment (section 104(1)(a) of the RMA)

6.1 Introduction

In accordance with section 88(2)(b) and the Fourth Schedule to the RMA, this part of the application provides an assessment, based on the detailed assessments contained in **Appendices 4 to 6**, of the actual and potential ongoing effects on the environment associated with the discharges and take activities that will continue to be associated with the Fairfield closed landfill during the site's aftercare period.

Given the nature of the activity, the following assessment of effects, and any means of avoiding, remedying or mitigating adverse effects, covers the following matters:

- Effects on water resources.
- Effect on the area's air resource.
- Effects on Climate Change – Greenhouse Gas Emissions.
- Effects from natural hazard risks.
- Effects on Kāi Tahu values.
- Positive effects.

6.2 Effects on Water Resources

6.2.1 Introduction

The Groundwater, Surface Water and Ecological Assessment (**Appendix 6**) has assessed, based on available information, the effects of the landfill's discharge and take activities on water quantity (groundwater and surface water), groundwater quality, surface water quality and ecological values of the Kaikorai Stream, Wetland (Kaikorai Lagoon Swamp) and Estuary. An overview of the assessments findings is provided below.

In addition, the Groundwater, Surface Water and Ecological Assessment, based on monitoring that has been carried out at the landfill in accordance with the requirements of the site's existing resource consents, has assessed the effects of subsurface gas migration. The findings of this component of the assessment have been provided in **Section 6.3** (Effects on the Area's Air Resource) below. The conclusion of the Groundwater, Surface Water and Ecological Assessment in relation to landfill gas migration, is that the risks to nearby residents from subsurface landfill gas migration, from the landfill, are acceptably low.

6.2.2 Effects on Water Quantity – Groundwater and Surface Water

Based on analysis of groundwater monitoring, and consideration of the hydrogeological setting of the area, the Groundwater, Surface Water & Ecological Assessment outlines that a hydraulic depression is being created by the leachate interception drain where shallow groundwater from either side of the drain is being drawn into the leachate interception drain (Section 5 of the assessment). While this is a reversal of the natural downstream gradient, or movement of groundwater, it means that the leachate interception drain is operating as intended (and as required by the conditions of the site's existing resource consents – refer to Condition (4) of Consent 93540 (**Appendix 1**)).

Section 10 of the Groundwater, Surface Water & Ecological Assessment discusses the potential effects on water quantity, both groundwater and surface water. The main findings of this assessment include:

- Since 2017, the volume of leachate (and associated groundwater) being taken and removed from the site has been generally declining. This is likely related to the closure of the Eastern Landfill and its subsequent capping to reduce the entry of rainfall into the waste material. This declining trend is expected to continue during the landfill's aftercare period.
- Drawdown effects associated with the pumping from the leachate interception drain, given the low permeability marine sediments in the area, do not appear to propagate far into the adjacent strata, including into deeper groundwater. In addition, drawdown effects are expected to occur locally, including within the sediments, within a localised area of the Stream and Wetland.
- Given the location of neighbouring wells used for water supply purposes (i.e., closest well is over 1km away to the southeast and on the other side of the Kaikorai Stream), there will be no drawdown effects on such wells.
- The assessment also states that it expected that there will not be any saline intrusion effects arising from the pumping associated with the leachate interception drain. This is primarily due to the low rate of the take and the geological characteristics of the area.
- In relation to surface water quantity, the take of leachate and groundwater from the interception drain will result in reduced surface water flows in the Stream, Wetland and Estuary. However, the potential loss of groundwater, where it emerges into the Wetland-Estuary (i.e., potentially 1.2km downstream of the site given the area's geology), is likely to occur diffusely over a reasonably large area. This 'loss' has been assessed as likely to be minimal in comparison to wider water level fluctuations associated with estuary mouth closure or opening (and potential flooding during heavy rainfall events).

The assessment, as contained in Section 10 of the Groundwater, Surface Water & Ecological Assessment, identifies that the volume of leachate and associated groundwater that is taken from the leachate interception drain is currently calculated based on pumping rates. For this reason, instantaneous take rates are not available (i.e., only averaged rates are recorded). The assessment recommends that meters are installed, as required by the Water Take Regulations, to record the rate of take from the drain. A condition reflecting this recommendation has been included in the proposed conditions contained in **Appendix 8**.

In summary, the effects on groundwater and surface water quantity as a result of the operation of the leachate interception drain during the initial phases of the landfill's aftercare period, are considered to be minimal. As the volume of groundwater (containing leachate) required to be taken reduces over time, as the volume of leachate being generated reduces, then any such effects will also reduce.

6.2.3 Effects on Groundwater Quality

The effects on the area's groundwater quality are assessed in Section 9 of the Groundwater, Surface Water & Ecological Assessment. The assessment of effects is based on monitoring data, and a 2012 groundwater investigation which gathered additional data on the groundwater system downgradient of the landfill, which is summarised in Section 5 of the assessment.

In relation to leachate chemistry, which is the source of contaminant that has the potential to affect groundwater quality, the assessment states that potential contaminant concentrations are generally on the low end of the range of typical landfill leachate concentrations. In addition, since 2017, when landfill ceased, there has been a slight decline in key leachate indicator compounds, particularly total ammoniacal nitrogen (**TAN**). Additional leachate analysis undertaken every two years has shown no evidence of any of the more toxic leachate compounds, such as polychlorinated biphenyls, organochlorine pesticides, chlorinated solvents, petroleum hydrocarbons or dioxins. In addition, whole effluent toxicity testing showed that the landfill's leachate was consistent with the estimated 'safe' concentration of leachate required to mitigate the potential for chronic effects in the receiving water environment.

Sections 5.2 to 5.5 of the assessment, and associated appendices, contain an analysis of the monitoring that has been carried out. As a high-level overview:

- Groundwater temperatures tended to reflect typical seasonal variation that occurs throughout the year.
- TAN in the leachate wells is elevated representing the presence of landfill leachate, although there is a general decreasing trend in the interception drain and shallow wells (i.e., within the groundwater that is 'captured' by the leachate interception drain). TAN is present in the wells downgradient of the landfill, including in wells beyond the influence of the interception drain (including deeper wells in and around the landfill). The 2012 'wetland' well investigations detected TAN ranging from 1.4 to 9.9mg/L, with decreasing concentrations evident with distance from the landfill. For comparison, TAN concentrations in leachate generally range from 30 to 3,000mg/L.
- Heavy metals, in a steady-state condition, have been detected in deeper landfill monitoring wells. However, the 2012 'wetland' well investigations did not detect heavy metals above detection limits (although the detection limits were high).
- Nitrate-nitrogen was not detected above the detection limit during the 2012 'wetland' well investigations.
- For dissolved reactive phosphorus (**DRP**), while detected in groundwater samples collected during the 2012 'wetland' well investigation, the assessment notes that the Wetland and Estuary is generally enriched with DRP and there are wide range of potential sources from within the broader catchment which contribute to this enrichment.

In summary, the Groundwater, Surface Water & Ecological Assessment stated that the sampling indicates that the leachate interception drain is intercepting the majority of leachate migrating from the site (i.e., estimated to be between 95.4 to 99.4%). The assessment then outlines that some leachate, which is not captured by the leachate interception trench, is migrating into groundwater.

It is also noted, as outlined above in relation to groundwater water quantity (**Section 6.2.3** above), given the location of neighbouring wells, it is anticipated there will be no adverse effects on groundwater used for water supplies from the landfill's discharge of leachate via seepage.

6.2.4 *Effects on Surface Water Quality*

Introduction

The Groundwater, Surface Water & Ecological Assessment describes, based on monitoring data, the quality of stormwater from the site (Section 7 of the assessment) and the water quality, as overviewed in **Section 6.2.3** above, of the deeper groundwater quality that has the potential to reach the Kaikorai Stream and the Wetland-Estuary.

Stormwater runoff

In relation to stormwater, the assessment states that since the closure of the Eastern Landfill in 2017 there has been no obvious changes in the water quality of the North Pond, and since 2013 there has been no stormwater present in the Weighbridge Pond when sampling rounds have taken place. This is not unexpected given that the landfill is now closed, covered in topsoil and vegetated.

Water quality of the Stream, nearby creeks, the Wetland and Estuary

Section 8.3 of the Groundwater, Surface Water & Ecological Assessment provides an overview of the water quality of the Coal and Christies Creek, the Kaikorai Stream (upstream, alongside the landfill and downstream) and the Wetland-Estuary based on available monitoring data. Wetland-Estuary sediment quality is also discussed. The assessment identifies that:

- The Kaikorai Stream, upstream of the landfill, is a moderately impacted stream, with degrading trends in nutrient (nitrogen and phosphorus), clarity, turbidity and *E. Coli*. While this trend is occurring, the assessment identifies that nitrate-nitrogen and DRP concentrations are within Attribute Band B of the NPS-FM 2020.
- Nitrate-nitrogen concentrations in all tributaries and the Wetland are within Attribute Bands A and B of the NPS-FM 2020.
- TAN concentrations in Christies Creek (upstream and downstream), Coal Creek, and at times in the Kaikorai Stream both upstream of the landfill and downstream (i.e., within the Wetland-Estuary) of both the Fairfield and Green Island landfills, is below the national bottom lines of the NPS-FM 2020 (Attribute Bands C and D - refer to Table 2 of the assessment). The monitoring indicates that there is a decreasing trend of TAN concentrations from the upstream tributaries to the monitoring site at the tip of the estuary stream (Site FH40) which potentially indicates a degree of dilution. TAN concentrations that are below the NPS-FM 2020 national bottom line means that 20% of the most sensitive species would be regularly impact by TAN toxicity leading to reduced survival and fecundity in the Wetland and its tributaries.
- pH values at the monitoring sites exceeded the annual median 95th percentile default guideline value (**DGV**) for lowland rivers in the 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)' (**ANZG**). The 5-yearly median 95th percentile pH concentrations are within the DGV range. The assessment also outlines that pH in Christies and Coal Creeks have consistently been recorded below pH 6.0 with these low pH levels thought to have been influenced by historical coal mines in the catchment.
- The dissolved oxygen (**DO**) monitoring data indicates aquatic organisms in Christies Creek would experience moderate DO stress, but where Christies and Coal Creeks converge data indicates that aquatic organisms would experience minor DO stress. In Kaikorai Stream and the Wetland, DO concentrations fall within Attribute Band A of the NPS-FM 2020 meaning aquatic organisms would not be stressed from available DO.
- Dissolved boron levels, at all monitoring sites except the Kaikorai Stream, exceeded the 95% protection DGV of the ANZG. However, all sites were below the 80% protection level DGV.
- Zinc concentrations at all monitoring sites, except for Christies Creek, were below the hardness corrected 95% protection DGV of the ANZG.
- The assessment also comments on the sediment quality in the Wetland and Estuary, based on ORC's state of the environment monitoring. This monitoring programme

indicates that sediment quality in the upper and lower reaches of the Wetland and Estuary indicate low stress and good estuarine health, while sediment quality in the middle of the Wetland and Estuary indicates moderate to poor health.

The monitoring data therefore identifies that there is elevated TAN, boron and zinc concentrations in the area's surface water, as well as reduced DO and pH levels. However, as outlined above, the reduced DO and pH levels tend to be associated with Christies Creek (and Coal Creek to a lesser degree) upstream of the landfill.

In summary, the long-term water quality monitoring shows that the surrounding area's creeks, streams and Wetland-Estuary are degraded, although are relatively stable. The assessment also notes that activities that have contributed to this degradation having been present in the catchment for over 100 years (with a number still present) and given the complexity of the system and past and present activities in the catchment, it is difficult to ascribe the landfill's contribution to this degradation.

While the assessment states that it may be difficult to ascribe the landfill's contribution to the degradation of the area's water quality, the assessment, based on monitoring data, in conjunction with the leachate migration conceptual model (Section 9 of the assessment), identifies that a portion of leachate contaminated deep groundwater is likely to be entering the Wetland-Estuary. It is estimated, based on TAN concentrations, that between 4.6 to 0.6% of leachate from the landfill (i.e., approximately 121 to 1,007g of TAN per day), is being diffusely discharged into the Wetland-Estuary. The estimated location for this groundwater upwelling into the Wetland-Estuary is likely to be around 1.2km downgradient of the site (i.e., at the point of the Abbotsford Mudstone outcropping in the Wetland-Estuary).

6.2.5 Ecological Effects

Section 8 of the Groundwater, Surface Water & Ecological Assessment, based on a desktop review[21] of available information, describes the nature of the Wetland-Estuary and the ecological values associated with the area's surface waterbodies (including the Wetland-Estuary). An assessment of effects on ecological values is then provided in Section 11 of the assessment. An overview of this information is provided in the following paragraphs.

In describing the existing environment, the assessment identifies that the 'Kaikorai Wetland – Estuary Complex' (the Wetland and Estuary) is a moderately-sized coastal lagoon with extensive adjacent swamp/marsh area. The Wetland-Estuary is located in a 170ha catchment currently dominated by pasture and urban areas, with the major land use being residential housing and a small amount of light industrial activity. Landfills, consisting of the closed Fairfield landfill and the operational Green Island landfill are located on the edge of the Wetland-Estuary. Historically, the Kaikorai Valley has included heavy industrial activities including a freezing works and cement factory. **Section 2.2** of this application, and the assessment, describe the various values associated with the Wetland-Estuary that are identified in statutory planning documents, including the area's biodiversity and cultural values and the fact that the 'natural inland wetland' component of the complex is classified as a Regionally Significant Wetland. The assessment, in Section 8.2, outlines that the Kaikorai Lagoon Swamp (the Wetland), is characterised by a 'swamp marsh' area, while the lower reaches of the complex (the Estuary) is characterised by a shallow, intertidal estuary, which undergoes intermittent mouth closure (and the elevated water levels).

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[21] An ecological assessment was not carried out at the time that the Groundwater, Surface Water & Ecological Assessment was being prepared as water levels in the wetland/estuary were too high to enable the proposed work to be carried out (i.e., the estuary mouth was closed).

Sections 8.6 to 8.9 of the assessment the describes the ecological values of the area's waterbodies which include:

- **Macroinvertebrates** - Freshwater macroinvertebrate community index (**MCI**) and quantitative macroinvertebrate community index (**QMCI**) data within the Kaikorai Stream, upstream of the landfill, falls below the national bottom line of the NPS-FM 2020 (Attribute Band D). This is indicative of severe organic pollution or nutrient environment as the communities comprised of taxa that pollution tolerant, which is consistent with many lowland streams.
- **Macrofauna** - Estuarine macrofauna health is assessed using an Estuary Macrofauna Score (**EMS**). The EMS score, at the three sentinel sites in the Estuary range from moderately to highly impacted meaning that the Estuary's macrofauna community has a reduced diversity and abundance due to the presence of mud.
- **Vegetation** - In relation to vegetation, the Wetland is an approximate 33.8ha saltmarsh and thus dominated by vegetation tolerate to saline conditions. Around 85% (28.6ha) of the saltmarsh is characterised by a herbfield dominated by shore leptinella. Other dominant vegetation types in the saltmarsh include rushland and sedgeland with vegetation types including jointed wirerush, primrose and ribbonwood. In the estuary, marine macroalgae, in particular ulva, dominate. Phytoplankton blooms are also known to occur in warmer months and when the estuary mouth is closed.
- **Fish** - Nine fish species have been recorded in the Kaikorai Stream (including upland bullies, common bullies, longfin eels and the nationally vulnerable lamprey on one occasion), four in the Wetland (most commonly eels) and a number of freshwater and marine species in the Estuary (black flounder and yellow-eye mullet most frequently and 7 banded kokopu on one occasion. Table 3 of the assessment contains a full list of fish species recorded in the area's various waterbodies.
- **Birds** - Over 15 bird species are known to utilise the Wetland-Estuary, with the Wetland-Estuary recognised as an important habitat for the nationally threatened species Australasian Bittern and Banded Dotterel. The area is regarded as a critical habitat for the life cycle of a number of indigenous birds, as well as a habitat utilised by a range of birds, including white-faced heron, oystercatchers and paradise shelducks. Table 4 of the assessment contains a full list of bird species recorded in the area.

Section 8.10 of the assessment uses the New Zealand Trophic Index (**ETI**) toolbox to determine the susceptibility of the Wetland-Estuary to eutrophication. The outcomes of this assessment placed the Wetland-Estuary in Band D for susceptibility, macroalgae and phytoplankton meaning that there are significant, persistent stresses on a range of aquatic biota caused by indicators exceeding tolerance levels. This assessment also indicates that there is a likelihood of local extinctions of some species and loss of ecological integrity.

Given the known characteristic of the area's surface water bodies, the assessment undertook an Aquatic Ecological Valuation (**AEV**) using the Environment Institute of Australia and New Zealand Guidelines. The valuation process is provided in Section 11.1, and Tables 7 to 9, in the Groundwater, Surface Water & Ecological Assessment. The conclusions of the AEV are that the overall ecological value of the Kaikorai Stream and other Wetland-Estuary tributaries is ranked as 'high', while the overall ecological value of both the Wetland and the Estuary are ranked as 'very high'. These rankings largely reflect the presence of nationally vulnerable fish and bird species in parts of the Wetland-Estuary and its tributaries.

Given the context in relation to the ecological values associated with the area's surface water bodies, particularly the Wetland-Estuary, Section 11 of the Groundwater, Surface Water & Ecological Assessment, then assessed the effects of the Fairfield closed landfill on these values. However, the assessment specifically notes that there are challenges in assessing the magnitude and level of effects given a lack of comparable sites upstream of the potential influence from any of the landfills (both Fairfield and Green Island) for both water quality and ecological values, nor any distinction between contributions from the different landfills.

The conclusions of the Groundwater, Surface Water & Ecological Assessment, based on the information available (as outlined above), in relation to surface water quality and ecological effects, are as follows:

> *The discharge of leachate into the estuary may result in reduced water and sediment quality, as indicated by elevated concentrations of TAN, boron, and zinc, and reduced dissolved oxygen and pH within the existing monitoring data. This may lead to chronic and non-lethal toxicity effects to aquatic organisms, compositional shifts to pollution tolerate communities and behavioural avoidance of degraded water.*
>
> *Degradation of several water quality parameters was indicated in the long-term monitoring data for Christies/Coal Creeks and Kaikorai Stream, just prior to discharge into the wetland swamp. However, the wetland-estuary complex has been negatively affected by a wide range of anthropogenic-derived impacts over the last 100 years, including the Green Island Landfill on the eastern side of the estuary, so it is difficult to ascribe the contribution from these activities to the contaminant loading with the existing dataset. Poor water quality in the tributaries suggests that the aquatic biota would be negatively impacted, leading to reduced biodiversity and food sources.*
>
> *Long term water quality data of both the wetland swamp and its tributaries showed that it, while degraded, was relatively stable. Current ecological values within the swamp and tributaries would be integrated with the long-term stable water quality. On occasions, elevated TAN concentrations may act as a barrier to fish migration. The presence of nationally vulnerable fish and bird species indicate that, at least, parts of the swamp and its tributaries, support high ecological values and high rarity/distinctiveness. Due to the Very High Ecological Value of the wetland swamp, the magnitude of any effects of ongoing leachate seepage (roughly between 0.6% to 4.6% of leachate generated) would be considered to be higher than in the estuary, or the tributaries. However, with uncertainty on the location of where groundwater emerges as surface water in the wetland-estuary complex and the lack of monitoring data, the effects cannot be determined with any accuracy.* [22]

6.2.6 *Summary*

As outlined in the Groundwater, Surface Water & Ecological Assessment, the landfill lies at the head of the Kaikorai Wetland – Estuary complex. The Wetland-Estuary, although it is in a catchment with a high degree of modification and impacts, is recognised a regionally significant. The overall ecological values, based on an AEV, of the Wetland-Estuary is ranked as 'Very High', and the Kaikorai Stream and other tributaries of the Wetland and Estuary are ranked as 'High'.

While the landfill's leachate interception drain is, based on a rough calculation, capturing (and removing) around 95.4% to 99.4% of the landfill's leachate, monitoring indicates that some leachate impacted groundwater is likely to be passively entering the Wetland-Estuary (as indicated by TAN concentrations in the Wetland and Estuary). It is also acknowledged that a reduction, albeit a minimal reduction, in the volume of groundwater entering the Wetland-

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[22] From the Groundwater, Surface Water & Ecological Assessment's Executive Summary (**Appendix 5**).

Estuary is anticipated given the abstraction of leachate and groundwater from the leachate interception drain.

Monitoring indicates that the discharge of leachate into the Wetland-Estuary may be contributing to the degraded water quality present in the Wetland-Estuary, which in turn may contribute to adverse effects on aquatic organisms, a compositional shift to pollution tolerant communities and/or behavioural avoidance of degraded water. However, in the context of the broader environment, it is also recognised that long-term water quality monitoring shows that the area's creeks, streams, including upstream of the landfill, and Wetland-Estuary are degraded, although relatively stable, with activities that have contributed to this degradation having been present in the catchment for over 100 years (with a number still present). Accordingly, given the complexity of the system and past and present activities in the catchment, and the limitations associated with the available data, it is difficult to ascribe the landfill's contribution to this degradation.

Given the limitations associated with the assessment, a tentative groundwater, surface water and ecology monitoring programme has been proposed, as conditions of consent, to more directly assess the effects of the leachate discharge from the landfill (refer to Appendix I of the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**)). The proposed conditions contained in **Appendix 8** of this application provided for a continued monitoring programme, to assess these effects, during the landfill's aftercare period.

While the above is a summary of the conclusions of the Groundwater, Surface Water & Ecological Assessment, it is also considered that in the context of this application, it is important to recognise that the site's landfilling activity has ceased since 2017 , the landfill leachate is controlled and managed such that the discharge of landfill leachate is minimised and, as the landfill is closed, over time the volume of leachate generated will be reduced and ultimately cease. On this basis, adverse effects associated with the discharge of leachate, and the take of groundwater, from the Fairfield closed landfill will diminish and ultimately cease. On this basis, the health and well-being of the area's water resources, will improve over time.

6.3 Effects on the Area's Air Resource

6.3.1 Introduction

The Air Quality Assessment (**Appendix 4**) assesses the effects of the discharges to air from the Fairfield closed landfill, with the assessment recognising the environmental setting within which the landfill is located. In assessing the effects on the environment from the site's discharges to air, the Air Quality Assessment identifies that the main potential discharge from the site will be landfill gas. The landfill gas will mainly consist of methane and carbon dioxide and trace amounts of odorous reduced sulphur compounds (including hydrogen sulphide) and other volatile organic compounds.

Given the nature of the discharge to air from the site, the Air Quality Assessment identifies that:

- Given the period of time that has elapsed since landfilling ceased at the Western Landfill (in 1996), discharges to air from this part of the site are discharged passively and are expected to be at much lower levels due to the period of time since landfill closure. The Groundwater, Surface Water & Ecological Assessment (**Appendix 5** – refer to Section 6.2), which assessed the landfill gas monitoring data, confirmed that there is minimal gas being produced in the Western Landfill.
- The discharge of landfill gas from the Eastern Landfill will continue for a considerable period of time post-closure as organic material in the landfill slowly decomposes,

although the rate of decomposition, and thus generation of landfill gas, will also reduce over time.

Given this context, the effects assessed in the Air Quality Assessment are:

- Potential odour effects as landfill gas discharges are a potential source of offensive or objectionable odour. Odourous compounds in landfill gas are primarily generated from anaerobic decomposition (as provided for within landfills) and sulphur reduction processes.
- Potential effects from the discharge of particulate matter arising from the combustion of the Eastern Landfill's landfill gas.

In terms of other potential effects, the Air Quality Assessment states that due to the low level of the landfill gas discharges from the site, it is expected that there are negligible off-site effects associated with the discharge of other products of combustion from the flaring of the landfill gas. For this reason, the Air Quality Assessment does not consider the other combustion products[23] further in its assessment.

It is also acknowledged that landfill gas contains greenhouse gases, namely methane and carbon dioxide. The effects on climate change arising from the discharge of greenhouse gases is assessed separately in **Section 6.4** below.

6.3.2 Odour Effects

The Air Quality Assessment identifies that given the environmental setting within which the closed landfill is located, odour, from landfill gas, is the main potential adverse effect from discharges to air beyond the site boundary.

However, the assessment then outlines that provided an appropriate landfill cap and a landfill gas control system (including flaring) are in place, it is unlikely that offensive or objectionable offsite odour effects will be generated from a closed landfill. This is because such systems ensure that landfill gas is captured with flaring of the landfill gas destroying the methane and the odorous compounds contained in the landfill gas. In addition, it is noted that the Groundwater, Surface Water & Ecological Assessment (**Appendix 5** – refer to Section 6.2), based on landfill gas monitoring data, concluded that there are no indicators to suggest that subsurface lateral migration of landfill gas beyond the landfill is occurring.

On the above basis, given the presence of these systems at the Eastern Landfill, the main risk of odour from the site are likely to be associated with 'upset conditions'. Upset conditions include the failure of the landfill gas controls system meaning landfill gas is no longer being controlled resulting in gas migrating beyond the landfill site and/or landfill cap failure where cracking results in landfill gas being vented to the atmosphere in an uncontrolled manner.

The Air Quality Assessment carried out a FIDOL[24] of the potential odour effects from the closed landfill. The assessment recognises that the existing nearest sensitive receptors to any such odour discharges is the residential dwellings located adjacent to the western boundary of the site, although prevailing wind conditions (northwest and nor-northwest – refer to Figure 4.4 of the Air Quality Assessment) mean that any odour that is generated will be transported away from the sensitive receptors. The findings of the Air Quality Assessment in relation to potential odour effects are as follows:

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[23] The other combustion products, not assessed further in the Air Quality Assessment, include nitrogen oxides, sulphur dioxides and carbon monoxide.

[24] FIDOL -Frequency, Intensity, Duration, Offensiveness and Location.

- *The offensiveness or hedonic tone of uncontrolled LFG emitted from the site is expected to be moderately unpleasant.*
- *However, the frequency, intensity and duration of odour exposure at receptors with high sensitivity is considered to be very low. This is principally due to the fact that the landfill is closed and the management practice of capping the landfill and collecting and flaring the LFG.*
- *The design of the gas collection and flaring system also provides for a significant degree of redundancy, meaning one of the three flares can be taken off-line for maintenance or repairs without affecting the ability to adequately flare the gas.*
- *Cumulative odour effects from the nearby Green Island Landfill and WWTP are not expected due to the odour effects from the Fairfield Closed Landfill being very unlikely.*[25]

The Air Quality Assessment concludes that it is unlikely that offensive or objectionable odour effects will occur beyond the site boundary. This conclusion is supported by the absence of recorded odour complaints for the site and industry experience in relation to other closed landfills which have similar controls in place.

6.3.3 Effects from the Discharge of Particulate Matter from Landfill Gas Flaring

As stated in **Section 6.3.1** of this application, the main discharge associated with the flaring of gas is particulate matter, namely PM_{10} (particulate matter less than 10 microns in diameter). PM_{10} is a combustion product that is generated as a result of the flaring of landfill gas at the site.

In relation to the site's particulate matter discharges, the Air Quality Assessment identifies that a high proportion of the PM_{10} is expected to be in the size fraction that is less than 2.5 microns in diameter ($PM_{2.5}$). For the purpose of the assessment carried out as part of the Air Quality Assessment, it was assumed that all PM_{10} emissions are in the $PM_{2.5}$ fraction, which is a conservative approach.

To assess the potential effects of the particulate matter discharges from the landfill gas flares, the Air Quality Assessment undertook dispersion modelling to estimate the PM_{10} emissions likely to be generated as the site. The modelling carried out was conservative as it assumed all three flares were in operation, whereas normal operating conditions is for only two flares to operate, and that the also assumed that flaring of landfill gas is a new activity at the site.

The maximum off-site 24-hr average PM_{10} concentration predicted by the dispersion modelling is 0.4µg/m^3 (immediately to the north of the Eastern Landfill). As assessed in the Air Quality Assessment, and discussed in **Section 4.4** of this application, this predicted concentration is well below the 2.5µg/m^3 criterion of Regulation 17 of the NES-AQ and therefore the NES-AQ does not place any barriers on granting the air discharge permit being sought by this application.

The Air Quality Assessment, based on the dispersion modelling, then concludes that cumulative effects of PM_{10} (and thus $PM_{2.5}$) discharges from the landfill site, based on the predicted maximum off-site 24-hr average PM_{10} concentration of 0.4µg/m^3, will be negligible. In addition, the Air Quality Assessment also concludes that the potential effects of other combustion products are also expected to be negligible.

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[25] Section 6.1.4 of the Air Quality Assessment (**Appendix 4**).

6.3.4 Summary

The Air Quality Assessment concludes that overall, provided the various mitigation and monitoring measures that are proposed for managing landfill gas and minimising odour are in place (as contained in Section 7 of the Air Quality Assessment), the discharges to air from the Fairfield closed landfill will have **less than minor** air quality effects. The mitigation and management measures outlined in Section 7 of the Air Quality Assessment have been incorporated into the proposed consent conditions provided in **Appendix 8** of this application.

In addition, the Air Quality Assessment also states that there are no impediments in granting the air discharge permit being sought by this application under Regulation 17 of the NES-AQ (refer to **Section 4.4** of this application).

6.4 Effects on Climate Change – Greenhouse Gas Emissions

As outlined in **Section 6.3.1** above, landfill gas mainly consists of methane and carbon dioxide, and trace elements of other compounds. Methane and carbon dioxide are greenhouse gases.

The greenhouse gases that are present in landfill gas are generated as a result of the decomposition of organic waste, such as food, greenwaste, wood and paper, in the waste material that has been deposited into the closed landfill. Chapter 15 (Waste) of 'Aotearoa New Zealand's First Emissions Reduction Plan' (hereafter referred to as the '**2022 Reduction Plan**'), which was published in May 2022, identifies that in 2019 'waste' was responsible for 4% of New Zealand's total gross greenhouse gas emissions, with 94% of those emissions being biogenic methane generated by the decomposition of organic materials in landfills[26]. The 2022 Reduction Plan also identifies that biogenic methane has a warming effect 28 times greater than carbon dioxide[27].

Given the above context, the 2022 Reduction Plan identifies a number of actions for reducing greenhouse gas emissions from waste management activities in New Zealand. Many of these actions reflect the 'waste hierarchy' which involves: firstly, rethinking/redesigning (i.e., avoid unnecessary resource use and thus waste generation); reducing; reusing/repurposing; recycling/composting; recovering; and, finally, treating. As Waste Management's Fairfield landfill is closed, and thus no longer receiving waste, the 'treat' actions are the only actions that are now relevant to this site, and thus this application.

'Focus area 5' and part of Action 15.5.1 in the 2022 Reduction Plan is to increase the amount methane capture and flaring of landfill gas at municipal (Class 1) landfills. Flaring of landfill gas converts biogenic methane to carbon dioxide, which has a lesser impact on climate change[28].

While the Fairfield closed landfill is not, or was not, a Class 1 landfill, as was described in **Section 4.5** of this application, Waste Management has installed a landfill gas capture and flaring system within the Eastern Landfill (even though flaring of the landfill was not required in accordance with the NES-AQ regulations). As a result, the majority of the biogenic methane being generated at the closed landfill (i.e., from the Eastern Landfill) is being effectively captured and destroyed.

Another important consideration is the fact that the landfill is closed, which means that the amount of greenhouse gas emissions from the site will only reduce over time. The Air Quality Assessment (**Appendix 4**) recognises this fact when it states that the discharges to air (which

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[26] p.298 of the 2022 Reduction Plan.

[27] p.295 of the 2022 Reduction Plan.

[28] pp. 312 and 313 of the 2022 Reduction Plan.

will include greenhouse gases) from the Western Landfill are expected to be at very low levels due to the period that has elapsed since landfilling ceased in 1996.

On the above basis, the effects on climate change from the landfill are being effectively mitigated and reduced as landfill gas from the Eastern Landfill is being captured and flared (thus destroying methane in the gas) and, as the landfill is closed, the volume of gas generated will reduce over time.

6.5 Effects from Natural Hazard Risks

6.5.1 Introduction

The Natural Hazard & Climate Assessment (**Appendix 6**) has assessed the potential risks to the site associated with natural hazards. The natural hazards identified in this assessment, and therefore considered, include those arising from or exacerbated by climate change influences (i.e., increased temperatures and dry periods, increased intense rainfall events and flood risks and sea level rise) and seismic considerations.

These potential natural hazard risks, based on the findings of the Natural Hazard & Climate Assessment, are overviewed below.

6.5.2 Site's Natural Hazards and Climate Change Influences

The Natural Hazard & Climate Assessment describes the potential natural hazards, including those likely to be exacerbated by climate change,[29] and the implications for the landfill site and recommended actions, are as follows:

- **Temperatures, Dry Periods and Strong Winds.** Under the 'high' (RCP8.5) climate projections, Dunedin's annual average temperatures are projected to increase by 0.6°C by 2040 and 1.8°C by 2090. Maximum annual temperatures, under the same projections, may increase by 0.8°C by 2040 and 2.4°C by 2090. Other climate change influences on Dunedin's weather, under the high climate projections, include a decrease, by the end of the century, of up to 5 days of the maximum number of consecutive dry days and a projected decrease in the strongest winds (i.e., decrease of around 0.3% by 2040 and 1.3% by 2090). The identified implications for the landfill arising from these risks are that the higher temperatures have the potential to result in cracking of the Eastern Landfill's cap, which could result in landfill gas emissions to the atmosphere and increased rainfall ingress into the waste material thus potentially increasing leachate generation from the site. However, this potential risk could be offset by fewer dry days and the slight reduction in maximum wind strengths. The proposed identified risk mitigation method is to ensure that the landfill cap is inspected and appropriately maintained throughout the aftercare period.
- **Rainfall**. Under the high projections, average annual rainfall in Dunedin is projected to increase by 4% by 2040 and 13% by 2090. In terms of extreme rainfall events under the high projections, the depth of water associated with a one-hour 100-year annual return interval (**ARI**) is projected to increase from its current depth of 32mm, to around 36mm (+13%) by 2040 and 42mm (+34%) by 2090. Increases are also projected for the 6-hr 100-year ARI (+11% by 2050 and +30% by 2090) and 24-hr 100-year ARI (+6% by 2040 and +22% by 2090). The implications of these changes for the landfill include: the potential for elevated groundwater which could inundate the landfill toe and threaten the stability of the landfill; resultant increased pumping of groundwater and leachate from the

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[29] The hazards are identified and assessed in Table 1 of the Natural Hazard & Climate Assessment.

interception drain; an increase in the level of erosion risk; and, the potential for increased landfill gas migration as a result of low barometric pressures. The key action recommended in response to these risks, in addition inspecting and maintaining landfill integrity (including associated infrastructure), is to increase the height, and to provide armouring, of the perimeter access road which extends around the southern and eastern side of the landfill. The assessment identifies that assessment and design of these works, or as suggested by Waste Management alternative solution/s that achieve the same purpose, will need to be embedded in the consent conditions being sought by this application.

- **River Flow Changes**. Increased flows of between 5 to 10% by 2050, and 20 to 50% by 2100, are expected in Dunedin's rivers and streams under the high climate projections. For the landfill site, this means that there is an increased flood risk arising from the streams that border the site, namely Kaikorai Stream and Christies and Coal Creeks. The Natural Hazards & Climate Assessment identifies that flooding in the Kaikorai Stream is likely to be characterised by low velocity flood waters with resultant risks being inundation of the landfill toe and leachate interception drain, and also flooding of the leachate pumping chamber (and thus pump shut down). In relation to Christies and Coal Creeks, given the more confined nature of the channels and the proximity to parts of the site, flooding of these creeks comes with a potential erosion risk for the Western Landfill. The recommended actions in response to the flood risks at the site are the same as those proposed in response to the rainfall risk (refer above).
- **Sea Level Rise/Encroachment.** Sea level is projected, under the high climate projection, to increase by 0.25m by 2050 and 0.81m by 2100. While recognising that these increased sea levels could be realised at the landfill site, the Natural Hazard & Climate Assessment also notes that the water levels in the Wetland-Estuary, which adjoin the site (i.e., the site does not adjoin the open coast), are dependent on whether or not the estuary outlet is open. The assessment also notes that future 'active' management of the estuary outlet, which is under ORC's control, is currently uncertain. The implications of sea level rise at the landfill site include temporary or permanent inundation/flooding of the landfill toe, perimeter access road and leachate interception system and thus flooding of the leachate pumping chamber (and the need to shut down the pump). The recommended actions in response to the risks associated with sea level rise are the same as those proposed in response to the rainfall risk (refer above).
- **Storm Surges, King Tides and Waves**. The Natural Hazard & Climate Assessment outlines that with sea level rise the chance of flooding of the site increases exponentially (i.e., the current flood risk associated with a 100-year ARI will happen every two years with a 0.3m sea level rise and every high tide with a 0.9m sea level rise). This, in turn, increases the risk of wave erosion and inundation of the landfill toe during storm surges and king tides, particularly given the north to south orientation of the Wetland-Estuary channel (i.e., the channel could act as a funnel during southerly storm events). The implications to the site from these natural hazard risks include increased rates of overtopping and landfill erosion. Similar to the other potential natural hazard risks, as outlined above, the recommended actions in response to these risks are the same as those proposed in response to the rainfall risk (refer above).

Based on the assessment contained in Table 1 of the Natural Hazards & Climate Assessment, Section 3 of the assessment provides a more detailed description of the actions recommended in order to manage and/or mitigate the potential risks to the landfill, and thus the environment, arising from the area's natural hazards, including those arising from climate change influences.

In addition to surveillance (including inspections and maintenance) of the integrity and stability of the landfill and its management systems, the key action recommended in response to these risks, is to increase the height, and to provide armouring, of the perimeter access road which extends around the southern and eastern sides of the landfill. All of these recommended actions have been incorporated into the proposed consent conditions contained in **Appendix 8** of this application.

It is noted that Waste Management have identified that there may be alternative solutions, that achieve the same outcome as the proposal to increase the height of the perimeter road (and associated armouring). Therefore, the proposed 'Mitigation – Effects of Climate Change' condition contained in **Appendix 8** requires an assessment and design of mitigation works that will minimise/control the potential for inundation of the leachate management system, and protect the landfill toe and landfill stability, from the adverse climate change effects.

6.5.3 Seismic Considerations

In relation to the potential risks associated with seismic events (i.e., earthquake and/or tsunami as a result of earthquakes), the assessment recognises that there are potential high environmental consequences should such an event result in a breach of the landfill.

The Natural Hazard & Climate Assessment (refer to Table 1 of the assessment) identifies that the mapped active faults in the area are the Akatore fault, which is located directly offshore and to the east, and the Titri fault, which is located along the eastern side of the Taieri Plain and thus to the west of the site.

To manage the risks associated with the two known faults that are in the vicinity of the site, the assessment recommends surveillance monitoring (inspections and maintenance) of the landfill's structural integrity throughout the aftercare period, as well as five-yearly risk assessment updates of the landfill's slope stability which accommodates site risks arising from potential seismic event. To mitigate potential tsunami risks, the assessment recommends an assessment, and subsequent design, of mitigation works that will minimise/control the potential for inundation of the leachate management system, and protect the landfill toe and landfill stability, from the adverse climate change effects are put in place. Proposed conditions reflecting these recommendations are provided in **Appendix 8** of this application.

6.5.4 Summary

The recommendations of the Natural Hazard & Climate Assessment have been accommodated in the proposed consent conditions (**Appendix 8)**. Accordingly, it is considered that the potential risks to the site from natural hazards, namely climate change influences and seismic considerations, can and will continue to be effectively managed throughout the consent term being sought by this application.

6.6 Effects on Kāi Tahu Values

The Fairfield closed landfill, and the surrounding area including the Kaikorae estuary, is located within the rohe of Kāi Tahu and the takiwā of Te Rūnanga o Otakou (**Te Rūnanga**).

As described in **Section 2.2** of this application, the estuary is part of the Te Tai o Arai Te Uru (Otago CMA) SAA under the Ngai Tahu Claims Settlement Act 1988, which means that the significance to Kāi Tahu has been recognised by the Crown. Local statutory planning documents also recognise the cultural significance of the Wetland and Estuary to Kāi Tahu, including through the application of a Wāhi Tupuna – Mapped Area (A4.51 – Kaikorae) under the 2GP and the description of the cultural and spiritual values identified in the Coastal Plan (as provided in **Section 2.2** of the application). Waste Management also acknowledges that a range of other cultural values may be associated with the site, as well as the broader area around the closed landfill.

Waste Management acknowledges that only Te Rūnanga can identify the effects on cultural values associated with the closed landfill. Therefore, Waste Management, as outlined in **Section 10** and **Appendix 7** (Record of Consultation) of this application, have consulted with Te Rūnanga, through Aukaha, in relation to the closed landfill and its discharge and take activities. As a result of this engagement and consultation, Aukaha are in the process of preparing a CIA, on behalf of Te Rūnanga.

Given the need to lodge this application at least six months prior to expiry of the landfill's existing resource consents, this application has been lodged without the CIA. This timing matter has been discussed with Aukaha, as noted in the Aukaha Letter (**Appendix 3**). The CIA, which will assess the effects on cultural values associated with the landfill, will be provided as soon as it is available. In the meantime, Waste Management, requests that this application is placed on hold until the CIA is provided to ORC.

6.7 Positive Effects

A positive effect associated with the landfill, is that it is now closed and the discharge of landfill gas and leachate is going to reduce over time to a point where the discharges no longer occur (and thus the take of leachate and associated groundwater is no longer required). This means, that in time, these discharges to the environment will cease, thus contributing to the improvement of the area's air and water resources, and the values associated with these resources.

Also, as outlined in the AMP (**Appendix 2**), the site, now that landfilling activities have ceased, can be made available for a range of other land uses. This includes providing access for passive recreation (i.e., walking) while also potentially enabling other recreational activities or low-impact commercial enterprises to be accommodated within the site. In addition, as outlined in the AMP, after the aftercare period, dependent on any residual risks and liabilities that may continue to be associated with the site, it is possible that the land will be transferred to other landowners for whatever land use is appropriate (e.g., as an area of open space for public use).

6.8 Summary

The discharge and take activities associated with the Fairfield closed landfill during the site's aftercare period has the potential to continue to adversely affect the area's water (groundwater, surface water and the Wetland-Estuary) and air resource, including potential effects on climate change, as well as Kāi Tahu values. There are also potential risks arising from natural hazards.

In relation to the effects on the area's water resources, it is acknowledged that the area's surface water resources are degraded (which the landfill will likely have contributed to, along with a range of other past and present activities in the catchment) and that the Wetland is regionally significant. However, in the context of this application, it is important to recognise that the site's landfilling activity ceased in 2017, the landfill leachate is controlled and managed such that the discharge of landfill leachate is minimised and, as the landfill is closed, over time the volume of leachate generated will reduce and ultimately cease. On this basis, adverse effects associated with the discharge of leachate, and the take of groundwater, from the Fairfield closed landfill will diminish and ultimately cease. On this basis, the health and well-being of the area's water resources, will improve over time.

The Air Quality Assessment (**Appendix 4**) concludes that overall, provided the various mitigation and monitoring measures that are proposed for managing landfill gas and minimising odour are in place (as incorporated into the proposed consent conditions), the discharges to air from the Fairfield closed landfill will have less than minor air quality effects.

The potential effects on climate change from the discharge of greenhouse gases (methane and carbon dioxide), which is a component of the site's discharge of landfill gas, are being effectively mitigated and reduced as landfill gas from the Eastern Landfill is being captured and flared (thus methane is being destroyed) and, as the landfill is closed, the volume of gas generated will reduce over time.

The Natural Hazard & Climate Assessment (**Appendix 6**) concludes that the potential risks to (and thus from) the site arising from natural hazards can be effectively managed throughout the consent term provided the recommendations of the assessment, as contained in the proposed consent conditions, are implemented.

In relation to potential effects on Kāi Tahu values, Waste Management acknowledges that only Te Rūnanga can identify the effect on cultural values associated with the closed landfill's ongoing activities. For this reason, Waste Management have consulted with, and will continue to consult with, Te Rūnanga, through Aukaha, and as a result of this engagement and consultation, Aukaha are in the process of preparing a CIA, on behalf of Te Rūnanga. The CIA will be provided to ORC as soon as it is available.

There are also positive effects associated with this application. As the landfill is now closed, the discharge of landfill gas and leachate will reduce and ultimately cease, thus, over time, contributing to the improvement of the area's air and water resources, and the values associated with these resources. In addition, now that landfilling activities have ceased, the site can now be made available for passive recreation (i.e., walking) and potentially other recreational activities or low-impact commercial enterprises to be accommodated within the site. In the future, dependent on any residual risks and liabilities that may continue to be associated with the site, it is also possible that the land will be transferred to other landowners for whatever land use is appropriate (e.g., as an area of open space for public use).

In summary, the continued effects of the activities, for which resource consents are being sought, are being effectively controlled and managed, and thus minimised. Also, landfilling activities have ceased and given that active management of landfill leachate and gas will be ongoing until such time as decomposition of the waste in the landfill slows or ceases, resulting in the volume of leachate and landfill gas being generated diminishing, it is considered that the continued effects associated with the landfill are less than minor.

7 Alternatives for Discharges (section 105 of the RMA)

7.1 Introduction

Section 105, as well as clause 6(1)(d) of Schedule 4, of the RMA identifies that where an application relates to the discharge of any contaminant, a description of the nature of the discharge, the sensitivity of the receiving environment to adverse effects and alternative discharge methods and locations is required.

The nature of the discharges associated with the closed landfill's aftercare period are described in the assessments contained in **Appendices 4** and **5** and outlined in **Section 3** of this application. The sensitivity of the receiving environment, namely the area's water and air resources, to the adverse effects of the discharges from Waste Management's closed landfill, are assessed in the Groundwater, Surface Water & Ecological Assessment and the Air Quality Assessment contained in **Appendices 5** and **4** respectively, and overviewed in **Section 6** of this application.

The remaining considerations arising from section 105 and Schedule 4 of the RMA that require assessment are the potential alternative discharge methods and locations. Accordingly, a description of the alternative treatment and disposal methods for the discharge of landfill leachate to groundwater via seepage, the discharge of treated stormwater to the Kaikorai Stream and Kaikorai Lagoon Swamp, and the discharge of landfill gas to air has been provided below.

In relation to alternative locations, it is important to recognise that the discharges are directly connected to past decisions to undertake landfilling activities at the site. In this context, while it may be feasible, on a theoretical basis, to remove the waste material contained in the site's closed landfills and relocate this material elsewhere, thus also relocating the discharges which are the subject of this application, it is considered that this alternative is fanciful. It is also considered this alternative, if it were to be adopted, would result in significant economic and environmental costs or effects. For these reasons, this alternative is not viable and has not been considered further.

7.2 Alternative Treatment and Disposal Methods

7.2.1 Discharge of Landfill Leachate

The site's existing discharge of landfill leachate to groundwater, via seepage, in terms of alternative treatment and disposal methods cannot be considered in isolation from the site's leachate management system as a whole, or past decisions that have been made about the site and its management. In this context, it is considered, when considering alternatives for the discharge of leachate, that there are three key past decisions relevant to the generation and discharge of landfill leachate at the site. These past decisions are:

- The fact that the site has been used for landfilling activities, or in other words, the site has been used for the disposal of waste materials that will decompose and generate leachate. As discussed above in **Section 7.1**, it is not a viable alternative to remove the waste material that generates the leachate from the site and dispose of it elsewhere.
- The fact that lining of the base of the landfills did not occur when the Western and Eastern Landfills were commissioned (i.e., the Eastern Landfill was commissioned in 1990s and it is unknown when the Western Landfill was commissioned). Lining of landfills, with impermeable liners, is now an essential component of modern landfill development. Landfill liners, in association with other landfill engineering approaches (i.e., use of cells, intermediate and final capping etc), enable leachate to be more efficiently captured and managed. However, this was not the standard practice at the time the landfill was constructed.
- The development and ongoing active management of leachate that was put in place during the development of the Eastern Landfill. The site's leachate management system is designed to capture and manage leachate from both the Western and Eastern Landfills. The site's leachate management system consists of the leachate interception drain, which runs around the eastern and southern edge of both the Western and Eastern Landfills, the pumping of the leachate from the drain and then the transfer of the landfill leachate into Dunedin's wastewater network. The capping of the Eastern Landfill and the

various monitoring wells located around the landfill also play a role in the active management of leachate from the site.

Given these past decisions and the nature of development at the site, it is considered that there are no additional new ‘engineering best practice’ alternative leachate treatment and disposal options available at the site. Principally, it is not feasible to retrospectively line the landfills, as that would require significant disturbance of the site, potentially with limited environmental benefits, particularly in light of the effectiveness of the site’s existing leachate management system.

In relation to the leachate management system itself, it is considered that the existing system, providing it continues to be maintained (as required by the proposed consent condition contained in **Appendix 8** of this application), represents the best practicable option for the initial aftercare period. It is also important to recognise that the pipe infrastructure associated with this system is contained within the landfill. The system is designed to capture and remove from the site’s landfill leachate (i.e., it is pumped into the city’s wastewater network), thus reducing and minimising the amount of leachate that can migrate off-site into the area’s groundwater, the Kaikorai Stream and the Wetland-Estuary. The Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), based on an approximate calculation, estimates that the site’s leachate management system is between 95.4 to 99.4% effective at capturing and removing leachate from the site.

As outlined in the AMP (**Appendix 2**), the proposed consent conditions (**Appendix 8**), and overviewed in **Section 3.3** of this application, Waste Management proposes to ensure that the site’s leachate management system continues to operate until such time as leachate generation has reduced to levels where ‘active’ management is no longer required. This change in approach would occur when leachate generation within the waste material has ceased or reduced to such levels that leachate is not reaching the interception drain. When this point is reached, the site will switch over to a passive system whereby eventually no pumping of the underground water containing leachate is required. The updated and certified AMP, as required by the proposed consent conditions, will identify that the criteria, or trigger limit, for the move from active to passive management of the landfill leachate. Waste Management considers that during the aftercare period, that this staged, or adaptive management approach, to the discharge of landfill leachate from the site also represents the best practicable option.

In the context of past decisions that have been made at the site, Waste Management considers that the discharge of leachate to groundwater, via seepage, subject to continuing to use the active leachate management system present at the site and only transferring to a passive system once leachate levels are at the identified trigger limit, represents the best practicable option for the discharge.

7.2.2 Discharge of Stormwater

Similar to the discharge of landfill leachate (discussed above), the continued ‘periodic’ discharge of stormwater to the Kaikorai Stream and Kaikorai Lagoon Swamp is directly connected to past decisions to manage and treat stormwater from the site when the Eastern Landfill was operational. At that time, the system consisted of ensuring that all stormwater from disturbed areas within the site was diverted to stormwater ponds prior to discharge to the stream (and swamp) via a pipelines. The stormwater ponds, located on the western and northern side of the Eastern Landfill, treated the stormwater (i.e., removed sediment via settlement), provided for attenuation of stormwater and also provided a water supply for the site.

The potential alternative treatment and disposal methods for the site’s stormwater, during the aftercare period, include:

- Retention of the site's existing system; or
- The 'do nothing option' which entails the removal of this infrastructure so that there is no active management, and thus discharge, of the site's stormwater.

The 'do nothing option', given the presence of the infrastructure of the stormwater system at site, does not necessarily represent the best practicable option. While the stormwater system is no longer required for the removal of sediment from the stormwater given that the site is now fully vegetated (i.e., there is no disturbed areas), Waste Management considers that there are benefits to continuing to retain and use the system at the site, at least during the early parts of the aftercare period. The benefits include that: a degree of stormwater retention at the site would be retained; and, retention of the system also avoids land disturbance activities at the site that would be associated with removal, or disestablishment, of the system. It is also considered that the removal of the stormwater infrastructure from the site, given that it will entail site earthworks, has the potential to result in unnecessary short-term adverse effects.

For the above reasons, Waste Management considers that the 'retention' of the site's existing stormwater management system has benefits, even if, as is the case now, the direct discharge of stormwater from the two stormwater ponds to the Kaikorai Stream and Kaikorai Lagoon Swamp occurs infrequently. Also, given that the site's stormwater system is not required for the removal of contaminants from the site's stormwater, Waste Management also consider that during the closed landfill's aftercare period, that the two stormwater ponds (i.e., the North and Weighbridge Ponds) can be left to become overgrown and thus become more like a wetland in terms of operation.

7.2.3 Discharge of Landfill Gas

As with the site's discharge of landfill leachate (discussed in **Section 7.2.1** above), the discharge of landfill gas to air, including any associated odour, is directly connected to past decisions that have been made about the site, namely disposing of organic waste material at the site. The presence of the waste material, and the decomposition of the material, results in the generation of landfill gas which discharges to air. Given this context, when considering alternatives for the discharge of landfill gas, as outlined in **Section 7.1** above, it is considered that it is not a viable alternative to remove the waste material (and thus cease the generation of landfill gas at the site) from the site and dispose of it elsewhere.

In relation to the landfill, the AMP (**Appendix 2**) and the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**) identify that there is no evidence of landfill gas is being generated in significant volumes at the Western Landfill and therefore it is not necessary to consider alternative treatment or discharge options (i.e., there is not enough landfill gas being generated to enable flaring).

The closed Eastern Landfill, as also stated in the AMP, is generating landfill gas and will continue to do so for several decades (although the half-life, in terms of decreased quality, is estimated to be 10 to 15 years). Therefore, given that landfill gas will continue to be discharged from the Eastern Landfill during the term of consent being sought by this application, a description of alternative treatment and disposal options is provided below.

The alternative treatment and discharge options for the discharge of landfill gas from the Eastern Landfill, during the aftercare period, are:

- The passive discharge of landfill gas (no treatment or controlled discharge);
- Collection of landfill gas and:
  - Flaring of the landfill gas; or

  - Generation of energy from the landfill gas.
- A combination of the above options (i.e., passive and active management of landfill gas).

Given the volume of waste that has been disposed of within the Eastern Landfill (<1,000,000 tonnes – refer to **Section 4.5** of this application), Waste Management are not required to control and flare the landfill gas under the NES-AQ (Regulations 25 to 27). However, Waste Management made the decision, while the Eastern Landfill was operational, to collect and flare landfill gas. It is understood that the key reason for making this decision was that it was considered that the collection and flaring of the site's landfill gas was the most environmentally responsible in terms of aiming to reduce greenhouse gas emissions, and therefore also the best practicable option. As a result of this decision, a gas collection system, including vents and flares, has been in place at the landfill since 2007. Also, as described in the Air Quality Assessment (**Appendix 4**), flaring of the landfill gas from the Eastern Landfill has been occurring at the site since 2009.

Given this past decision to collect and flare landfill gas, it is considered that the continued use of this infrastructure remains the best practicable option for the site, that is, as long as gas continues to be generated at sufficient volumes for the flares to operate. Continued effective implementation of this option will entail reducing the number of flares and/or changing the flares when the volume of gas being generated is no longer sufficient for the current flare set-up at the site. Ultimately, once landfill gas generation at the site reduces to levels where there are no effective flaring options, passive generation of landfill gas, albeit at minimal levels of discharge, is the only viable option. As noted in the Air Quality Assessment (refer to Section 7), the criteria or trigger level for the transfer to this option, based on the design criteria for the flares, is likely to be when gas levels at the site drop below 8.5m^3/hr.

The only other option, which was analysed by Waste Management in 2018, was whether it was viable for energy to be generated from the landfill gas, either at the site or at the existing gas turbine at the Green Island Wastewater Treatment Plant (located on the opposite site of the Wetland- Estuary). Following Waste Management's analysis, it was decided that it was not a viable option. The reasons for arriving at this decision were:

- The volume of gas that will be generated is relatively small and therefore the cost/benefit analysis of installing a generating plant at the site did not stack up.
- The cost of installing a pipeline to convey the gas to the Green Island Wastewater Treatment Plant was high, given the environment to be traversed, and there were also potential significant environmental effects on the values associated with the Kaikorai Stream, Wetland or Estuary (if the pipeline were to cross the Stream, Wetland or Estuary).

In the context of the past decisions that have been made at the site, Waste Management considers that the discharge of landfill gas to air from the site, subject to continuing to use the existing gas collection and flare system present at the site, and only transferring to a passive system once gas levels are at the identified trigger limit, represents the best practicable option for this discharge.

8 Assessment of Relevant Objectives and Policies (section 104(1)(b) of the RMA)

8.1 Introduction

An assessment of the closed landfill's discharge and take activities against the relevant objectives and policies contained in the relevant statutory plans is provided in the following sections of this application.

The national and regional level statutory plans that are relevant to the resource consents being sought by this application, and which are assessed in **Sections 8.2** and **8.4 to 8.7** below, are the NPS-FM 2020, PORPS 2019, PORPS 2021, Waste Plan and Water Plan.

In addition, given that the landfill is located alongside the Wetland, which then adjoins the Estuary, which is located within the CMA (i.e., within mean high water springs), objectives and policies of the NZCPS and Coastal Plan are also relevant to this application. These statutory plans are assessed in **Sections 8.3 and 8.8** below.

Although the Waste Plan's landfill objectives and policies provide for the landfill's discharges to air, for completeness, relevant Air Plan objectives and policies have also been assessed in **Section 8.9** below.

8.2 National Policy Statement for Freshwater Management 2020

The NPS-FM 2020 came into force on 3 September 2020, with amendments having been incorporated into the NPS-FM 2020 in December 2022 and then February 2023. 'Part 1 – Preliminary Provisions' of the NPS-FM 2020 identifies that Te Mana o te Wai, which applies to the management of all of New Zealand's freshwater, is the fundamental concept of the NPS-FM 2020. The NPS-FM 2020 also identifies that Te Mana o te Wai encompasses six principles (Clauses 1.3(3) and (4)). These principles[30] are: mana whakahaere; kaitiakitanga; manaakitanga; governance; stewardship; and, care and respect. Clause 1.3(1) describes the fundamental concept of Te Mana o te Wai as:

> *Te Mana o te Wai is a concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai. Te Mana o te Wai is about restoring and preserving the balance between the water, the wider environment, and the community.*

Part 4 of the NPS-FM 2020 contains provisions about implementation timing. Clause 4.1(1) requires local authorities to give effect to the NPS-FM 2020 as soon as reasonably practicable. Clause 4.1(2) also requires local authorities to publicly notify changes to planning documents

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[30] Clause 1.3(4) of the NPS-FM 2020 describes the six principles as follows:
   (a) ***Mana whakahaere:*** *the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater.*
   (b) ***Kaitiakitanga****: the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations.*
   (c) ***Manaakitanga:*** *the process by which tangata whenua show respect, generosity, and care for freshwater and for others*
   (d) ***Governance:*** *the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future.*
   (e) ***Stewardship:*** *the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations.*
   (f) ***Care and respect:*** *the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation.*

which are necessary to give effect to the NPS-FM 2020 in accordance with the RMA (i.e., which requires notification by 31 December 2024[31]).

The Water Plan, and the PORPS 2019, do not give effect to the NPS-FM 2020. The PORPS 2021 contains 'freshwater planning instruments' (**FPI**) components which are intended to give effect to the NPS-FM 2020. The FPI components of the PORPS 2021 were re-notified in September 2022[32], with hearings having took place in August and September 2023, meaning that only limited weight can currently be applied to the FPI components of the PORPS 2021. In terms of giving full effect to the NPS-FM 2020, ORC is currently proceeding through the National Objectives Framework (**NOF**) process required by the NPS-FM 2020 with this process feeding into the development of a proposed 'Land and Water Regional Plan' which ORC intend to notify by mid-2024.

As the statutory planning documents relevant to this application do not give effect to the NPS-FM 2020, and given the requirement under section 104(1)(b) of the RMA for ORC to consider the relevant provisions of all RMA planning documents, an assessment of the relevant provisions of the NPS-FM 2020 in relation to Waste Management's closed landfill activities is provided below. In undertaking this assessment, provisions that relate to the processes that ORC are still undertaking in order to give effect to the NPS-FM 2020 have not been assessed (i.e., as contained in Part 3 – Implementation of the NPS-FM 2020, including the NOF process described in sub-part 2 of Part 2 of the NPS-FM 2020).

While the upcoming NPS-FM 2020 implementation requirements have not been considered below, it is acknowledged that the NOF process requires the identification of relevant attribute states that are to apply to the identified 'freshwater management units' (**FMU**) in the region or which may apply to compulsory values. Attribute state bands and associated numeric attributes states, for a range of attributes in different water bodies, are provided in Appendices 2A and 2B of the NPS-FM 2020. These appendices specify attributes for surface water bodies, and given that the NOF process has not yet been completed in the Otago region, the NPS-FM 2020 attribute states have not been considered in detail within this application. However, it is noted that the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**) has assessed the effects of the discharges, and take of underground water, on the Kaikorai Stream, with the assessment having included consideration of the surface water monitoring data against the relevant NPS-FM 2020 surface water attribute states.

The NPS-FM 2020 objective and policies relevant to this application seek to:

- Ensure that resources are managed, consistent with Te Mana o te Wai, so that the health and well-being of water bodies and ecosystems are the first priority, followed by the health needs of people (i.e., drinking water) then followed by other activities that enable people and communities to provide for their social, economic and cultural well-being now and into the future (the NPS-FM 2020 **Objective** and **Policy 1**).
- Actively involve tangata whenua in the management of freshwater, and identify and provide for Māori values (**Policy 2**).

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[31] This timeframe is currently in accordance with section 80A(4) in 'Sub-part 4 – Freshwater planning process' of the Resource Management Amendment Act 2020.

[32] In June 2021, the whole PORPS 2021 was notified as a FPI. A High Court decision, dated 22 July 2022, declared that the ORC was incorrect in determining that the whole PORPS 2021 was a FPI. The High Court instructed ORC to renotify the parts of the PORPS 2021 that were FPI provisions, with the High Court directing that FPI provisions are those that directly relate to the maintenance or enhancement of water quality or quantity.

- Ensure that there is no further loss of extent of natural inland wetlands, that their values are protected and their restoration is promoted (**Policy 6**[33]).
- Avoid, to the extent practicable, that the loss of river extent and values is avoided (**Policy 7**).
- Protect the habitat of indigenous freshwater species, trout and salmon, with the habitat of trout and salmon being protected where it is consistent with protecting the habitat of indigenous freshwater species (**Policies 9 and 10**).
- Provide for the social, economic and cultural well-being of communities in a manner consistent with the NPS-FM 2020 (**Policy 15**).

As assessed in **Section 6** of this application and the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), the discharge of leachate may be contributing to the degraded water quality present in the area's surface waterbodies, including the Kaikorai Swamp Lagoon, which in turn may contribute to adverse effects on aquatic organisms, a compositional shift to pollution tolerant communities and/or behavioural avoidance of degraded water. However, given the complexity of the surface water systems in the area, particularly the Wetland, and past and present activities in the catchment, it is difficult to ascribe the landfill's contribution to this degradation. While this situation is recognised, it is also important to acknowledge that the effects associated with the continuation of site discharges and the take of landfill leachate (and associated groundwater) does not result in any further degradation of the ecosystem health of the Kaikorai catchment (including the natural inland wetland associated with the Kaikorai Lagoon Swamp). Also, given that the landfill is closed and that leachate generation will diminish to nothing over time this will contribute to an improvement in the ecosystem health of the area's freshwater resources. For these reasons, the first priority of Te Mana o Te Wai is being provided for (as well as Policies 6, 7, 9 and 10).

In addition, as assessed in **Sections 6.2.2** and **6.2.3** of this application, there are no adverse effects on the health needs of people as a direct result of the ongoing discharges and take at the closed landfill, which means the second priority of Te Mana o te Wai is also provided for. Finally, granting the resource consents being sought by this application enables Waste Management to meet its obligations associated with the landfill's aftercare period, thus providing for the third priority of Te Mana o Te Wai and Policy 15.

Given the guidance contained in Policy 2, and as outlined in **Sections 6.6** and **10** of this application, Waste Management have consulted with Te Rūnanga. An outcome of this consultation is that Aukaha, on behalf of Te Rūnanga, have been engaged to prepare a CIA in relation the closed landfill and its discharge and take activities. The CIA is still being prepared, but will be submitted, as part of this application, once it is completed.

Given the above assessment, it is considered that Waste Management's application to discharge within, and take underground water from, within the Kaikorai catchment is consistent with the relevant policy framework of the NPS-FM 2020.

8.3 New Zealand Coastal Policy Statement 2010

The NZCPS came into force in December 2010 and replaced the earlier 1994 coastal policy statement. The purpose of the NZCPS is to establish a policy framework to achieve the sustainable management of New Zealand's coastal environment.

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[33] This policy also reflects Clause 3.22 of the NPS-FM 2020, in as far as it applies to this application, which is discussed in **Table 3** below.

The Wetland adjoins the closed landfill at its southern boundary, and the Wetland then adjoins the Estuary which is located within the CMA (refer to **Figure 4**). Policy 1 of the NZCPS provides guidance on the extent and characteristics of the coastal environment, which, where relevant to this application includes:

> ***Policy 1 – Extent and characteristics of the coastal environment.***
>
> *…*
>
> *(2) Recognise that the coastal environment includes:*
> - *(a) the coastal marine area;*
> - *…*
> - *(c) areas where coastal processes, influences or qualities are significant, including coastal lakes, lagoons, tidal estuaries, saltmarshes, coastal wetlands, and the margins of these;*
> - *(d) areas at risk from coastal hazards*
> - *(e) coastal vegetation and the habitat of indigenous coastal species including migratory birds;*
> - *…*
> - *(g) items of cultural and historic heritage in the coastal marine area or on the coast;*
> - *(h) inter-related coastal marine and terrestrial systems, including the intertidal zone; and*
> - *(i) physical resources and built facilities, including infrastructure, that have modified the coastal environment.*

While the activities for which Waste Management are seeking resource consents do not take place directly within the CMA, it is considered that the landfill and the receiving environment associated with the activities for which resource consents are being sought are located in 'coastal environment', as identified by Policy 1 of the NZCPS above. This conclusion is reached as: the landfill is located on the margin of a 'coastal wetland', namely the Kaikorai Lagoon Swamp, which then adjoins the Estuary which is located within the CMA (Policy 1(2)(a) and (c)); as assessed in the Natural Hazard & Climate Assessment (**Appendix 6**), the landfill is at potential risk from coastal hazards (Policy 1(2)(d)); indigenous coastal species, including migratory birds, are present in the Wetland-Estuary (Policy 1(2)(e)); a SAA applies to the estuary and various cultural values are identified in statutory planning documents as being associated with the Wetland-Estuary (Policy 1(2)(g)); the landfill site, the Wetland and Estuary are connected and therefore inter-related (Policy 1(2)(h)); and, the landfill itself is a built form that has modified the edge of the Wetland that adjoins the Estuary (Policy 1(2)(i)). On this basis, the policy framework of the NZCPS is relevant to this application.

In addition, an assessment of the NZCPS policy framework, where relevant to the site, is required as the Coastal Plan, which became operative in 2001, does not give effect to the NZCPS.

The NZCPS objective and policies relevant to this application seek to:

- Safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems by maintaining or enhancing its biological and physical processes, including water quality (**Objective 1**).
- Take into account the principles of the Treaty of Waitangi, and ensure that Māori values are provided for and that tangata whenua are involved in the management of the coastal environment (**Objective 3 and Policy 2**).
- Manage and respond to coastal hazard risks, including arising from climate change, for existing development (**Objective 5**).

- Enable people and communities to provide for their social, economic and cultural wellbeing, whilst recognising that protection of the coastal environment does not preclude appropriate use and development (**Objective 6**). This includes ensuring that activities and development are managed so not to compromise the character and values of the coastal environment, including within the CMA,, while recognising their contribution to social, economic and cultural wellbeing (**Policy 6**).
- Protect indigenous biodiversity of the coastal environment (**Policy 11)**.
- Where water quality has deteriorated, prevent further degradation of water quality and restoring it to a state that can support ecosystems, natural habitats and activities taking place in the coastal environment (**Policy 21**).
- Manage the discharge of contaminants to water in the coastal environment such that the sensitivity of the receiving environment, its capacity to assimilate the contaminants and the nature of the contaminants being discharged is considered to ensure that the smallest mixing zone is necessary to achieve required water quality (**Policy 23**).

As overviewed above, although in the context of the relevant provisions of the NPS-FM 2020 (**Section 8.2** above), the effects associated with the continuation of site discharges and the take of landfill leachate (and associated groundwater) does not result in any further degradation of the water quality or biological values of the Kaikorai catchment, which includes the Wetland and Estuary. It is also recognised that the water quality and values associated with the Wetland-Estuary are degraded with this being a result of past and present development in the catchment, including activities associated with the Fairfield closed landfill during its aftercare period. Therefore, while the Wetland-Estuary is recognised as being degraded, in the context of this application, given that the landfill is now closed and that leachate generation will diminish to nothing over time, this will contribute to an improvement of the quality, and thus values, present in the Wetland-Estuary. For these reasons, it is considered the application is not contrary to Objective 1 and Policies 11, 21 and 23 of the NZCPS.

Furthermore, as outlined in **Section 6.6** of this application, Waste Management have consulted with Te Rūnanga, and will continue to consult with Te Rūnanga in relation to the site. An outcome of the consultation to date is that Aukaha, on behalf of Te Rūnanga, have been engaged to prepare a CIA in relation the closed landfill and its discharge and take activities. The CIA is still being prepared, but will be submitted, as part of this application, once it is completed. On this basis, a process is in place that seeks to ensure that cultural values are provided for and that tangata whenua are involved in this consent process (Objective 3 and Policy 2).

The risks to the site from natural hazards, including from climate change, have been assessed in the Natural Hazard & Climate Assessment (**Appendix 6**), and is overviewed in **Section 6.5** of this application. The assessment outlines a range of recommended responses, management and monitoring actions in order to manage and mitigate the potential risks from natural hazards. The actions identified have all been incorporated into the proposed conditions contained in **Appendix 8** of this application. On this basis, the risks to the site as a whole from natural hazards will continue to be managed (Objective 5).

Finally, granting the resource consents being sought by this application enables Waste Management to meet its obligations associated with the landfill's aftercare period. For this reason, the policy intent of Objective 6 and Policy 6, where relevant to this application, are also being provided for.

On the above basis, as the discharge and take activities at the landfill, where they occur within the broader coastal environment, are part of Waste Management's aftercare responsibilities at the closed landfill, and are consistent with (and therefore not contrary to) the relevant objectives and policies of the NZCPS.

8.4 Proposed Otago Regional Policy Statement 2021

The PORPS 2021 was originally notified in June 2021, with the document as a whole notified as a FPI. However, as a result of a High Court decision (dated 22 July 2022), the ORC was required to re-notify the provisions of the PORPS 2021 that were FPI components, with the High Court directing that FPI components are those that directly relate to the maintenance or enhancement of water quality or quantity. Accordingly, in September 2022, the ORC re-notified the FPI components of the PORPS 2021. The hearings on both the non-FPI and FPI components of the PORPS 2021 were formally closed by the Hearings Panel on 17 October 2023. Accordingly, given that decisions have not yet been released any components of the PORPS 2021, it is considered that only limited weight should be applied to its provisions.

The PORPS 2021 states its purpose is to provide a policy framework that aims to achieve long-term environmental sustainability by integrating the protection, restoration, enhancement and use of Otago's natural and physical resources.

The PORPS 2021 objectives and policies, relevant to this application, are assessed in **Table 1** below. The key provisions that are directly relevant to this application are contained in the mana whenua, integrated management, air, coastal environment, land and freshwater and hazard and risks sections of the PORPS 2021.

Given that no decisions have been released on the PORPS 2021, the notified version of provisions has been provided below. In addition, where a provision has been re-notified as a FPI component of the PORPS 2021, this is noted alongside the provision in the table below.

Table 1 – PORPS 2021 - Assessment of Relevant Objectives and Policies (as notified)

Objectives and Policies	Comment
MW – Mana whenua	
MW–O1 – Principles of Te Tiriti o Waitangi. The principles of Te Tiriti o Waitangi are given effect in resource management … decisions, utilising a partnership approach between councils and Papatipu Rūnaka to ensure that what is valued by mana whenua is actively protected in the region.	Policies that reflect the principles of Te Tiriti, in the context of resource management decisions and where they are of potential relevance to this application include, but are not limited to, **MW-P3(3)**, **IM-P3(3) and (4)**, **CE-P13** and **LF-WAI-P2**. As outlined in **Section 6.6** of this application, Waste Management have consulted with Te Rūnanga. An outcome of the consultation to date is that Aukaha, on behalf of Te Rūnanga, have been engaged to prepare a CIA. The CIA is still being prepared, but will be submitted, as part of this application, once it is completed.
IM – Integrated management	
IM–O2 – Ki uta ki tai. Natural and physical resource management and decision making in Otago embraces ki uta ki tai, recognising that the environment is an interconnected system, which depends on its connections to flourish, and must be considered as an interdependent whole.	**IM-P5** (Managing environmental interconnections), in support of this objective, aims to co-ordinate the management of interconnected natural and physical resources. In addition, **LF-WAI-P3** aims to manage freshwater and land in accordance with tikaka and kawa using and integrated approach. In assessing the effects associated with the continued discharges and take of landfill leachate (and associated groundwater), the interconnectedness of the activities and the area's natural and physical resources have been considered (i.e., the connections between groundwater, surface water and the Wetland-Estuary).

Objectives and Policies	**Comment**
AIR - Air	
AIR-O1 - Ambient air quality. Ambient air quality provides for the health and well-being of the people of Otago, amenity and mana whenua values, and the life-supporting capacity of ecosystems.	As identified in the Air Quality Assessment (**Appendix 4**) and outlined in **Section 4.4** of this application, the landfill is located within a polluted airshed (Otago 2 airshed). On this basis, AIR-P1, which seeks to maintain good ambient air quality is not relevant to this application. Policies relevant to this application, in support of these two objectives, aim to: improve ambient air quality where it is 'poor' (**AIR-P2**); and, provide for discharges to air and manage the effects of such discharges so that effects listed in **AIR-P3 to AIR-P6** do not occur. The Air Quality Assessment (**Appendix 4**), in conjunction with the assessment of landfill gas monitoring and migration included in the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), concludes that effects associated with the main discharges to air from the site, namely odour associated with the landfill gas and the discharge of PM_{10} from the combustion of landfill gas, are less than minor. Thus, adverse effects from these discharges are being appropriately managed such that there are no adverse effects associated with the discharge, and thus ambient air quality, on human health, amenity, or the life-supporting capacity of ecosystems. It is expected that an assessment of the adverse effects on mana whenua values, from the discharge of landfill gas to air, will be provided in the CIA that is still being prepared by Aukaha (on behalf of Te Rūnanga). In addition, as the landfill is closed and is no longer receiving waste material for disposal, over time the volume of landfill gas generated at the landfill will reduce and diminish. In time, this also means that management of landfill gas at the site will change from the site's current flaring (combustion) of landfill gas to the passive venting of landfill gas. When this change occurs, the discharge of PM_{10}, which is the contaminant that triggers the polluted status of the gazetted 'Otago 2 airshed', will no longer occur, thus resulting in an 'improvement' of the area's ambient air quality.
AIR-O2 - Discharges to air. Human health, amenity and mana whenua values and the life-supporting capacity of ecosystems are protected from the adverse effects of discharges to air.	
CE – Coastal environment	
CE–O1 – Safeguarding the coastal environment. The integrity, form, functioning and resilience of Otago's coastal environment is safeguarded so that: (1) the mauri of coastal water is protected, and restored where it has degraded, (2) coastal water quality supports healthy ecosystems, natural habitats, water-based recreational activities, existing activities, and customary uses, including practices associated with mahika kai and kaimoana, …	For the reasons outlined above in **Section 8.3**, the coastal environment provisions of the PORPS 2021 are also relevant to this application. **CE-P3**, in support of CE-O1, aims to improve coastal water quality where it is deteriorated to provide for the various values and attributes listed in Clauses (1) to (4) of this policy. In addition, **CE-P5**, which reflects Policy 11 of the NZCPS, seeks to protect indigenous biodiversity in the coastal environment. While the Wetland and Estuary are recognised as being degraded (as outlined in **Section 6** of this application and the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**)), in the context of this application, given that the landfill is now closed and that leachate generation will diminish to nothing over time (even though the leachate is being actively managed to minimise discharges beyond the interception drain), ultimately the fact that the landfill is closed will contribute to an improvement of the quality, and thus values, present in the Wetland and Estuary.
LF - Land and freshwater / LF-WAI – Te Mana o te Wai	
LF–WAI–O1 – Te Mana o te Wai (FPI component). The mauri of Otago's water bodies and their health and well-being is	**LF-WAI-P1** (FPI component), in support of this objective, outlines the hierarchy of prioritisation for the management of freshwater. The prioritisation reflects Te Mana o te Wai, as

Objectives and Policies	Comment
protected, and restored where it is degraded, and the management of land and water recognises and reflects that: (1) water is the foundation and source of all life – na te wai ko te hauora o ngā mea katoa, (2) there is an integral kinship relationship between water and Kāi Tahu whānui, and this relationship endures through time, connecting past, present and future, (3) each water body has a unique whakapapa and characteristics, (4) water and land have a connectedness that supports and perpetuates life, and (5) Kāi Tahu exercise rakatirataka, manaakitaka and their kaitiakitaka duty of care and attention over wai and all the life it supports.	described in the NPS-FM 2020 (refer to **Section 8.2** above). **LF-WAI-P4** requires all persons exercising functions and powers under the PORPS 2021 to give effect to Te Mana o te Wai when making decision affecting fresh water. Please refer to the NPS-FM 2020 objectives and policies in **Section 8.2** of this application.
LF - Land and freshwater / LF-VM – Visions and management	
LF–VM–O5 – Dunedin & Coast FMU vision (FPI component). By 2040 in the Dunedin & Coast FMU: (1) fresh water is managed in accordance with the LF-WAI objectives and policies, (2) the ongoing relationship of Kāi Tahu with wāhi tūpuna is sustained, (3) healthy estuaries, lagoons and coastal waters support thriving mahika kai and downstream coastal ecosystems, and indigenous species can migrate easily and as naturally as possible to and from these areas, (4) … (5) discharges of contaminants from urban environments are reduced so that water bodies are safe for human contact.	The Fairfield closed landfill is located within the Dunedin and Coast FMU. An assessment of the effects of the closed landfill's continued discharge and take activities during the landfill's aftercare period, is provided in **Section 6** of this application. As a brief summary, the continuation of site discharges and the take of landfill leachate (and associated groundwater) does not result in any further degradation of the water quality or biological values of the Kaikorai catchment. It is also recognised that the water quality and values associated with the Wetland-Estuary are degraded with this being a result of past and present development in the catchment, including activities associated with the Fairfield closed landfill during its aftercare period. Therefore, while the Wetland-Estuary is recognised as being degraded, in the context of this application, given that the landfill is now closed and that leachate generation will diminish to nothing over time (even though the leachate is being actively managed to minimise discharges beyond the interception drain), ultimately the fact that the landfill is closed will contribute to an improvement of the quality, and thus values, present in the area's surface water bodies in and around the landfill. In relation to the relationship that Kāi Tahu have with the area, it is anticipated that this will be outlined more fully in the CIA being prepared by Aukaha.
LF - Land and freshwater / LF-FW – Fresh water	
LF–FW–O8 – Fresh water (FPI component). In Otago's water bodies and their catchments: (1) the health of the wai supports the health of the people and thriving mahika kai, (2) … (3) the interconnection of fresh water (including groundwater) and coastal waters is recognised,	**LF-FW-P7** (FPI components), in support of this objective, outlines how the health and well-being of water bodies are to be maintained, or improved where degraded, and habitats protected. As assessed in **Section 6** of this application, it is acknowledged that the health of the wai and ecological values in the Kaikorai Stream and the Wetland-Estuary, which is the ultimate receiving environment for the landfill's leachate discharge, is degraded. It is also acknowledged that this degradation is associated with past and present development in the catchment, including landfilling activities at the Fairfield landfill.

Objectives and Policies	Comment
(4) native fish can migrate easily and as naturally as possible and taoka species and their habitats are protected, and (5) …	In the context of this application, given that the landfill is now closed and that leachate generation will diminish to nothing over time (even though the leachate is being actively managed to minimise discharges beyond the interception drain), ultimately the fact that the landfill is closed will contribute to an improvement of the quality, and thus values, present in the area's surface water bodies in and around the landfill.
LF–FW–O9 – Natural wetlands (FPI component). Otago's natural wetlands are protected or restored so that: (1) mahika kai and other mana whenua values are sustained and enhanced now and for future generations, (2) there is no decrease in the range and diversity of indigenous ecosystem types and habitats in natural wetlands, (3) there is no reduction in their ecosystem health, hydrological functioning, amenity values, extent or water quality, and if degraded they are improved, and (4) their flood attenuation capacity is maintained.	As assessed in **Section 4.5** of this application, under the NES-F, the Kaikorai Lagoon Swamp, is classified as a 'natural inland wetland' (i.e., the term that, as at January 2023, replaced the previous concept of 'natural wetlands'). **LF-FW-P9** and **LF-FW-10** (both of which are FPI components), in support of this objective, outline how 'natural wetlands' are to be protected (LF-FW-P9) and/or restored (LF-FW-P10). **Section 6** of this application, and the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), based on available information, has assessed the effects of closed landfill's discharge and take activities, on the Kaikorai Lagoon Swamp. These assessments identify that the Wetland is degraded, as a result of a range of past and present activities in the catchment, including the landfilling activities at Fairfield. However, in the context of this application, it is considered important to recognise that the landfill is closed and overtime the discharge of leachate, and associated take of groundwater, will diminish and cease, thus contributing to the restoration of the health and well-being of the Wetland.
LF–FW–P15 – Stormwater and wastewater discharges (FPI component). Minimise the adverse effects of direct and indirect discharges of stormwater and wastewater to fresh water by: (1) except as required by LF–VM–O2 and LF–VM–O4, preferring discharges of wastewater to land over discharges to water, unless adverse effects associated with a discharge to land are greater than a discharge to water, and (2) requiring: (a) all … industrial or trade waste to be discharged into a reticulated wastewater system, where one is available, (b) all stormwater to be discharged into a reticulated system, where one is available, (c) … (3) promoting the reticulation of stormwater and wastewater in urban areas.	This application is seeking a discharge permit to discharge stormwater to the Kaikorai Stream/Kaikorai Lagoon Swamp and therefore this policy is relevant to this application. In addition, while the landfill leachate generated at the site may not be considered to be wastewater, an assessment of the landfill leachate, as if it is wastewater, against this policy has also been provided below. In relation to the site's stormwater discharge, connection to a reticulated system is not feasible (i.e., there is no such system at the site), but nor is it needed. As the site is closed and re-vegetated, contaminants will not become entrained in the stormwater. In addition, for any stormwater that makes it into the ponds, and is then subsequently discharged into the stream and /or lagoon, attenuation and treatment of the stormwater does occur prior to discharge. On this basis, the potential adverse effects of the discharge are being minimised. In relation to the landfill leachate, this contaminant is effectively connected to Dunedin's reticulated wastewater system. However, given that the landfill was not lined prior to landfilling activities commencing, the landfill's leachate is discharged to the environment (to land and groundwater, not surface water) prior to being 'recaptured' and pumped into the reticulated system. Therefore, while a discharge permit is required for the discharge of landfill leachate (via seepage), active management systems are in place to minimise any adverse effects of the discharge (i.e., by removing around 95.4 to 99.4% of the landfill's leachate from the site, via the interception drain and subsequent pumping of the leachate into the wastewater network).
HAZ – Hazard and Risks / HAZ-NH – Natural Hazards	
HAZ–NH–O2 – Adaption. Otago's people, property and communities are prepared	In support of this objective **HAZ-NH-P4** aims to reduce existing natural hazard risks, including by, managing existing land uses where there are risks to people and communities. **HAZ-NH-P10**

Objectives and Policies	Comment
for and able to adapt to the effects of natural hazards, including climate change.	also outlines a range of approaches to managing the risks to land which is potentially affected by coastal hazards over the next 100 years. These considerations are assessed in **Section 6.5** of this application and in the Natural Hazard & Climate Assessment (**Appendix 6**). Based on this assessment, and given the nature of the risks at the site and the management and mitigation actions identified (as incorporated into proposed consent conditions (**Appendix 8**)), natural hazard risks, including those associated with climate change, have been appropriately identified and will be appropriately managed and mitigated at the site.
HAZ – Hazard and Risks / HAZ-CL – Contaminated Land	
HAZ–CL–O3 – Contaminated Land. Contaminated land and waste materials are managed to protect human health, mana whenua values and the environment in Otago.	**HAZ-CL-P14**, in support of this objective, aims to actively manage contaminated land, including by requiring closed landfills to be managed in accordance with a closure plan which identifies monitoring requirements and remedial actions to address ongoing risks (HAZ-CL-P14(4)). The Eastern Landfill has been closed in accordance with a Closure Plan (as required by the conditions of the existing consents). Waste Management propose to continue to actively manage the site during the aftercare period in accordance with an updated and certified AMP as required by the proposed consent conditions (**Appendix 8**) (a draft AMP is contained in **Appendix 2** of this application). The updated and certified AMP will contain procedures for ongoing monitoring and management of the various risks associated with the site (as currently outlined in the proposed consent conditions). Also, as assessed in **Section 6** of this application, the effects associated with the continuation of site discharges and the take of landfill leachate (and associated groundwater) does not result in any further degradation of the ecosystem health of the Kaikorai catchment. Also, given that the landfill is closed and that leachate generation will diminish over time (even though the leachate is actively managed to minimise discharges beyond the interception drain), ultimately the fact that the landfill is closed will contribute to an improvement in the ecosystem health of the area's freshwater resources.

Although it is considered that only limited weight should be applied to the provisions of the PORPS 2021, based on the above assessment, the closed landfill activities for which resource consents are being sought by application are considered to be consistent with (and not contrary to) the relevant objectives and policies of the PORPS 2021.

8.5 Partially Operative Otago Regional Policy Statement 2019

The PORPS 2019 is to be made fully operative on 4 March 2024[34,35]. The PORPS 2019 establishes a high-level policy framework that provides for the sustainable integrated management of the region's resources, and directs how these resources will be managed within the region's regional and district plans.

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[34] As per a public notice dated 24 Februaty 2024 - https://www.orc.govt.nz/news-and-events/news-and-media-releases/2024/february/partially-operative-regional-policy-statement-2019-to-become-fully-operative .

[35] The Regional Policy Statement for Otago 1998 was revoked in March 2021 when the PORPS 2019 was made partially operative.

The PORPS 2019 objectives and policies relevant to this application are assessed in **Table 2** below.

Table 2 – PORPS 2019 - Assessment of Relevant Objectives and Policies

Objectives and Policies	Comment
Chapter 1 - Resource Management in Otago is Integrated	
Objective 1.1 - Otago's resources are used sustainably to promote economic, social, and cultural wellbeing for its people and communities	**Policy 1.1.1**, in support of this objective, aims to provide for economic well-being while enabling the resilient and sustainable use and development of resources. **Policy 1.1.2** then outlines a range of measures that will be adopted to ensure resource use activities achieve the outcomes sought by Objective 1.1. In the past, landfilling operations at the site contributed to the economic wellbeing of the region by providing a place for waste to be disposed of. In the context of this application, the discharges to air, groundwater and the area's surface water bodies from the closed landfill and the taking of landfill leachate, and associated groundwater, are directly associated with Waste Management's continued aftercare operations at the site. Therefore, the activities for which resource consent is being sought play an important role in ensuring that the closed landfill continues to be managed in a safe, efficient and sustainable manner, thus ensuring that the well-being of the local community is being provided for.
Objective 1.2 - Recognise and provide for the integrated management of natural and physical resources to support the wellbeing of people and communities in Otago.	**Policy 1.2.1**, in support of this objective, outlines a range of methods as a means of achieving the integrated management of the region's resources. In assessing the effects associated with the continued discharges and take of landfill leachate (and associated groundwater), as reflected in this application and the appended assessments, the interconnectedness of the activities and the area's natural and physical resources have been considered (i.e., the connections between groundwater, surface water and the Wetland-Estuary).
Chapter 2 - Kāi Tahu Values and interests are recognised and Kaitiakitaka is recognised	
Objective 2.1 - The principles of Te Tiriti o Waitangi are taken into account in resource management processes and decisions. **Objective 2.2** - Kāi Tahu values, interests and customary resources are recognised and provided for.	Where relevant to this application, **Policy 2.1.2**, in support of Objective 2.1, seeks to ensure that local authorities when exercising their functions and powers, involve Kāi Tahu in resource management processes and take account or recognise and provide for the matters listed in Clauses (c) to (h) of the policy. **Policies 2.2.1 and 2.2.2** aim to ensure that the natural environment is managed to support Kāi Tahu wellbeing, and the sites of cultural significance are recognised and provided for. As outlined in **Section 6.6** of this application, Waste Management have consulted with Te Rūnanga. An outcome of the consultation to date is that Aukaha, on behalf of Te Rūnanga, have been engaged to prepare a CIA. The CIA is still being prepared, but will be submitted, as part of this application, once it is completed.
Chapter 3 – Otago has high quality natural resource and ecosystems	
Objective 3.1 - The values (including intrinsic values) of ecosystems and natural resources are recognised and maintained, or enhanced where degraded.	Refer to the **Policy 3.1.1 and 3.1.6** comments provided below.
Policy 3.1.1 - Safeguard the life-supporting capacity of fresh water and manage fresh water to:	**Policy 3.1.9**, similar to this policy, also seeks to manage and provide for ecosystem and indigenous biological diversity in terrestrial, freshwater and marine environments by maintain or enhancing the diversity of these natural resources. **Policy 3.1.10**

Objectives and Policies	**Comment**
a) … enhance water quality where it is degraded, including for: i. Important recreation values, including contact recreation; and, … b) Maintain or enhance aquatic: i. Ecosystem health; ii. Indigenous habitats; and, iii. Indigenous species and their migratory patterns. d) Maintain or enhance, as far as practicable: … ii. Coastal values supported by fresh water; …	also aims to avoid significant adverse effects, and avoid, remedy or mitigate the adverse effects of activities on the coastal environment. **Policy 3.1.13** aims to contribute to the resilience and enhancement of the natural environment including by, but not limited to, improving water quality, restoring habitat for indigenous species, as well as protecting and restoring wetlands. Refer to the **PORPS 2021 CE-O1, LF-WAI-O1, LF-VM-O5, LF-FW-O8 and LF-FW-O9** comments provided in **Table 1** above.
Policy 3.1.6 - Manage air quality to achieve the following: a) Maintain good ambient air quality that supports human health, or enhance air quality where it has been degraded; b) Maintain or enhance amenity values.	Refer to the **PORPS 2021 AIR-O1 and AIR-O2** comments provided in **Table 1** above.
Objective 3.2 - Otago's significant and highly-valued natural resources are identified and protected, or enhanced where degraded.	It is considered that this objective is relevant to this application as parts of the surface waterbodies adjoining the site are classified as a Regionally Significant Wetland and natural inland wetland (the Kaikorai Lagoon Swamp which includes parts of the Kaikorai Stream). In addition, the estuary, which is located within the CMA, is classified as a Coastal Protection Area. **Policy 3.2.16**, in support of this objective, aims to protect the functions and values of wetlands by, amongst a range of approaches, maintaining the significant values of wetlands, and avoiding, remedying or mitigating other adverse effects. In relation to the Regionally Significant Wetland, refer to the **PORPS 2021-FW-O9** comments provided in **Table 1** above. In relation to the estuary, refer to the assessments contained in **Sections 8.3** and **8.8** of this application. These assessments consider the relevant objectives and policies of the NZCPS and Coastal Plan respectively.
Chapter 4 - Communities in Otago are resilient, safe and healthy	
Objective 4.1 - Risks that natural hazards pose to Otago's communities are minimised.	**Policy 4.1.5**, in support of this objective, aims to manage natural hazard risk to people, property and communities. Natural hazard risks in the area, including potential risks to the site, are assessed in **Section 6.5** of this application, and in the Natural Hazard & Climate Assessment (**Appendix 6**). Given the nature of the risks at the site and the management and mitigation actions identified (as incorporated into proposed consent conditions (**Appendix 8**)), natural hazard risks, including those associated with climate change, have been appropriately identified and will be appropriately managed and mitigated at the site.
Objective 4.6 - Hazardous substances, contaminated land and waste materials do not harm human health or the quality of the environment in Otago.	**Policy 4.6.5,** in support of this objective, aims to ensure that contaminated land, such as closed landfills, do not pose an unacceptable risk to people and the environment. Refer above to **Table 1** and the comment provided in relation to the **PORPS 2021's HAZ–CL–O3.**

Objectives and Policies	Comment
Chapter 5 – People are able to use and enjoy Otago's natural and built environment	
Objective 5.4 - Adverse effects of using and enjoying Otago's natural and physical resources are minimised.	In relation to the area's water resources, the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), identifies that the site's management systems, namely the leachate interception drain is effective at capturing and removing the majority of the site's leachate (i.e., a rough estimate is that the system is 95.4 to 99.4% effective at capturing the leachate). While it is acknowledged that the area's surface water resources are degraded as a result of past and present activities in the broader catchment, in the context of this application, the site's leachate system is playing an important role in avoiding significant adverse effects and minimising adverse effects on these resources. In addition, as the landfill is closed, over time the generation of leachate at the landfill will diminish and ultimately cease. In relation to the area's air resource, the Air Quality Assessment (**Appendix 4**) concludes that the air quality effects associated with the main discharges to air from the site, namely odour associated with the landfill gas and the discharge of PM_{10} from the combustion of landfill gas, are less than minor. On the above basis, adverse effects from the closed landfill's ongoing discharges and take activities are being appropriately avoided, remedied or mitigated, as well as minimised.
Policy 5.4.1 - Manage offensive or objectionable discharges to land, water and air by: a) Avoiding significant adverse effects of those discharges; b) … c) Avoiding, remedying or mitigating other adverse effects of those discharges.	

Based on the above assessment, the closed landfill activities for which resource consents are being sought by application are considered to be consistent with (and therefore not contrary to) the relevant objectives and policies of the PORPS 2019.

8.6 Regional Plan: Waste for Otago

As outlined in **Section 4.2** of this application, Chapter 7 of the Waste Plan contains objectives, policies (and rules) that provide for the management framework for landfills, including closed landfills, within the Otago region. The objectives and policies relevant to this application are:

> ***Objective 7.3.1*** *- To avoid, remedy or mitigate the adverse environmental effects arising from the discharge of contaminants at and from landfills.*
>
> ***Policy 7.4.1*** *- To recognise and provide for the relationship Kāi Tahu have with Otago's natural and physical resources through:*
> *(a) Providing for the management and disposal of Otago's wastes in a manner that takes into account Kai Tahu cultural values; and*
> *(b) Supporting waste disposal methods which avoid, remedy or mitigate adverse effects on the environment and the mauri of its natural and physical resources; and*
> *(c) Protecting waahi tapu and waahi taoka from waste management practices; and*
> *(d) Ensuring that Kai Tahu access to waahi tapu and waahi taoka is not compromised by waste management practices; and*
> *(e) Acknowledging that future generations will inherit the results of good and bad waste management practices; and*
> *(f) Maintaining consultation with Kai Tahu on issues relating to landfill management.*
>
> ***Policy 7.4.3*** *- To ensure that landfills … managed in a manner whereby adverse effects on the environment are avoided, remedied, or mitigated.*
>
> ***Policy 7.4.4*** *- To monitor discharges to land, water, and air from … and closed landfills, and …*

> ***Policy 7.4.6** - To require that all … closed landfills are managed in compliance with approved management and post-closure procedures.*

As already described in this application, Waste Management are seeking resource consents for the continuation of the discharges and take associated with the aftercare period at the Fairfield landfill. The management of the site's discharges and the take of landfill leachate (and associated groundwater), during the aftercare period, will be carried out in accordance with an updated and certified AMP as required by the proposed consent conditions (**Appendix 8**) (the current draft AMP is contained **Appendix 2**). Also, as assessed in **Section 6** of this application, the effects associated with these closed landfill activities, given the active management of the landfill leachate and gas being generated at the site, as well as the proposed conditions (including monitoring requirements) provided in **Appendix 8** of this application, are being avoided, remedied or mitigated.

In relation to Kāi Tahu kaitiakitanga, Waste Management have consulted with Te Rūnanga, and will continue to engage with Te Rūnanga in relation to the site. An outcome of the consultation to date is that Aukaha, on behalf of Te Rūnanga, have been engaged to prepare a CIA. The CIA is still being prepared, but will be submitted, as part of this application, once it is completed.

Therefore, the continuing closed landfill discharges and take of landfill leachate (and associated groundwater), which are the subject of this application, are considered to be consistent with (and therefore not contrary to) the relevant objectives and policies in the Waste Plan.

8.7 Regional Plan: Water for Otago

As stated in **Section 4** above, as the Waste Plan regulates the consent renewals for the discharges to land, air and the Kaikorai Stream and Kaikorai Lagoon Swamp from the site, it is only the Water Plan provisions that apply to the take of landfill leachate and associated groundwater, as well as any connected surface water, that are relevant to this application. In addition, given that the recognition of the Kaikorai Lagoon Swamp as a Regionally Significant Wetland, the wetland provisions of the Water Plan are also relevant to this application.

Given that the Water Plan only applies to the take aspect of the closed landfill activities, the objectives and policies contained in Chapter 6 (Water Quantity), Chapter 9 (Groundwater), Chapter 10 (Wetlands) and Chapter 10A (Objectives, Policies & Rules for Replacement Take & Use Permits) are considered to be relevant to this application. An assessment of the policy framework of these chapters, where relevant to this application, is provided in **Table 3** below.

Table 3 – Water Plan - Assessment of Relevant Objectives and Policies

Objectives and Policies	Comment
Chapter 6 – Water Quantity	
Objective 6.3.1 - To retain flows in rivers sufficient to maintain their life-supporting capacity for aquatic ecosystems, and their natural character.	As described in the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), the active leachate management system at the site, which is what the take relates to, has been designed and is managed to capture the leachate that has been discharged to land (via seepage). As a result, shallow groundwater present under the landfill is also captured, as is a
Objective 6.3.2A - To maintain long term groundwater levels and water storage in Otago's aquifers.	

Objectives and Policies	Comment
Policy 6.4.0 - To recognise the hydrological characteristics of Otago's water resources, including behaviour and trends in: (a) The levels and flows of surface water bodies; and (b) The levels and volumes of groundwater; and (c) Any interrelationships between adjoining bodies of water, when managing the taking of water.	small portion of groundwater and potentially surface water immediately downgradient of the interception drain. However, as assessed in **Section 6.2.2** of the application, the take, given where the landfill is located and the nature of the leachate management system, does not adversely affect long term groundwater levels or water storage in the area. Nor, as assessed in the Groundwater, Surface Water & Ecological Assessment, does it adversely affect the Kaikorai Stream or the Wetland- Estuary.
Policy 6.4.1A - A groundwater take is allocated as: (a) Surface water, subject to a minimum flow, if the take is from any aquifer in Schedule 2C; or (b) Surface water, subject to a minimum flow, if the take is within 100 metres of any connected perennial surface water body; or (c) Groundwater and part surface water if the take is 100 metres or more from any connected perennial surface water body, and depletes that water body most affected by at least 5 litres per second as determined by Schedule 5A; or (d) Groundwater if (a), (b) and (c) do not apply.	An important component of the closed landfill's leachate management system is the site's leachate interception and associated pump station. This system enables the take of 'underground water containing leachate and other groundwater', as currently authorised by Consent 93541 (**Appendix 1**), thus ensuring that a significant majority of the leachate generated by the landfill is captured (i.e., estimated to be between 95.4 to 99.4%) and disposed of within the city's wastewater system. As described in Section 10.2 of the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), as the interception drain runs alongside the Kaikorai Stream and the Wetland, the take of 'underground water' occurs within 100m of surface waterbodies. Therefore, under this policy, the take is allocated as a surface water take in accordance with Clause (b) of this policy. Accordingly, where relevant within this application, the groundwater take has also been considered or assessed as a surface water take. However, in relation to the requirement to assign a minimum flow to the take (as required by Clause (b)), the Groundwater, Surface Water & Ecological Assessment considers that applying a minimum flow restriction would be detrimental to the receiving environment.
Policy 6.4.2A - Where an application is received to take water and Policy 6.4.2(b) applies to the catchment, to grant from within primary allocation no more water than has been taken under the existing consent in at least the preceding five years, except	Under **Policy 6.4.2(b)(ii)**, the take of underground water at the landfill falls into the catchment's primary allocation as the take was consented, as at 10 April 2010. As assessed in **Section 4.3.3** of this application (in relation to the rules contained in Chapter 10A of the Water Plan), although the landfill's leachate and groundwater take is not currently metered, Consent 93541 limits the rate of take to 72,000L/hr (i.e., the consented rate of take limit), with the typical volume of the take, over recent years, ranging from around 48 to 120m^3/day (or 2,000 to 5,000L/hr). These rates are based on pumping rates from the landfill's interception drain. Also, as the landfill is closed, the rate of leachate generation within the landfill will decrease, and thus the required rate of take will also decrease and at some time in the future the take will no longer be required. On this basis, in the future, the take will not exceed that rate or volume of take that has occurred in the past five years.
Policy 6.4.4 - For existing takes outside Schedule 2A catchments, minimum flows, for the purpose of restricting primary allocation takes of water, will be determined after investigations have established the appropriate minimum flows in accordance with Method 15.9.1.3.	**Policy 6.4.5(e),** not (d), identifies that for any existing resource consent where minimum flow requirements are not identified in (a) to (d) of this policy, minimum flows will set by a plan change and review of conditions. Clauses (a) to (d) of Policy 6.4.5 do not apply to the Kaikorai Stream. In addition, the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**) considers that applying a minimum

Objectives and Policies	Comment
The new minimum flows will be added to Schedule 2A by a plan change and subsequently will be applied to existing takes in accordance with Policy 6.4.5(d).	flow restriction would be detrimental to the receiving environment.
Policy 6.4.7 - The need to maintain a residual flow at the point of take will be considered with respect to any take of water, in order to provide for the aquatic ecosystem and natural character of the source water body.	As described in the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), the average rate of the underground water take is around 0.6 to 1.4L/s, which occurs along the 1km length of the interception drain, is small given the allowable stream depletion effect of 5L/s for groundwater abstractions located more than 100m from a water body (refer to **Policy 6.4.1A** above). The actual take of surface water associated with the landfill's take of leachate and associated groundwater, is only a small portion of the landfill's take. The take is also diffuse, in that it occurs along the length of the interception drain, and thus there is not specific point of take. For the above reasons, and given the location of the take (i.e., at the bottom of the catchment and alongside the Stream and Wetland), and as assessed in **Section 6.3.3** of this application, the take has a minimal effect on the water flows and levels in the Stream and Wetland. On the above basis, the application of a residual flow at the 'point of take' is not appropriate.
Policy 6.4.10A4 - Where an application is received to take groundwater by a person who already holds a resource consent to take that water, grant no more water than has been taken under the existing consent, in at least the preceding five years, when: …	Waste Management already hold a resource consent (Consent 93541 – **Appendix 1**) to take underground water (i.e., leachate and other groundwater). This application is not seeking to take any more underground water than that already provided for by the existing consent. In fact, as the volume of leachate that needs to be captured reduces over time (i.e., given that the landfill is closed), the amount of underground water to be taken will also reduce over time. In time, when the active management of leachate ceases, once the identified criteria or trigger levels are met (as identified in the updated and certified AMP required by the proposed consent conditions (**Appendix 8**)), then the take will cease altogether.
Policy 6.4.10A5 - In managing the taking of groundwater, avoid in any aquifer: (a) Contamination of groundwater or surface water; and (b) Permanent aquifer compaction.	The purpose of the take of underground water (i.e., from beneath the closed landfill) is to provide for the active management of the landfill leachate so as not to minimise potential contamination of downstream groundwater, surface water or Wetland-Estuary water. In addition, given that the take is correlated to the volume of the leachate generated, permanent aquifer compaction will not occur.
Chapter 9 - Groundwater	
Objective 9.3.1 - To sustain the recognised uses of Otago's groundwater.	It is considered that these objectives and policy are not directly relevant to the take of underground water, containing leachate and other groundwater. However, in the context of the broader activities associated with the closed landfill, for which this application is seeking resource consents, it is important to recognise that the take of underground water is specifically for the purpose of actively managing (and removing) landfill leachate from the area. In addition, ongoing monitoring of the effectiveness of the leachate management system, and of the nearby environment, is proposed as part of the consents being sought by this application (refer to the proposed consent conditions provided in **Appendix 8** of this application).
Objective 9.3.3 - To maintain the quality of Otago's groundwater.	
Policy 9.4.18 - To identify land of high risk in terms of the vulnerability of underlying groundwater to leachate contamination and to manage, with respect to this land: (a) …. (b) Existing land use activities so that any potential for groundwater contamination is monitored and,	

Objectives and Policies	Comment
where necessary, corrective action is taken;	
Chapter 10 - Wetlands	
Objective 10.3.1 - Otago's wetlands and their individual and collective values and uses will be maintained or enhanced for present and future generations.	The Fairfield closed landfill, which has been lawfully established, adjoins the Kaikorai Lagoon Swamp which the Water Plan identifies as a Regionally Significant Wetland. The Kaikorai Lagoon Swamp, which lies outside of the CMA, is also associated with the Kaikorai Stream where it flows past the site. As the Kaikorai Lagoon Swamp is not located within the CMA, it is also a natural inland wetland in accordance with the definition contained in the NPS-FM 2020. As assessed in the Groundwater, Surface Water & Ecological Assessment (**Appendix 5**), the Kaikorai Lagoon Swamp (the Stream and Wetland) is recognised as degraded, with the degradation associated with the past use of the immediate area and past use and development in the upstream catchment. It is also acknowledged that past landfilling activities at the site may have contributed to the Regionally Significant Wetland's degradation. However, in the context of this application, the site's landfilling activity has ceased, the landfill leachate is controlled and managed such that the discharge of landfill leachate is minimised. Also, as the landfill is closed, over time the volume of leachate generated will be reduced and ultimately cease. On this basis, while it is considered that the landfill has and is contributing to the degradation of the values associated with the Kaikorai Lagoon Swamp, the reduction and cessation of the discharge and take activities from the closed landfill will contribute to improvements (enhancements) to the Regionally Significant Wetland and its values.
Objective 10.3.2 - Otago's Regionally Significant Wetlands and their values and uses are recognised and sustained.	
Policy 10.4.2 - Avoid the adverse effects of an activity on a Regionally Significant Wetland or a regionally significant wetland value, but allow remediation or mitigation of an adverse effect only when the activity: (a) Is lawfully established; or (b) … (c) Has the purpose of maintaining or enhancing a Regionally Significant Wetland or a regionally significant wetland value.	
Policy 10.4.8 - The loss of natural inland wetlands is avoided, their values are protected, and their restoration is promoted, except where: …	This policy is Clause 3.22 of the NPS-FM 2020. As assessed in **Sections 4.5** and **6** of this application, the take of underground water, containing landfill leachate and other groundwater, will not result in the loss of any parts of a natural inland wetland (i.e., the Kaikorai Lagoon Swamp). In the broader context of the activities for which resource consents are being sought by this application, the future reduction and cessation of the site discharges and take from the closed landfill will also contribute to improvements (enhancements) to the nearby environment.
Chapter 10A - Objective, Policies & Rules for Replacement Water Take & Use Permits	
Objective 10A.1.1 - Facilitate an efficient and effective transition from the operative freshwater planning framework toward a new integrated regional planning framework, by managing: … (c) The replacement of water permits for takes and uses of freshwater where those water permits expire prior to 31 December 2025.	This objective is process related and as such underpins the policies and rules contained in Chapter 10A of the Water Plan. Accordingly, the policies relevant to the take of landfill leachate and associated groundwater, which is to be allocated as a surface water take, are assessed below. The assessment of rule of applicability is provided **Section 4.3.3** of this application.
Policy 10A.2.1 - Replacement consents Irrespective of any other policies in this Plan, avoid granting resource consents that replace … water permits for takes and uses	The specific requirements of this policy are effectively reflected in Conditions (ii), (v) to (vii) of Rule 10A.3.1.1 (controlled activity) of the Water Plan. As assessed in **Section 4.3.3** of this application, where relevant to the landfill's take of leachate and

Objectives and Policies	Comment
of surface water (including groundwater considered as surface water under Policy 6.4.1A (a), (b) and (c) of this Plan) where those water permits expire prior to 31 December 2025, except where: (a) The Deemed Permit or water permit that is being replaced is a valid permit; and (b) … (c) Any existing residual flow, minimum flow or take cessation condition is applied to the new permit; and (d) For takes other than community water supplies there is no increase in: (i) The historical instantaneous rate of abstraction; and (ii) Any historical volume of water taken.	associated groundwater, the take complies with the requirements of the specific rule conditions, and thus also complies with this policy.
Policy 10A.2.3 - Duration Irrespective of any other policies in this Plan concerning consent duration, avoid granting resource consents … that replace water permits to take and use surface water (including groundwater considered as surface water under Policy 6.4.1A (a), (b) and (c) of this Plan) where those water permits expire prior to 31 December 2025, for a duration of more than six years, except …	The consent term restriction outlined in this policy forms Condition (i) of Rules 10A.3.1.1 (controlled activity) and 10A.3.1A.1 (restricted discretionary activity). Rule 10A.3.2 then provides for the take and use of surface water, including groundwater allocated as surface water in accordance with Policy 6.4.1A(b), as a non-complying activity where the conditions of the 10A.3.1.1 and 10A.1A.1 (and Rule 10A.3.1.1B.1 which applies to hydro-generation activities) are not met, including the six year consent duration conditions. Therefore, while this policy is an 'avoidance' policy, the Chapter 10A rules, given the presence of Rule 10A.3.2, does not lock out a consent pathway for longer term consents. Although there is no 'use' of water associated with the take of landfill leachate and associated groundwater (and connected surface water) at the site, an assessment of the Chapter 10A rule applicability, and compliance with the consent duration conditions, is provided in **Section 4.3.3** of this application. The rule assessment identifies that the consent duration conditions of the controlled and restricted discretionary activity rules are not complied with as Waste Management are seeking a 30-year consent term. Therefore, this application is seeking consent, for the take aspect of the landfill's aftercare activities, as a non-complying activity in accordance with Rule 10A.3.2. As stated in Section 4.3.3 of this application, a 30-year consent term is being sought for very specific reasons. The closed landfill's ongoing discharge and take activities are anticipated to continue for 30-years, thus the 30-year consent term reflects the likely aftercare period associated with the landfill (i.e., when leachate and gas will continue to be generated, albeit at levels that reduce over time). Throughout this aftercare period, the take of landfill leachate and groundwater, and thus any connected surface water, is a vital component of the site's leachate management system (i.e., the take of groundwater is the directly connected to the need to manage the discharge of landfill leachate to groundwater, by seepage, through the base of the landfill). If the take does not occur, then leachate from the landfill is not captured and removed, resulting in the discharge of leachate into the surrounding environment, which includes the Kaikorai Stream and the Wetland-Estuary. The take must operate as long as the active management of the leachate

Objectives and Policies	Comment
	being generated at the landfill is required, which is throughout the aftercare period.

In the context of the continued take of underground water which contains landfill leachate and associated groundwater (and any connected surface water), and based on the above assessment, the closed landfill activities for which resource consents are being sought by application are considered to not be contrary with the relevant objectives and policies of the Water Plan.

8.8 Regional Plan: Coast for Otago

The Coastal Plan, became operative in 2001, with one plan change and one amendment arising from the NZCPS having become operative since that time. The purpose of the Coastal Plan, as stated in the plan, is to provide a framework for the integrated and sustainable management of Otago's CMA.

As stated in **Section 4.1** of this application, while the Fairfield closed landfill site is not located within the CMA, it does adjoin the Kaikorai Lagoon Swamp (the Wetland), which in turn adjoins the Kaikorai Estuary which is located within the CMA. In addition, the Estuary is identified in Schedule 2.1 of the Coastal Plan as a Coastal Protection Area (CPA 22).

Given the stated purpose of the Coastal Plan and given that none of the closed landfill activities are taking place within the CMA, the following objectives are considered to be relevant to this application:

- **Chapter 6 – Cross Boundary Issues**. The relevant objective is as follows:

  > ***Objective 6.3.1*** *- To avoid, remedy or mitigate the adverse effects of activities crossing the boundary line of mean high water springs.*

- **Chapter 10 – Discharges.** The relevant objectives are as follows:

  > ***Objective 10.3.3*** *- To safeguard the life-supporting capacity of Otago's coastal marine area.*
  >
  > ***Objective 10.3.4*** *- To enhance water quality in:*
  > *(a) Coastal protection areas; and …*

- **Chapter 14 – Natural Hazards.** The relevant objective is as follows:

  > ***Objective 14.3.1*** *- To take into account the potential adverse effects of natural hazards within and adjacent to Otago's coastal marine area when considering the use, development or protection of the area.*

As assessed in **Section 6** of this application, the effects associated with the closed landfill activities, given the active management of the landfill leachate and gas being generated at the site and the requirements of the proposed conditions (including monitoring requirements) provided in **Appendix 8** of this application, are being avoided, remedied or mitigated. On this basis, while it is acknowledged that the estuary is degraded, it is considered that the existing life-supporting capacity of the estuary will be safeguarded. In addition, given that the landfill is closed and therefore the reduction and cessation of the site discharges will occur over time, the activities for which resource consent are being sought by this application will also contribute to the enhancement of water quality in the estuary (which is a Coastal Protection Area).

The potential adverse effects, or risks, to the landfill site from coastal related natural hazards have been assessed in the Natural Hazard & Climate Assessment contained in **Appendix 6**. The assessment outlines a range of recommended response, management and monitoring actions in order to manage and mitigate the potential risks from natural hazards. Therefore, the potential adverse effects arising from natural hazards have been taken into account.

Therefore, the continuing closed landfill discharges and take of landfill leachate (and associated groundwater), which are the subject of this application, are considered to be consistent with (and not contrary to) the policy framework, where relevant, of the Coastal Plan.

8.9 Regional Plan: Air for Otago

The Air Plan became fully operative in 2003, with three plan changes having become operative since that time. The purpose of the Air Plan, as stated in the plan, is to promote the sustainable management of Otago's air resource and to assist the ORC in carrying out is functions under the RMA.

As stated in **Section 4.1** of this application, and Section 16.2.2 of the Air Plan itself, the Air Plan rules do not apply to the discharge of contaminants to air from closed landfills. While the rules do not regulate the closed landfill's discharge to air, the objectives and policies of the Air Plan are potentially relevant.

While Air Plan objectives and policies are not dissimilar to the PORPS 2019 and PORPS 2021 air resource related objectives and policies assessed in **Tables 1 and 2** above, an assessment of Air Plan objectives and policies has also been carried out below. Relevant objectives and policies include:

- **Objective 6.1.2** seeks to avoid adverse localised effects from air discharges on: human health; cultural, heritage and amenity values; ecosystems and the plants and animals within them; and, the life supporting capacity of air.
- Relevant policies in support of this objective seek to:
    - Recognise and provide for the relationship that Kāi Tahu have with the air resource (**Policy 7.1.1**).
    - In considering applications to discharge contaminants to air, have particular regard to avoiding adverse effects on the values/matters listed in Objective 6.1.2, as well as Kāi Tahu values, while also having regard to any existing discharge from the site and its effects (**Policy 8.2.3**).
    - To avoid discharges which are noxious, dangerous, offensive or objectionable on the surrounding environment (**Policy 8.2.8**).
    - In relation to odour, avoid or mitigate any adverse effects on human health or amenity values from the discharge of offensive or objectionable odour, including through the use of good management practices and appropriate control technologies (**Policy 11.1.1**).

As assessed in the Air Quality Assessment (**Appendix 4**), and overviewed in **Section 6.3** of this application, it is considered that overall, provided the various mitigation and monitoring measures that are proposed for managing landfill gas and minimising odour are in place, the discharges to air from the Fairfield closed landfill will have less than minor air quality effects. The mitigation and management measures outlined in Section 7 of the Air Quality Assessment have been incorporated into the proposed consent conditions provided in **Appendix 8** of this application.

In relation to the relationship that Kāi Tahu have with the area's air resource, as outlined in **Section 6.6** of this application, Waste Management have consulted with Te Rūnanga, with an outcome of that consultation being that Aukaha, on behalf of Te Rūnanga, are currently in the process of preparing a CIA (as outlined in the Aukaha Letter (**Appendix 3**)).

Therefore, the discharges to air from the Fairfield closed landfill are considered to be consistent with (and not contrary to) the policy framework, where relevant, of the Air Plan.

9 Other Matters (section 104(1)(c) of the RMA)

9.1 Kāi Tahu ki Otago Natural Resource Management Plan

The Kāi Tahu MP, published in 2005, is the principal planning document for the four Papatipu Rūnaka, and associated whānau and rōpū, of Kāi Tahu in the Otago region. The Fairfield closed landfill, which is the subject of this application, is located within the takiwā of Te Rūnanga o Otakou.

As described in **Section 6.6** of this application, and the Record of Consultation contained in (**Appendix 7**), an outcome of the consultation, to date, with Te Rūnanga, is that Aukaha have been engaged to prepare a CIA. The CIA is still being prepared, but will be submitted, as part of this application, once it is completed (refer to the Aukaha Letter – **Appendix 3**).

It is anticipated the CIA will assess, in the context of this application, the relevant objectives and policies of the Kāi Tahu MP. For this reason, an assessment of these provisions has not been provided, at this point in time, within this application. While an assessment has not been provided below, it is considered that the following objectives and policies of the Kāi Tahu MP are relevant to the application:

- The following Otago Regional objectives and policies, as contained in Chapter 5 of the Kāi Tahu MP:
    - Chapter 5.2 - Overall Objectives. Objectives (i) to (iv).
    - Chapter 5.3 - Wai Māori / 5.3.3 - Wai Māori General Objectives. Objectives (i), (ii) and (iv).
    - Chapter 5.3 - Wai Māori /5.3.4 - Wai Māori General Policies / Discharges. Policies 5.3.4.1, 5.3.4.2, 5.3.4.4, 5.3.4.9, 5.3.4.10, 5.3.4.12 to 5.3.4.15 and 5.3.4.18.
    - Chapter 5.3 - Wai Māori /5.3.4 - Wai Māori General Policies / Water Extractions. Policies 5.3.4.22, 5.3.4.23 and 5.3.4.25.
    - Chapter 5.5 - Mahika Kai and Biodiversity / 5.5.3 - Mahika Kai and Biodiversity Objectives. Objectives (i) to (v).
    - Chapter 5.5 - Mahika Kai and Biodiversity / 5.5.4 - Mahika Kai and Biodiversity General Policies. Policies 5.5.4.7 and 5.5.4.12.
    - Chapter 5.6 - Cultural Landscapes / 5.6.4 – Cultural Landscapes General Policies / Landscapes. Policies 5.6.4.22 and 5.6.4.23.
    - Chapter 5.7 – Air and Atmosphere / 5.7.2 – Objectives. Objectives (i) and (iii).
    - Chapter 5.8 - Coastal Environment / 5.8.3 - Taku Tai Moana Me Wai Māori Objectives. Objectives (i) and (ii).
    - Chapter 5.8 - Coastal Environment 5.8.4 / Taku Tai Moana Me Wai Māori Policies / Discharges. Policy 5.8.4.8.

- As the closed landfill is located within the 'Otago Harbour Catchment', Policy 8.4.3.1, contained in Chapter 8 of the Kāi Tahu MP is also relevant. This policy aims to identify and protect mahika kai sites of importance to rūnaka.

9.2 Dunedin City Council's Waste Minimisation and Management Plan 2020 / Te Mahere Whakamimiti Para

DCC released its WMM Plan, in accordance with its obligations under the Waste Minimisation Act 2008, and to outline its high level strategy for waste minimisation and management in the site, along with its implementation pathways.

Of potential relevance to the Fairfield closed landfill is Objective 7 of the WMM Plan which is as follows:

> *All open and closed landfills in Dunedin District have been identified and are operating in accordance with industry best practice.*

The policy in support of this objective identifies that DCC will support Council in reviewing its Waste Plan.

Waste Management's Fairfield closed landfill has been' identified' in accordance with Objective 7 of the WMM Plan, in that its existence is 'known' by both the DCC and Council. In fact, the landfill is identified on Council's HAIL Database as a closed landfill. Also, as assessed in Section 7 of this application, it is considered that while the landfill is no longer operating, the control and management systems that are place represent best practice, in the context of decisions that were made at the time the landfills were established and developed.

10 Consultation and Notification

10.1 Consultation

Prior to the lodgement of this application, Waste Management have consulted with a number of interested and potentially affected parties[36] in relation to the resource consents being sought by this application.

The parties consulted include: Te Rūnanga o Ōtākou (**Te Rūnanga**) (via Aukaha); nearby residents ('the local community'); Te Whatu Ora/Health New Zealand – Public Health (**Public Health**); the Department of Conservation (**DOC**); Otago Fish and Game Council (**F&G**); and, Royal Forest and Bird Protection Society of New Zealand (**F&B**). A 'Record of Consultation' with these parties provided in **Appendix 7** of this application. This record should be referred to as it provides an overview of the consultation that has been carried out, and other relevant notes or comments.

Outcomes of the consultation that has been carried out by Waste Management, that it is is considered is relevant to the processing application, include the following:

- As outlined in **Section 6.6** of this application, it was agreed that a CIA would be prepared by Aukaha, on behalf of Te Rūnanga, in relation to the resource consents being sought by

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[36] Waste Management discussed with the ORC, during a pre-application meeting held on 13 September 2022, who may be interested or affected parties in the context of this application. Waste Management have subsequently consulted with all the parties, as outlined in **Section 10.1** of this application, identified during the pre-application meeting with ORC.

this application. As outlined in the Aukaha Letter (**Appendix 3**), the CIA is still being prepared.

- Public Health have advised (via an email dated 10 October 2023), following receipt of the assessments now contained in **Appendices 3 to 6** of this application, that they support the management controls that are in place, and the proposed monitoring, and have nothing further to add (at that point in time).
- Of the residents and neighbours invited, via a letter drop in the area, to register their interest in this resource consent process, only two did so. One of these residents advised that as the landfill was now closed, issues that they had experienced in the past were no longer occurring. This resident then expressed an interest in the 'long-term' vision for the area, including the Wetland and Estuary. The second resident advised that their main interest related to ensuring that the landfill site does not adversely affect the amenity they enjoy from their home. Following a discussion with Waste Management, who provided an overview of what is and will happen at the now closed landfill, this second resident advised that they no longer needed to receive any further information in relation to this resource consent process.

In addition, to the interested and affected party consultation, Waste Management also met with ORC personnel as well as their technical advisors/reviewers. The initial pre-application meeting was held on 13 September 2022, with a second pre-application meeting held on 9 November 2023.

10.2 Notification

10.2.1 Introduction

Sections 95A to 95E of the RMA outlines the decision process to be followed by consent authorities in deciding the notification pathway, and identifying affected persons, for applications in accordance with the RMA.

10.2.2 Public Notification

Section 95A of the RMA outlines the steps to be followed when deciding whether or not to publicly notify an application. Waste Management has not requested public notification and the requirements of section 95A(3)(b) and (c) of the RMA do not apply (Step 1). The activity is not for a controlled activity (section 95A(5)(b)(i) of the RMA), nor is it covered by the other subsections in Step 2. Public notification is not required by the rules which apply to the activity (section 95A(8)(a) of the RMA), the effects of activities for which resource consents being sought are not more than minor (section 95A(8)(b) and 95D of the RMA).

If an application has not been publicly notified as a result of any of the previous steps, under section 95A(9) of the RMA, the consent authority is required to determine whether special circumstances exist that warrant it being publicly notified.

"Special circumstances" have been defined as *"something…outside the common run of things which is exceptional, abnormal or unusual but less than extraordinary or unique. A special circumstance would be one which makes notification desirable despite the general provisions excluding the need for notification."* (Far North District Council v Te Runanga-a-Iwi o Ngati Kahu [2013] NZCA 221 at [36]).

In this case there are no special circumstances that are considered to warrant public notification of the application (section 95A(9) of the RMA). A closed landfill is not exceptional, abnormal, or unusual.

Based on the above notification assessment, public notification of this application is not required.

10.2.3 Limited Notification

Although public notification is not required, section 95A(9)(b) requires the provisions of section 95B to be assessed to determine whether or not limited notification is required.

While the activities for which resource consent is sought does not affect any of the groups or persons listed under section 95(2), the Estuary, which adjoins the Wetland that adjoins the landfill, is in Te Tai o Arai Te Uru (Otago CMA) SAA and therefore section 95B(3)(a) applies. For the time being, given that a CIA is still being prepared by Aukaha, it is considered that Te Rūnanga should be considered an affected person in accordance with sections 95B(3)(b) and 95E.

The application is not one where limited notification is precluded under the 'certain circumstances' outlined in section 95B(6) of the RMA, a section 95B(7) of the RMA, under Step 3, does not apply to this application;

It is also considered that special circumstances do not apply that warrant notification to other parties not already identified (section 95B(10) of the RMA).

10.2.4 Section 95E

If the application is not publicly notified and limited notification is not otherwise precluded, a consent authority must undertake an assessment in accordance with section 95E and decide if there are any affected persons, and give limited notification to those persons. A person is affected if the effects of the activity on that person are minor or more than minor (but not less than minor).

In deciding who is an affected person under section 95E:

- adverse effects permitted by a rule in a plan or NES may be disregarded;
- only those effects that relate to a matter of control or discretion can be considered (in the case of restricted discretionary or controlled activities);
- the adverse effects on those persons who have provided their written approval must be disregarded; and
- must have regard to every relevant statutory acknowledgement made in accordance with an Act specified in Schedule 11 of the RMA.

As the adverse effects on any person (except for Te Rūnanga), in accordance with section 95E, is not minor or more than minor, the application can be processed on a limited notified basis with Te Rūnanga being notified of the application.

While reaching the above notification conclusion within this application, it is acknowledged that ORC will be responsible for determining the notification pathway for this resource consent application.

11 Proposed Conditions

The proposed conditions provided in **Appendix 8** are generally based on the conditions attached to the existing resource consents (Consents 95008 and 93540 to 93542 – **Appendix 1**) which currently authorise the discharge and take activities from the Fairfield closed landfill.

However, the proposed conditions have been amended from those attached to the existing resource consents to reflect:

- The fact that the landfill is now closed.
- The need for the resource consents to reflect the changes to the nature of the activities, and thus the management of the discharges and take, that will occur during the site's aftercare period.
- Recommendations contained in the assessments contained in **Appendices 4 to 6**.
- The nature of conditions that the ORC now tends to attach to consents compared to when the existing consents were granted.

Further additions or amendments to the conditions may be proposed, following the lodgement of this application, to address or respond to the outcomes and recommendations of the CIA (which was still being prepared at the time this application was lodged).

12 Conclusion

Waste Management 'operates' the Fairfield closed landfill site, with landfilling at the site have commenced in 1967 (under a different owner), initially near the entrance to the site off Old Brighton Road. The landfill ceased disposing of waste material in July 2017, and the final closure requirements (i.e., capping, gas flare installation etc), in accordance with the requirements of Consent RM18.066.01, were completed in August 2022.

Although the landfill is now closed, new regional resource consents are required to authorise the ongoing discharge of landfill leachate, discharge of landfill gas to air, discharge of stormwater to the Stream and Wetland, as well as the take of underground water containing leachate which forms a key component of the site's leachate management system. for these ongoing activities from the closed Western and Eastern Landfills. These activities are a critical component of the site's aftercare activities as they play a crucial role in managing, and removing from the environment, landfill leachate and landfill gas which will continue to be generated, albeit at reducing volumes, as the waste material in the landfill decomposes. Waste Management is therefore applying, through this application, for resource consents for these activities. A 30-year consent term, which reflects the aftercare period for the closed landfill, is being sought.

The ongoing potential effects associated with the closed landfill's discharge and take activities are assessed in **Section 6** of this application and the technical assessments contained in **Appendices 4 to 6**. The ongoing effects on Kāi Tahu values will be considered and assessed in the CIA currently being prepared by Aukaha, on behalf of Te Rūnanga. The findings of the effects assessment conclude that as the site's landfilling activity have ceased, and given that the landfill leachate and landfill gas are controlled and managed such that the discharge of leachate and gas to the environment is minimised and, as the landfill is closed, over time the volume of leachate generated will be reduced and ultimately cease. Accordingly, the effects on the environment associated with the closed landfill's discharge and take activities will also reduce and cease, in time, resulting in the improvement, where degraded (i.e., the Wetland-Estuary), in the quality of the environment. There are also positive effects, as outlined in **Section 6.7** of this application, associated with associated with the resource consents being sought by this application.

The closed landfill's continued discharge and take activities, during the 30-year aftercare period, as assessed in **Section 8** of the application, have also been assessed as not being contrary to, and thus consistent with, the relevant objectives and policies of the relevant statutory planning document. Also, there is no barrier to granting the discharge permit to discharge landfill gas to air arising from the NES-AQ.

The closed landfill's discharge and take activities, which are the subject of this application, play an important role in ensuring that the closed landfill continues to be managed in a safe and efficient manner, thus ensuring that the well-being of the local community is being provided for. Failing to authorise these ongoing activities, given the management measures in place for the active management of leachate and landfill gas during the landfill's aftercare period, will have detrimental effects on environmental, social and cultural values, and thus would not provide for the sustainable management of the area's natural resources. In addition, as assessed in **Section 6** of this application, given the nature of the discharges and take, the management and treatment systems that are in place, and the fact that over time the discharges will diminish and thus the take will no longer be required, the actual and potential effects of the aftercare activities at the landfill are appropriately avoided or mitigated such that any effects on people and the environment are minimal. Therefore, adverse effects on the environment will continue to be avoided, remedied or mitigated such that the existing life-supporting capacity of the environment surrounding the Fairfield landfill site and Kaikorai Lagoon Swamp are safeguarded and sustained for future generations, if not improved.

Overall, the ongoing aftercare discharge and take activities at the Fairfield closed landfill, given the control and management systems that are in place and which are incorporated into the proposed consent conditions (**Appendix 8**), provides for the sustainable management of the area's natural resources as sought by the relevant planning documents and therefore is in accordance with the purpose and principles of Part 2 of the RMA.

APPENDIX 1:

Existing Resource Consents

(Consents 95008 and 93540 to 93542)

A518488 Consent No: 95008.V1

DISCHARGE PERMIT

Pursuant to Section 105 of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: [~~Fulton Hogan Limited~~] Transferred 21 August 2000
Address: [~~Private Bag 1962, Dunedin~~]

Name: [~~EnviroWaste Services Limited~~] *Transferred 2 November 2009*
Address: [~~Private Bag 92810, Penrose, Auckland~~]

Name: *Waste Management Limited previously known as Transpacific Industries Group New Zealand Limited*
Address: *86 Lunn Avenue, Mt Wellington, Auckland*

to discharge landfill gas, odour and dust to air, resulting from the operation of a landfill

for a term expiring 1 September 2024

Location: Fairfield, adjacent to the Kaikorai Estuary, approximately 1 km off Old Brighton Road

Legal description of land at discharge point: Part Lot C DP 1685

Map reference: In the vicinity of NZMS 260: I, J44:085-745

Conditions:

1. The consent holder shall operate the landfill in accordance with the development and management procedures specified in the discharge permit applications, and the Landfill Management Plan prepared pursuant to consents 93540, 93541 & 93542. Development and management of the landfill shall be consistent with the Proposed Regional Plan : Waste. The landfill management plan shall be reviewed at least annually or at such lesser frequency as the Otago Regional Council may approve.

2. The consent holder shall adopt the best practicable option to avoid and/or mitigate any adverse effects on the environment resulting from the discharge of contaminants to air. This shall require that the consent holder operate, supervise and maintain the landfill and monitor the discharges so as to ensure that any adverse effect on the environment is avoided or mitigated.

3. Beyond the boundary of the landfill site there shall be no odour caused by discharges from the site which, in the opinion of an enforcement officer of the Otago Regional Council, is objectionable or offensive.

4. Dust emissions shall be kept to a practicable minimum. The consent holder shall

ensure that dust emissions from the site do not create nuisance conditions beyond the boundary which, in the opinion of an enforcement officer of the Otago Regional Council, are objectionable or offensive.

In complying with this condition the consent holder shall seal the access road within 6 months of the date of this consent.

5. The consent holder shall not dispose of any material in the landfill by burning. Should any fire arise in the landfill it shall be extinguished as soon as is practicable upon being detected.

6. The consent holder shall undertake monthly inspections of the landfill site for evidence of landfill gas such as odours, gas bubbling in puddles, or fissures in the landfill cover. The consent holder shall record the results of these inspections and make these results available to the Otago Regional Council on request. Where a potential nuisance or hazard is identified, the consent holder shall investigate and remedy or mitigate the nuisance or hazard.

7. *Quarterly* monitoring for methane levels shall be undertaken *in January, April, July and October at the locations identified as LGS1, LS4, LD5, LGS7, LGS27, LGS29, LS31, LS32, G34, G35 (cesspit), G36, G37, G38 and shown on attached plans*. ~~at two monthly intervals at the following general localities. The exact positions and number of monitoring sites shall be determined in consultation with the Otago Regional Council :~~

~~(a) an existing monitoring borehole towards the centre of the landfill, eg Borehole 4~~
~~(b) at points within the leachate collection trench around the perimeter of the landfill~~
~~(c) at points along the boundary between the landfill site and the nearest residential enclave.~~

Where a potential nuisance or hazard is identified, the consent holder shall investigate and remedy or mitigate the nuisance or hazard. The consent holder shall *forward quarterly monitoring results before the end of February, May, August and November respectively. Notwithstanding this, the Council shall be notified immediately if any sudden adverse change in gas levels is detected or if a trend of increasing gas is indicated.* ~~provide the Otago Regional Council with the results of the gas monitoring programme at 6 monthly intervals. After the first year of the exercise of this consent, the consent holder may, under S127 of the Act, apply to the Otago Regional Council to have the sampling frequency and number of sampling sites reduced should the monitoring data demonstrate that there is unlikely to be nuisance or hazard created by landfill gas.~~

8. All sampling procedures, including collection and transportation of samples, and laboratory analysis undertaken in connection with this permit must be performed either to standards and procedures approved in advance by the consent authority in writing or, where appropriate, by a laboratory Telarc registered to undertake the required tests and procedures, to the approval of the Manager, Otago Regional Council.

9. At five yearly intervals upon the date of issue of this consent the consent holder shall provide a report to the Otago Regional Council fully reviewing the exercise of the

consent and compliance with consent conditions.

10. The Otago Regional Council may, within 3 months of each anniversary of the date of this consent, in accordance with S129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent for the purposes of determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage.

First issued at Dunedin on the 3rd day of November 1997
Reissued at Dunedin this 13th day of September 2000 to reflect transfer of holder
Resissued at Dunedin this 5th day of February 2002 to reflect variation of conditions.
Reissued at Dunedin this 23rd day of December 2009 to reflect transfer of holder and update legal description of land at site of landfill
Reissued this 29th day of August 2011 to reflect the inclusion of the variation which was omitted from transferred consent issued on 23rd day of December 2009

Julene Ludlow
Manager Resource Management Administration

Our Reference: A302789 Consent No: 93540.V1

DISCHARGE PERMIT

Pursuant to Section 105 of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: [~~Fulton Hogan Limited~~] Transferred 21 August 2000
Address: [~~Private Bag 1962, Dunedin~~]

Name: [~~EnviroWaste Services Limited~~] *Transferred 2 November 2009*
Address: [~~Private Bag 92810, Penrose, Auckland~~]

Name: *Waste Management NZ Limited previously known as Transpacific Industries Group New Zealand Limited*
Address: *86 Lunn Avenue, Mt Wellington, Auckland*

to discharge up to 103 cubic metres per day of landfill leachate to groundwater by seepage through the 21 hectares area being the base of the landfill bounded by the leachate

for a term expiring 1 September 2024

for the purpose of controlling landfill leachate

Legal description of land at site of landfill: Part Lot C, DP 1685 (adjacent to the Kaikorai Estuary approximately 1 km off Old Brighton Road).

Map reference at or about NZMS 260 I,J:44:085-745

Conditions:

1. The waters and bed sediments of the Kaikorai Stream and estuary shall be substantially free of contaminants, due to activities of the Fairfield landfill conducted after the first exercise of this permit, as determined by the results of conditions 11 and 12 of this permit, which adversely affect humans, plans, animals or aquatic life.

2. The groundwater outside of the landfill and leachate collection system shall at all times be substantially free of contaminants, due to activities of the Fairfield landfill conducted after the first exercise of this permit, as determined by the results of conditions 8, 10 and 11 of this permit which adversely affect directly or indirectly water uses or adversely effect humans, plants, animals or aquatic life.

3. The location of the leachate collection system and location and number of shallow

and deep groundwater monitoring bores shall be determined in consultation with the Regional Council with the assistance of data derived from a resistivity study which shall be carried out prior to the first exercise of this permit.

4. The leachate collector drain shall be installed and pumped to maintain a depression in the phreatic (zone of saturation) groundwater level surface at all times. The depression of the phreatic surface shall be sufficient to cause the drain to intercept phreatic groundwater which would, ordinarily, have flowed outward from the drain to adjacent groundwater and the Kaikorai Stream or associated water bodies. The presence of the depression shall be determined by measuring the slope of the phreatic groundwater level between the leachate collector drain and fluid level in the landfill. The slope shall be inward, towards the collector drain at all times.

5. During installation of the leachate collection trench the geology of the area surrounding the trench shall be physically assessed and logged, including an appropriate photographic record, and the Regional Council shall be notified of any problems encountered. Where necessary (due to high permeability of the ground form) appropriate additional monitoring wells and/or systems to prevent outflow of leachate from the collector trench shall be installed.

6. This consent shall be exercised in conformity with a Landfill Management Plan prepared by the consent holder to the satisfaction of the Otago Regional Council. The Management Plan shall be prepared within 6 months of the first exercise of this consent and shall thereafter be reviewed at least annually or at such lesser frequency as the Regional Council may approve. The initial Management Plan shall:

   a) Present projections and intentions for landfill operations in relation to the future exercise of this consent (including: actions to minimise the working face, litter control, vermin and bird control, leachate collection, disposal and treatment, sampling and analytical protocols, management and control of hazardous wastes (including toxic, biological, medical and radioactive wastes) and stormwater management and monitoring). This section shall include reference to proposed measures to maximise recycling of leachate over the landfill where appropriate.

   b) Describe sequencing of works, procedures to be adopted during construction and filling, and the maintenance and management of facilities.

   c) Describe measures to be taken so that the conditions of this consent will be met at all times, and so that adverse effects on natural water are avoided or mitigated.

   d) Describe the precautionary measures that prevent unauthorised discharges or other adverse effects on natural water and present a contingency plan which will describe how any event will be managed so as to avoid or mitigate any adverse effects on natural water.

   e) Describe any additional monitoring necessary to identify the impacts of the exercise of this consent, and means of effective avoidance or mitigation of adverse effects both during the operational life, and post closure, of the landfill.

7. *The consent holder shall undertake quarterly monitoring in January, April, July and October and annual monitoring in October.*

With the exception of continuous monitoring results, the consent holder shall forward all quarterly monitoring results (as outlined in conditions 8 - 12 below) to the Council before the end of February, May, August and November respectively. Notwithstanding this, the Council shall be notified immediately if adverse trends are identified.

~~7~~8. Monitoring Groundwater Levels:
~~The consent holder shall establish a network of shallow and deep groundwater bores (the final location and number of which shall be determined with the assistance of data from the resistivity study specified in special condition 3.) and, during one day each week, measure and record the groundwater level in each of the wells:~~
The consent holder shall, once every three months (as specified in condition 7), measure and record the groundwater level at each of the locations listed below and shown on attached plans:

a) Leachate collection system - ~~monitoring water level in each of the sumps, in the collector trench midway between each of the sumps, and at each end of the collector system~~ *LS23, LS24, LS25, LS26, LGS27, LS28, LGS29, LS30, LS31, LS32, LS33.*

b) Groundwater outside landfill and collection system – ~~monitor both shallow and deep groundwater levels outside of the landfill and leachate collection system. One shallow well type shall be located adjacent to the collection trench and midway between each of the sumps (ie. giving a total of 6-8 external shallow wells). The wells should be 5 to 20 metres distance away from the leachate collection trench. In addition, a total of four deep well types shall be located at representative sites outside the landfill. One of the sites shall be at the east side of the landfill between the collector drain and the Kaikorai Stream. The others shall be along the south side of the landfill.~~

~~If locations of high permeability (eg. gravel or coarse sand) is known a sampling well shall be installed outside the leachate collection system in this location. (Number and location of these monitoring bores is also dependent on resistivity study as specified by condition 3)~~ *LGS1, LGS7, LS10, LS13, LS15, LS19, LS22, LD8, LD11, LD17, LD20.*

c) Surface water outside landfill and collector system – in situations where the "outside landfill groundwater wells" are located adjacent to Kaikorai Stream, the water level in the stream shall be monitored and recorded.

d) Leachate and deep groundwater within landfill - ~~monitor and record both shallow leachate and deep groundwater levels within the landfill and leachate collection system. Two shallow well types shall be located within the landfill in such a position that these are representative of the leachate level~~ *LS2, LS3, LS4, LS6, LS9, LS12, LS14, LS18, LS21, LD5, LD16.*

~~In addition, there shall be two deep groundwater well types within the landfill, one at each end of the site, and located to represent deep groundwater levels and chemistry (Number and location of these monitoring bores is also dependent on resistivity study).~~

~~The results shall be forwarded to the Council at three monthly intervals and the Council shall be notified immediately if outward gradients are identified.~~

~~8~~9. During installation of monitoring bores bore log information shall be collected by the consent holder and made available to the Regional Council on request.

~~9~~10. Monitoring Pumped Leachate/Groundwater Volume:
The consent holder shall continuously monitor and record the flow of the pumped discharge from the combined leachate collection sumps.

The results shall be forwarded to the Regional Council at three monthly intervals *as specified in condition 7. Notwithstanding this, the Council shall be notified immediately if adverse trends are identified.*

~~10~~11. Monitoring Leachate Chemistry:
(a) Combined leachate discharge – the consent holder shall, ~~at least annually (but once every three months for the first year)~~ *in October each year*, collect a representative sample of the combined groundwater/leachate pumped from the leachate collector sumps (prior to discharge). The sample shall be analysed for:

Calcium
Potassium
Bicarbonate
Sulphate
Conductivity
BOD_5
Nitrate
Lead
Cation/anion ratio
Magnesium
Sodium
Chloride
pH
COD
Ammonia
Iron
Zinc

If the combined leachate is discharged to the DCC sewer then on one occasion in each two year period the following parameters in the sample shall also be analysed:

USEPA priority pollutants (as for 1994 schedule)
Whole effluent toxicity screening using appropriate sensitive marine species

(b) Leachate collection system sumps and shallow and deep groundwater/leachate wells – the consent holder shall, once every ~~week~~ *three months on the same day as the level monitoring in condition 8*, collect a representative sample of the groundwater/leachate from each of:

- The leachate collection ~~pump~~ *system* sumps *identified as LS24, LS26, LS28, LS30 and LS32.*
- The shallow and deep groundwater wells outside the landfill and leachate collection trench *identified as LGS1, LGS7, LS10, LS13, LS15, LS19, LS22, LD8, LD11, LD17, LD20.*
- ~~The shallow and deep groundwater/leachate wells within the landfill.~~

The sample shall be analysed for:
pH
Conductivity
Ammoniacal nitrogen
Chloride
Temperature

On one occasion each year, during ~~September or~~ October, the following parameters shall also be analysed in each of the deep groundwater wells *identified as LD5, LD8, LD11, LD16, LD17, LD20*:

Calcium
Potassium
~~Bicarbonate~~*Alkalinity*
Sulphate
Conductivity
~~Ammonia~~*Ammoniacal nitrogen*
Iron
Zinc
Temperature

Magnesium
Sodium
Chloride
pH
BOD_5
Nitrate
Lead
~~Cation/anion ratio~~

An anion cation balance shall be calculated. If this is outside the range 90% to 100% then the individual results shall be reviewed and if necessary the tests repeated.

~~The results shall be forwarded to the Regional Council at 3 monthly intervals and the Council shall be notified immediately if any sudden change in chemistry is detected or if a trend of increasing concentration is indicated.~~

~~11~~12. Monitoring Kaikorai Estuary:
The consent holder shall, once every 3 months, collect a representative water sample from each of 3 sites in the Kaikorai Estuary.

The 3 water monitoring sites as depicted on the accompanying plan to this consent are:

~~FH4a~~FH39 west end of landfill
~~FH7~~FH40 present site in estuary
~~FH8 near Kaikorai Stream~~
EW43 Kaikorai Stream upstream of landfill

The samples shall be analysed for the following parameters:

Chloride
Conductivity
~~Ammonia~~*Ammoniacal nitrogen*
Iron
Zinc
Temperature

pH
BOD_5
Nitrate
Lead
Dissolved oxygen

~~On each occasion at the time of sampling, the consent holder shall estimate the flow in the Kaikorai Stream, record the water level, the tidal stage, rainfall over the past 7 days (from nearest existing recorder) and whether the estuary mouth is open or closed.~~

~~The results of each monitoring occasion shall be forwarded to the Regional Council within 3 months of sample collection and the Regional Council shall be notified immediately if a trend of increasing concentration is indicated.~~

If monitoring data indicates adverse effects on water quality directly attributable to landfill leachate entering the Kaikorai Estuary, the consent holder shall institute appropriate abatement procedures to avoid or mitigate these effects.

~~12~~13. Section 128 Review:
In accordance with S128 of the Resource Management Act 1991, the conditions of this consent may be reviewed on and in the period within 3 months upon each annual anniversary of the date of this consent, if, on reasonable grounds, the consent authority finds that:

there is or is likely to be an environmental effect as a result of the exercise of this consent, which was unforeseen when the consent was granted

monitoring of the exercise of the consent has revealed that there is or is likely to be an adverse effect on the environment

there has been a change in circumstances such that the conditions of the consent are no longer appropriate in terms of the purpose of the above Act.

~~13~~14. Five Yearly Report:
At five yearly intervals upon the date of issue of this consent the consent holder shall provide a report to the Regional Council fully reviewing the exercise of the consent and compliance with special conditions.

~~14~~15. All laboratory analyses undertaken in connection with this permit must be performed at a Telarc registered laboratory or otherwise as specifically approved by the Regional Council in writing.

~~15~~16.Closure Management Plan:
Prior to the expiry or surrender of this consent, the consent holder shall prepare a management, monitoring and contingency plan for the future management of the landfill and shall seek appropriate consents for any ongoing activity as required by the Resource Management Act 1991.

~~16~~17. Archaeological Record:
The consent holder shall record the presence and location of any items of archaeological significance found on the site and provide this record to the affected Runanga.

~~17~~18. Bond provisions:
The consent holder shall execute and maintain in existence a performance and annual monitoring bond to enable the monitoring requirements of this consent to be continued and the landfill to be closed should the consent holder not be in a position to continue monitoring or operating the site with a surety to the value of $200,000 for a period of 20 years.

Issued at Dunedin this 12th day of May 1995.
Reissued at Dunedin this 13th day of September 2000 to reflect transfer of holder.
Reissued at Dunedin this 5th day of February 2002 to reflect variation of conditions
Reissued at Dunedin this 23rd day of December 2009 to reflect transfer of holder and update legal description of land at site of landfill
Reissued this 29th day of August 2011 to reflect the inclusion of the variation which was omitted from transferred consent issued on 23rd day of December 2009

Julene Ludlow
Manager Resource Management Administration

A518485 Consent No: 93541.V1

WATER PERMIT

Pursuant to Section 105 of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: [~~Fulton Hogan Limited~~] Transferred 21 August 2000
Address: [~~Private Bag 1962, Dunedin~~]

Name: [~~EnviroWaste Services Limited~~] *Transferred 2 November 2009*
Address: [~~Private Bag 92810, Penrose, Auckland~~]

Name: *Waste Management NZ Limited previously known as Transpacific Industries Group New Zealand Limited*
Address: *86 Lunn Avenue, Mt Wellington, Auckland*

to take underground water containing leachate and other groundwater at a rate of 20,000 litres per hour (and not exceeding 72,000 litres per hour)

for a term expiring 1 September 2024

for the purpose of control of landfill leachate and to maintain the groundwater within the contained landfill area at a lower level than within the surrounding land

Legal description of land at site of landfill: Part Lot C, DP 1685 (adjacent to the Kaikorai Estuary approximately 1 km off Old Brighton Road).

Map reference at or about: NZMS 260:I,J:44:085-745

Conditions:

1. Landfill Management Plan:
   This consent shall be exercised in conformity with a Landfill Management Plan prepared by the consent holder to the satisfaction of the Otago Regional Council. The Management Plan shall be prepared within 6 months of the first exercise of this consent and shall thereafter be reviewed at least annually or at such lesser frequency as the Regional Council may approved.

   The Management Plan shall:
   a) Present projections and intentions for landfill operations in relation to the future exercise of this consent (including leachate collection, leachate recycling, disposal and treatment, sampling and analytical protocols).

   b) Describe sequencing of works, procedures to be adopted during construction and the maintenance and management of facilities.

c) Describe measures to be taken so that the conditions of this consent will be met at all times, and that adverse effects on natural water are avoided or mitigated.

d) Describe the precautionary measures that prevent unauthorised discharges or other adverse effects on natural water and present a contingency plan which will describe how any such event will be managed so as to avoid or mitigate any adverse effects on natural water.

e) Describe any additional monitoring necessary to identify the impacts of the exercise of this consent, and means of effective avoidance or mitigation of adverse effects, both during and post closure of the landfill.

2. Monitoring Pumped Leachate/Groundwater Volume

The consent holder shall continuously monitor and record the flow of the pumped discharge from the combined landfill leachate collection sumps undertaken pursuant to special condition ~~10~~*11* of permit 93540. ~~The results shall be forwarded to the Regional Council at 3 monthly intervals~~. *The consent holder shall forward the results to the Council on a quarterly basis in February, May, August and November and the Council shall be notified immediately if adverse trends are identified.*

3. 5 Yearly Report:

At five yearly intervals upon the date of issue of this consent the consent holder shall provide a report to the Regional Council fully reviewing the exercise of the consent and compliance with special conditions.

4. Section 128 Review:

In accordance with S128 of the Resource Management Act 1991, the conditions of this consent may be reviewed on and in the period within 3 months upon each annual anniversary of the date of this consent, if, on reasonable grounds, the consent authority finds that:

- there is or is likely to be an adverse environmental effect as a result of the exercise of this consent, which was unforeseen when the consent was granted

- monitoring of the exercise of the consent has revealed that there is or is likely to be an adverse effect on the environment

- there has been a change in circumstances such that the conditions of the consent are no longer appropriate in terms of the purpose of the above Act.

5. Closure Management Plan:

Prior to the expiry or surrender of this consent, the consent holder shall prepare a management, monitoring and contingency plan for the future management of the landfill and shall seek appropriate consents for any ongoing activity as required by the Resource Management Act 1991.

6. Archaeological Record:

The consent holder shall record the presence and location of any items of archaeological significance found on the site and provide this record to the affected

Runanga.

7. Bond provisions:
The consent holder shall execute and maintain in existence a performance and annual monitoring bond to enable the monitoring requirements of this consent to be continued and the landfill to be closed should the consent holder not be in a position to continue monitoring or operating the site with a surety to the value of $200,000 for a period of 20 years.

Issued at Dunedin this 12th day of May 1995
Reissued at Dunedin this 13th day of September 2000 to reflect transfer of holder.
Reissued at Dunedin this 5th day of February 2002 to reflect variation of conditions
Reissued at Dunedin this 23rd day of December 2009 to reflect transfer of holder and update legal description of land at site of landfill
Reissued this 29th day of August 2011 to reflect the inclusion of the variation which was omitted from transferred consent issued on 23rd day of December 2009

Julene Ludlow
Manager Resource Management Administration

Our Reference: Consent No. 93542

DISCHARGE PERMIT

Pursuant to Section 105 of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: [~~Fulton Hogan Limited~~] (transferred 21.8.2000)

Address: [~~Private Bag 1962, Dunedin~~]

Name: [~~Enviro Waste Services Limited~~] transferred 2 November 2009

Address: [~~Private Bag 92810, Penrose, Auckland]~~

Name: *Waste Management NZ Limited previously known as Transpacific Industries Group New Zealand Limited*

Address: *86 Lunn Avenue, Mt Wellington, Auckland*

to discharge up to 3,400 cubic metres per day of stormwater runoff diverted from non-working areas of the landfill into the Kaikorai Stream after treatment through silt retention ponds

for a term expiring 1 September 2024

for the purpose of controlling the effects of this stormwater discharge

Legal description of land at site of landfill: Part Lot C, DP 1685 (adjacent to the Kaikorai Estuary approximately 1 km off Old Brighton Road).

Map reference at or about NZMS 260 I,J44:085745

Conditions

1. Landfill Management Plan:

   This consent shall be exercised in conformity with a Landfill Management Plan prepared by the consent holder to the satisfaction of the Otago Regional Council. The Management Plan shall be prepared within 6 months of the first exercise of this consent and shall thereafter be reviewed at least annually or at such lesser frequency as the Regional Council may approve.

   The Management Plan shall:

   a) Present projections and intentions for landfill operations in relation to the future exercise of this consent (including intentions to minimise the working face, sampling and analytical protocols and stormwater management and monitoring).

b) Describe sequencing of works, procedures to be adopted during construction and the maintenance and management of facilities.

c) Describe measures to be taken so that the conditions of this consent will be met at all times, and that adverse effects on natural water are avoided or mitigated.

d) Describe the precautionary measures that prevent unauthorised discharges or other adverse effects on natural water and present a contingency plan which will describe how any such event will be managed so as to avoid or mitigate any adverse effects on natural water.

e) Describe any additional monitoring necessary to identify the impacts of the exercise of this consent, and means of effective avoidance or mitigation of adverse effects, both during and post closure of the landfill.

2. Appropriate silt retention ponds shall be in place prior to the exercise of this consent.

3. All silt retention ponds shall be designed for the runoff arising from storms having a return period of 1 in 2 years with a design storm duration of 24 hours.

4. The consent holder shall ensure that all practicable steps are taken to prevent contamination of stormwater by suspended solids or exposed landfill material or runoff by using appropriate landfill management practices.

5. Works associated with the exercise of this consent shall be designed, constructed and maintained in accordance with best engineering standards in consultation with the Regional Council. All designs shall be subject to the approval of the Regional Council prior to construction.

6. Monitoring Silt Pond Discharge:
The consent holder shall, once every three months, collect a representative sample of the discharge from each of the silt ponds. The sample shall be analysed for:

- pH
- BOD_5
- Turbidity
- Conductivity
- Ammonia
- Suspended Solids

The results shall be forwarded to the Regional Council within 3 months of sample collection and the Regional Council shall be notified immediately if a sudden change is detected or if a trend of increasing concentration is indicated.

7. All laboratory analyses undertaken in connection with this permit must be performed at a Telarc registered laboratory or otherwise specifically approved by the Regional Council in writing.

8. Section 128 Review:
In accordance with S128 of the Resource Management Act 1991, the conditions of this consent may be reviewed on and in the period within 3 months upon each annual anniversary of the date of this consent, if, on reasonable grounds, the consent authority finds that:

-there is or is likely to be an adverse environmental effect as a result of the exercise of this consent, which was unforeseen when the consent was granted

-monitoring of the exercise of the consent has revealed that there is or is likely to be an adverse effect on the environment

-there has been a change in circumstances such that the conditions of the consent are no longer appropriate in terms of the purpose of the above Act.

9. 5 Yearly Report:
At five yearly intervals upon the date of issue of this consent the consent holder shall provide a report to the Regional Council fully reviewing the exercise of the consent and compliance with special conditions

10. Closure Management Plan:
Prior to the expiry of surrender of this consent, the consent holder shall prepare a management, monitoring and contingency plan for the future management of the landfill and shall seek appropriate consents for any ongoing activity as required by the Resource Management Act 1991.

11. Archaelogical Record:
The consent holder shall record the presence and location of any items of archaeological significance found on the site and provide this record to the affected Runanga.

12. Bond provisions:
The consent holder shall execute and maintain in existence a performance and annual monitoring bond to enable the monitoring requirements of this consent to be continued and the landfill to be closed should the consent holder not be in a position to continue monitoring or operating the site with a surety to the value of $200,000 for a period of 20 years

First issued at Dunedin on the 12th day of May 1995
Reissued at Dunedin this 13th day of September 2000 to reflect transfer of holder
Reissued at Dunedin this 22nd day of December 2009 to reflect transfer of holder

Julene Ludlow
Manager Resource Management Administration

APPENDIX 2:

Draft Aftercare Management Plan

Document titled ‘Fairfield Aftercare Management Plan (Draft)’
prepared by Waste Management NZ Limited, dated 27 February 2024

Waste Management

Fairfield Aftercare Management Plan (Draft)

27 February 2024

Document Control Register

IMPORTANT NOTE:

This draft ‘Aftercare Management Plan’ forms an appendix to the resource consent application seeking new regional resource consents for ongoing discharge and take activities, during the aftercare period, at the closed landfill.

As this draft plan has yet not been finalised, or certified, in accordance with the conditions that it is anticipated will be attached to the new regional resource consents, the following ‘Document Control Register’ has not been completed. This register will be completed when the plan is finalised and certified, and also when any amended plan is finalised and certified.

Copy #	**Organisation**	**Person**	**Date**
Electronic pdf	Waste Management NZ Limited	David Fitzmaurice Senior Project Engineer	
Electronic pdf	Waste Management NZ Limited	Greg Nel Regional Manager Dunedin Waste Management South Island	
Electronic pdf	Otago Regional Council	TBC	

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IMPORTANT NOTE:

This is a draft ‘Aftercare Management Plan’ which forms an appendix to the resource consent application seeking new regional resource consents for ongoing discharge and take activities, during the aftercare period, at the closed landfill.

This is not a finalised, or certified, Aftercare Management Plan. An updated plan will be prepared once the new regional resource consents have been granted, with the updated plan addressing all of the relevant resource consent condition requirements. It is anticipated that the Otago Regional Council will then certify the plan, and once the plan is certified, Waste Management NZ Limited will operate the closed landfill in accordance with the requirements of the certified Aftercare Management Plan.

Until a certified Aftercare Management Plan is in place, Waste Management NZ Limited will continue to operate the site in accordance with the site’s ‘Closure Management Plan’ (dated 16 August 2022) required by the conditions of the site’s existing regional resource consent. The Closure Management Plan contains aftercare provisions that are similar to those provided in this draft Aftercare Management Plan.

1. INTRODUCTION

1.4 Objectives

The purpose of the Aftercare Management Plan (AMP) is to describe activities and management during the post-closure care, or ‘aftercare’, period of the Fairfield Landfill.

The landfill was closed to general waste disposal on 30 June 2017. This date marked the beginning of a ‘post-closure’ care period which will last for a minimum of 30 years (Ministry for the Environment, 2001). Final closure works were completed in August 2022, which moves the status, or phase, of the landfill into the aftercare period. The aftercare period predominantly entails maintenance and monitoring activities.

This AMP covers the whole site area, including the Eastern and Western landfill.

The site will be managed by Waste Management NZ Limited (Waste Management), trading as Otago Waste Services (OWS).

1.5 Site history

In summary:

- 1967 Landfill opened by Walton Park Sand Co (subsidiary of Fulton Hogan) off Old Brighton Road following demand from within Taieri County
- 1960s, 1970s, 1980s Landfilling continued and progressed eastwards
- 1985 Operations taken over by Maxwell Brothers (subsidiary of Fulton Hogan) and Landfill Management Plan prepared
- 1991, 1993, 1995 Resource consent applications sought for the Eastern Landfill.
- 1996 Ownership transferred to Tartan Industries Limited (subsidiary of Fulton Hogan)
- 1996 Operations taken over by Envirowaste Services Ltd
- 1996 Western Landfill closed to general waste
- 1996 Eastern Landfill opened
- 2006 Ownership of Tartan Industries Ltd transferred to Envirowaste Services Ltd
- 2008 Ownership of Envirowaste Services Ltd transferred to Transpacific Industries Group (NZ) Ltd (now known as Waste Management NZ Limited)
- 2017 (30/6/17) Eastern Landfill closed to general waste

Land titles

Legal description	**Area (ha)**	**Owner**	**Comments**
Lot 2 DP566541 (RT1021375)	29.9415	Tartan Industries Limited, a subsidiary of Waste Management NZ Limited	Easement Instrument 12281925.4, in favour of the Dunedin City Council to drain sewage and convey water. Right of way created by Easement Instrument 12281925.5.
Part Lot B DP 1685 (RT OT8D/1045)	30.9061	Tartan Industries Limited, a subsidiary of Waste Management NZ Limited	Easement as dominant tenement by 511438 Transfer over DP 7227 CT OT352/110. Contains historic Fulton Hogan landfill.
Pt Sec 41 Blk VIII Dunedin & East Taieri SD DP 7227 (RT OT352/110)	4.7538ha	Tartan Industries Limited, a subsidiary of Waste Management NZ Limited	Contains Right of Way from Old Brighton Road to the old landfill property

1.6 Management structure

The site management organisation structure is shown in Appendix 8.6 Organisation chart.

1.7 Existing site description

The site lies in the suburb of Fairfield, Dunedin. Site plans are in Appendix 8.1.

The features of the site and the surrounding land include:

- Fairfield Eastern Closed Landfill on the eastern part of the site
- Fairfield Closed Western Landfill on the middle part of the site and to the west of the Eastern Landfill
- Kaikorai Stream bordering the site to the east
- Estuarine lowland / wetland on the southern part of the site
- Buffer vegetation zone across the northern edge of the Eastern Landfill
- Undeveloped land, but residentially zoned land, to the north of the Eastern Landfill.
- Neighbouring farmland to the southwest
- Neighbouring bush reserve and residential suburb to the northwest

1.8 Post-Closure Timeline

Date	**Activity**	**Consents**
2017	Closure of the Eastern Landfill to general waste.	
2017 - 2022	Eastern Landfill closure and site restoration activities completed, including capping, topsoiling, planting fencing and gas control.	ORC Consent RM18.066.01and the Closure Management Plan under that consent.
2023 onwards	Start of aftercare period (as described in Section 4 of this Plan)	ORC Consents 95008 and 93540 to 93542 which expire on 1 September 2024. Replacement regional resource consents [insert consent number].
TBA	Switch to low-care passive gas treatment system (i.e., without flaring) at Eastern Landfill. The nature of the passive treatment system will be determined and designed closer to the time to switch (i.e., to reflect the most appropriate technology, which at present could be a vented pipe/s). Transfer to a ‘passive’ system is expected to occur at least 10 to 15 years after landfill closure (i.e., 2032) but will depend on a reduction in the volume of LFG being directed to the flares to the extent that flaring is no longer viable (i.e., there is insufficient LFG to sustain the operation of a single flare). According to the flare manufacturer, the minimum LFG volumetric flow rate that can be accommodated by a single flare (Solar-Spark CF-10 flares) is 5 cubic feet per minute (cfm) according to manufacturer specifications[1]. In units of cubic metres per hour (m^3/hr) this is 8.5 m^3/hr.	[Relevant consent reference to be inserted]
TBA	Switch to low-care passive leachate treatment system, possibly with gravity discharge (i.e., no active removal of leachate, via pumping, from the leachate interception trench). Timing for the transfer to a passive treatment system will occur based on an assessment of monitoring data. Key criteria for transferring to passive system will revolve around the volume of leachate being generated (i.e., minimal to none) and any off-site effects that may result if leachate interception is ceased.	[Relevant consent reference to be inserted]
TBA	Open for public recreation, or other potential future use (depending on any residual risks and liabilities associated with the landfill in the context of the potential future use).	

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2. REGULATORY REQUIREMENTS

2.1 Summary

Appendix 8.1.3 Location of Western and Eastern Landfill can be used as a reference to this section.

Eastern Landfill Only
The disposal of waste materials to land, and cleanfill for landfill closure, have been authorised by way of discharge permits issued by ORC. The initial discharge permit, Consent 95007, was issued in 1996 with the consent expiring on 1 September 2018. A second short term discharge permit (Consent RM18.066.01) was applied for in 2018, and subsequently granted, to authorise the discharge of cleanfill (hardfill) and capping material to land for the purpose of landfill closure. Consent RM18.066.01 expired on 1 March 2023.

Other resource consents issued by the ORC, as identified below under the heading ‘Eastern and Western Landfills’, also apply (or applied) to the Western Landfill.

The land use aspects of the landfill’s operations were permitted under operative Dunedin City District Plan (2006), which was notified in 1995, as a Scheduled Permitted Activity under Rules 6.5.2(v) and 6.5.8(v) and Appendix 6A. The 2nd Generation District Plan (2GP), which was notified in 2015 and which is not yet fully operative, does not contain a similar permitted activity rule. Existing use rights continue to apply to the site (RMA s10) once the 2GP becomes fully operative.

Eastern and Western Landfills
Various permits, granted by ORC, which expire on 1 September 2024, authorise the:

- Discharge of landfill gas, dust and odour to air (Consent 95008);
- Discharge of leachate to groundwater by seepage (Consent 93540);
- Take of underground water containing leachate and other groundwater (Consent 93541);
- Discharge of treated stormwater into the Kaikorai Stream and Kaikorai Lagoon Swamp (Consent 93542).

Conditions attached to these resource consents required site activities to be carried in accordance with a Landfill Management Plan (LMP), while conditions attached to some of these consents required a Closure Management Plan (CMP), including aftercare procedures, to be prepared prior to landfill closure.

New resource consents [insert no x], to continue discharge and take activities after closure of the landfill were lodged with ORC in 2024.

The ongoing post-closure district land use aspects of site activities continue to be provided for by existing use rights (RMA s10). If changes in land use or new activities (i.e., earthworks) were to occur at the site in the future, then resource consents may be required from ORC and/or DCC.

2.2 Operative Dunedin City District Plan 2006

Authority: Dunedin City Council.

Expiry: Indefinite, until superseded by 2GP (refer to Section 2.3 below). As the majority of the 2GP’s Rural Zone rules can be deemed to be operative, the provisions of this District Plan have effectively been superseded.

District Plan Maps 43, 44, 57 and 58 show:

- *Fairfield Eastern Landfill - zoned Rural*
- *Historic Fulton Hogan Fairfield Western Landfill - zoned Rural*
- *Kaikorai Stream border - esplanade reserve strip*
- *Estuarine lowland - zoned Rural/moderate flood hazard*
- *Undeveloped land on northern part of title - zoned Residential*

- *Whole of landfill site - no identified values such as significant tree or archaeological site*
- *Neighbouring farmland to the southwest - zoned Rural*
- *Neighbouring bush reserve to the northwest - zoned Rural*
- *Neighbouring residential suburb to the northwest - zoned Residential*

Rule 6.5.2(v) Permitted Activities which permits 'scheduled activities' listed in Rule 6.5.8. Rule 6.5.8 Scheduled Permitted Activities states:

> *(v) Landfill and activities associated with the operation of the landfill situated at:*
> *(a) EnviroWaste Fairfield Landfill confined to those areas marked "Landfill" and "Storage" in Appendix 6A on land known as Pt Lots B and C, DP 1685 (CTs 13B/390 and 8D/1045) and Lot 215 DP 16795 (CT328/116).*

Policies and Rules in the District Plan App. 6A address:

- *Closure Management Plan contents*
- *Sequence and timing*
- *Landscaping*
- *Monitoring*
- *Noise*
- *Hours of operation*
- *Screen planting*

2.3 2GP District Plan

Authority: Dunedin City Council.

Expiry: Indefinite, once made fully operative. All rules in the 2GP have legal effect, and the majority of provisions can be deemed to be operative.

Planning Maps are at https://apps.dunedin.govt.nz/webmaps/secondgenerationdistrictplan/

The Planning Maps show:

- The site is zoned Rural Coastal, with a Hazard 2 (flood) Overlay on parts of the site and a Hazard 2 (land instability) Overlay associated with the northwestern corner of the landholding.
- The site adjoins the Kaikorai Stream and Wetland-Estuary complex which is zoned Rural Coastal and has the following overlays: Area of Significant Conservation Value, Archaeological Alert Layer, Wahi Tupuna Mapped Area and Hazard 2 (flood) Overlay
- The undeveloped land to the north of the site is zoned Residential, with a Hazard 2 (flood) Overlay and Hazard 2 (land instability) Overlay associated with parts of the residentially zoned land.
- The neighbouring farmland to the southwest is zoned Rural Coastal, with a Hazard 2 (flood) Overlay on parts of the farmland.
- The neighbouring bush reserve to the northwest is zoned Recreation Reserve, with a Hazard 2 (land instability) Overlay on parts of the reserve.
- The neighbouring residential suburb to the northwest is zoned Residential, with a Hazard 2 (land instability) Overlay associated with parts of the residential suburb.

As the landfill is closed, and no earthworks or other activities (including change of use of the site) are occurring at the site, there is no requirement to assess 2GP rule applicability in relation to site activities. In addition, the site can continue to operate in accordance with existing use rights (RMA s10).

An assessment of 2GP rule applicability, and potentially the seeking of land use consents (if relevant), will occur if site activities change and/or new activities are proposed.

2.4 Regional Resource Consents

IMPORTANT NOTE:

As this draft plan has yet not been finalised, or certified, in accordance with the conditions that it is anticipated will be attached to the new regional resource consents, the following list of regional resource consents has not been updated. The following list will be completed when this plan is finalised, and certified, following the grant of the new regional resource consents for the site.

It is also noted that as the application for the new regional resource consents has been lodged six months prior to the expiry of the site's existing resource consents (as listed below), in accordance with section 124 of the Resource Management Act 1991, Waste Management NZ Limited will continue to operate the site in accordance with the resource consents listed below until a final on decision on the new regional resource consents has been made.

Authority: Otago Regional Council.

Expiry: As below.

Consent	Purpose	Expiry
Discharge Permit 93540_V1	To discharge leachate to groundwater	1 Sep 2024
Water Permit 93541_V1	To take groundwater containing leachate	1 Sep 2024
Discharge Permit 93542	To discharge stormwater to Kaikorai Stream	1 Sep 2024
Discharge Permit 95008_V1	To discharge gas, odour and dust to air	1 Sep 2024

The existing consents, which have not yet expired (Consents 95008 and 83450 to 93542), contain specific conditions of consent which Waste Management will continue to comply with until a final decision on the new regional resource consents, being sought by Waste Management, has been made.

2.5 Regulatory Requirements

2.5.1 Regional Plans

There are two regional plans that apply to the ongoing activities at the site's closed landfill. They are the Regional Plan: Waste for Otago (Waste Plan) and the Regional Plan: Water for Otago (Water Plan).

Waste Plan. Rule 7.6.1 applies to the Eastern and Western closed landfills. Given the requirements of Rule 7.6.1, the following rules apply to the consent renewals for the Eastern and Western Landfills:

- Rule 7.6.1.1 - continued discharge of landfill leachate to groundwater by seepage.
- Rule 7.6.1.2 - continued discharge of stormwater into the Kaikorai Stream and Kaikorai Lagoon Swamp.
- Rule 7.6.1.3 - continued discharge of landfill gas, and associated odour, to air.

Section 7.6.1.1 lists the information requirements for resource consent applications under Rule 7.6.1, which includes a site-specific management plan prepared in accordance with relevant Waste Management Institute New Zealand technical guidelines. Section 7.6.1.2 lists the assessment matters for resource consent applications under Rule 7.6.1.

Water Plan. RMA 2020 amendments mean that the ORC must notify a new freshwater planning instrument no later than 31 December 2024 (however the new government has announced that it will extend the deadline to 31 December 2027 for councils to notify their new freshwater plans). The take of landfill leachate and groundwater at the landfills (currently authorised by Consent 93541) is regulated by the Water Plan. For the consent renewals process, this activity at the site, resource consent for this activity is being sought in accordance with Rule 10A.3.2.1 (non-complying activity) and Rule 12.2.4.1(i) (discretionary activity) of the Water Plan.

2.5.2 National Environmental Standards

There are three national environmental standards that are relevant to the site. They are the:

- Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (NES-AQ).
- Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-F).
- Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES-CS).

NES-AQ. The regulations contained in the NES-AQ apply to the discharges to air from landfills. The applicability of these regulations is assessed in the consent renewal application.

NES-F. As the site adjoins a Regional Significant Wetland (as identified in the Water Plan), which is a natural inland wetland, regulations of the NES-F trigger the need to seek resource consents for the discharges and groundwater take associated with the landfill where these activities occur within 100m of the natural inland wetland. These consent triggers are included, and assessed, in the closed landfill consent renewal application.

NES-CS. The site, given its past landfilling activities is a contaminated site (HAIL site) and is subject to the regulations of the NES-CS. Any future soil disturbance, subdivision or change of the use of the land at the site, will be subject to the NES-CS regulations. Present site activities do not require resource consent under the NES-CS regulations.

2.5.3 District Consent - Trade Waste

The current trade waste consent to discharge trade waste (leachate) to the public sewer (Consent No. 91) will expire on 4 October 2030. The trade waste consent will continue to apply during the aftercare periods, until such time as the landfill’s leachate system may be transferred to a passive system.

There is no requirement for a management plan.

3. CLOSED LANDFILLS

3.1 Eastern Landfill Closure and Capping

Waste disposal at the Eastern Landfill ceased in June 2017. Landfill closure and capping activities were completed in August 2022.

The geometry of the capped landfill consists of slope batters of 1:4 on the east and south batters and 1:3 on the north and west batters to conform with relevant consent conditions. The maximum height of the landfill is nominally RL 25m (top of batters are RL 24 and 25m contour is ~30m from the batter top, at closest point).

The soil profile for the landfill final cap, as specified in Consent 95007 Condition 7(c) is:

- 300 mm intermediate cover
- 300 mm additional cover
- 200 mm Topsoil
- 800 mm TOTAL (minimum)

Landfill capping was completed to a minimum of 800mm Intermediate plus additional cover (from local clay source), and 200mm of topsoil, providing a thickness of 1m. In practice the average clay thickness typically exceeds the target minimum on average. Thickness was confirmed by consultants, based on pre and post site contour surveys.

3.2 Western (Old) Landfill Capping

This part of the landfill has remained as it was left when general waste disposal ceased in the 1990s.

3.3 Stormwater

The site’s existing stormwater drainage system, including the northern and weighbridge stormwater pond, will be retained during the aftercare period and will be regularly inspected and maintained.

Grass strike has taken well, so risk of erosion in severe weather events has been significantly reduced. Monitoring will be undertaken on a regular basis to ensure that vegetation cover of the landfills, and the site generally, is maintained.

3.4 Leachate

During aftercare, the landfill will continue to produce leachate which will require ongoing pumping to the existing point of disposal to the DCC sewer. The annual quantity of leachate should reduce during the aftercare period as the waste material in the landfills continue to decompose.

The strength of the leachate is expected to reduce during the aftercare period and may eventually become innocuous, at which time the current pumping regime will be reviewed with the intention to switch to a passive leachate management system, where the leachate is no longer intercepted and removed from the site.

3.5 Landfill Gas

All 3 gas collection wells have been installed in the Eastern Landfill. The gas collection flares will continue to be operated throughout the aftercare period, for as long as it can sustain the operation of a single flare. The lower threshold for the volume of LFG that can be treated by a single flare of the type that have been installed (Solar Spark® CF-10)[2] at the site is 5 cubic feet per minute (CFM)

(equivalent to 8.5 m³/hr). At this stage, it is recommended that a smaller LFG flare be installed (i.e., a Solar Spark® CF-5 model), if considered necessary, which would enable flaring down to 2 CFM (equivalent to 3.4 m³/hr). This lower flow rate (i.e., 3.4 m³/hr) could then be the basis for the threshold below which flaring of gas would cease and passive venting of LFG would occur. Written notice of the intended change to a passive landfill gas management system will need to be provided to the ORC at least one month prior to the change.

The landfill gas monitoring will be undertaken monthly while gas is being flared.

At the point that flaring ceases, the residual LFG could be vented from a vent(s) with a rotating aspiromatic cowl fitted. These vents would extend at least 2m above ground level to provide for good air dispersion and dilution, and they should ideally be situated at a location off the ring-main that is as far as practicable from the residential areas to maximise the separation distances.

Given the amount of time that has elapsed since closure of the Western Landfill, the LFG generated from this landfill is at much lower levels and has insufficient levels to enable flaring of LFG. Therefore, LFG from the Western Landfill is discharged passively and no gas collection provisions for active management of LFG have been proposed or installed on the Western landfill.

The historical and proposed timelines for gas collection and treatment are as follows.

Timeline for gas collection from Eastern Landfill

Date	**Activity**
Pre 2007	Three Gas Vents drilled.
2009	CF-5 Solar-Spark Vent Flare supplied by Geotechnics Ltd installed by Waste Management to design shown in Drg FFL01/03/A. Connected to three vents.
2016	Drilling of 17 Gas Extraction Wells. Testing of yields.
2018	Installation of additional flare capacity depending on results of testing.
2018	Reassessment of alternative piping of gas to Green Island gas plant.
2022	3 new gas flares installed
TBA	Decommissioning of gas flaring when gas yield is insufficient to sustain a flame in a single flare. Replacement with a passive management system, as described above.

The gas well layout is shown on the site plan in Appendix 8.4.1 Reticulation Layout (2022).

3.6 Access

The access gate from Old Brighton Rd is now permanently locked.

Signs and gates from the main access from Old Brighton Rd, and the cul-de-sacs of Walton Park Ave and Blanc Ave will be maintained as required. Signs read “Private Property – public access is not permitted”.

Access to the site may be provided in the future as outlined in Section 6 of this AMP.

3.7 Retained Facilities

The facilities retained at the site during the aftercare period include:

- Infrastructure for gas and leachate
- Minor roads for access to key infrastructure
- Drainage systems relating to stormwater flow rates

3.8 Signs

During the aftercare period, a sign located at the site entrance on Old Brighton Road will provide a contact for anyone who wants to report an issue, organise an event or consider a commercial use. The site will not be open to the wider public during the aftercare period, but there be opportunity for use by various recreational or hobby groups. These are described in more detail in Section 6.

4. AFTERCARE

4.1 Checklist

#	**Topic**	
	Final Aftercare Management Plan (updated) ○ *Management structure* ○ *Projected aftercare period* ○ *Site ownership* ○ *Consent status and renewal schedule* ○ *Maintenance programme* ○ *Monitoring programme* ○ *Inspection programme* ○ *Communications lines - owner / manager / contractors / Council / community / Kāi Tahu* ○ *Complaints procedures* ○ *OSH provisions* ○ *Record keeping* ○ *Reporting programme*	
	Independent review	
	Archive of records - where and how	
	Rationalisation of land ownership	
	Definition of liabilities	
	Insurance	
	Low-care installations for passive gas and leachate treatment.	
	Aftercare maintenance programme, responsibilities & contract ○ *Gas infrastructure* ○ *Leachate infrastructure* ○ *Stormwater system* ○ *Vermin control* ○ *Fencing* ○ *Paths* ○ *Roads*	
	Aftercare monitoring programme, responsibilities & contract ○ *Gas* ○ *Leachate* ○ *Groundwater* ○ *Surface Water*	
	Emergency and contingency provisions	
	Future communication channels for all interests	
	Access control arrangements	

4.2 Maintenance schedules

The Aftercare period will be at least 30 years.

Specific requirements for monitoring and maintenance are set out in the consent conditions as listed in Appendix 8.6.

4.3 Conditions

This AMP is provided in compliance with the conditions of consent for the following consents:

A. Discharge Permit – Discharges to Air (consent no. [x])
B. Discharge Permit – Discharge of Landfill Leachate (consent no. [x])
C. Water Permit – Take of Groundwater containing Leachate and other groundwater (consent no. [x])
D. Discharge Permit – Discharge of Stormwater (consent no. [x])

As set out in the conditions, the purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by the above consents are avoided, remedied or mitigated.

The substantive requirements for the AMP are also provided within the conditions for the above consents. The table below sets out the requirements of the AMP, and where these are addressed within the AMP.

AMP Requirements (as per consent condition requirements)	**Relevant AMP Section**
a) Compliance with the conditions of Consents [to insert] to [to insert].	Throughout AMP and Appendix 8.6
b) The roles and responsibilities of parties with management and operational responsibilities at the site, including relevant contact details.	4.5
c) Site maintenance and inspection requirements, including during the different phases of the aftercare period.	4.2 and Appendix 8.6
d) The performance of the site infrastructure and environment monitoring requirements, including during the different phases of the aftercare period.	4.1, 4.2, 5 and Appendices 8.5 and 8.6
e) The criteria, or trigger levels, for changing from active management of the site's landfill leachate and landfill gas to a passive system, and a description of the stages or steps, including interim stages or steps, associated with the change from active to passive management of these systems.	1.8, 3.4 and 3.5
f) Emergency management and contingency procedures, including, but not limited to, from natural hazards such as site flooding.	5.2, 5.4 and Appendix 8.8
g) Recording and responding to complaints and incidents at the site.	5.3
h) The future use and management of the site, including, but not limited to, the basis for providing access to site by third parties.	6
i) Reviews of the AMP, which at a minimum, must occur: - at least every two years during the first 10 years of this consent, and thereafter at least every five years; and - whenever there is a significant change in the nature of site operations, which includes, but is not limited to, when the site changes from active to passive management of the landfill leachate and landfill gas.	4.4

4.4 Aftercare Management Plan Review

As required by the site's consent conditions, this AMP must be reviewed, at a minimum, as follows:

- at least every two years during the first 10 years of the new resource consents, and thereafter at least every five years; and
- whenever there is a significant change in the nature of site operations, which includes, but is not limited to, when the site changes from active to passive management of the landfill leachate and landfill gas.

The Regional Manager and Site Supervisor are responsible for ensuring the reviews are carried out in accordance with the consent conditions.

If the AMP is amended as a result of the review of the plan, the amended AMP must be provided to the ORC, for certification, as required by the consents.

4.5 Responsibilities

Responsible person	**Tasks**
Regional manager ***Contact details:*** [To be inserted]	Ensure that required consents are held. Assist with the preparation and submit reports to regulators. Pay rates and consent fees. Engage suitable site staff. AMP review.
Site supervisor ***Contact details:*** [To be inserted]	Site Supervisor reports directly to Regional Manager Host surveyors and visits by consultants and regulators. Maintain vegetation by grazing and mowing. Run a weed and pest control programme. Continue monitoring by staff and contractors/consultants as required. Liaise with the ORC where appropriate. Arrange access for recreational users. Run the site's H&S programme. Respond to complaints and maintain complaint register. AMP review.

5. MONITORING & CONTINGENCIES

IMPORTANT NOTE:

The following monitoring overview, and the associated appendices, reflect the proposed conditions contained in the resource consent renewal application.

It is also noted that as the application for the new regional resource consents has been lodged six months prior to the expiry of the site's existing resource consents, in accordance with section 124 of the Resource Management Act 1991, Waste Management NZ Limited will continue to monitor the site in accordance with the site's existing resource consents until a final on decision on the new regional resource consents has been made.

Specific purposes of monitoring leachate, groundwater and surface water are to demonstrate and provide:

- compliance with consent conditions
- confirmation that the landfill engineering measures (where these have been implemented) are operating as designed
- information on the processes occurring within the landfill site
- information on the state and rate of stabilisation of the waste
- an early warning of potential adverse environmental effects
- information to enable decisions on the management of the site to be taken
- a determination of the nature, extent and rate of migration of contaminants from the site

Monitoring is an essential part of the overall management system for the closed landfill.

5.1 Summary Table

The following table provides an overview of the initial monitoring regime for the closed landfill. The conditions attached to the resource consents provide for a reduced frequency, or cessation, of monitoring subject to an assessment by a suitably qualified and experienced person and provision of written notice of the change to the ORC.

Source	Type	Continuous	Monthly	Three-monthly (Jan, Apr, Jul, Oct)	Six-monthly (Jan and Jul)	Yearly	Other
Inspections							
Landfill	Structural integrity				X		And within two weeks of events listed in Condition X of Consent no. [x]
Landfill	Slope stability						Within 2-years, thereafter 5-yearly
Leachate system	Effective operation		X	X			
LFG	Uncontrolled discharges		X				
Stormwater system	Effective operation			X			

Source	Type	Continuous	Monthly	Three-monthly (Jan, Apr, Jul, Oct)	Six-monthly (Jan and Jul)	Yearly	Other
Monitoring (additional information provided in the subsequent table below)							
Leachate	Rate of take	X					Recorded at 15-minute intervals
Leachate (pumping chamber)	Levels	X		X (Data download)			Data at 15-minute intervals
Leachate (incl. groundwater and surface water sites)	Levels			X			
Leachate (interception drain)	Chemistry				X		
Leachate (pumping chamber)	Chemistry					X	
Groundwater	Chemistry				X		
Groundwater (deep wells)	Chemistry					X	
Surface waterbodies	Chemistry			X			
Surface waterbodies	Ecology					X	
LFG (Eastern Landfill)	Flow rate		X				
LFG (Eastern Landfill)	Composition		X				
LFG (monitoring wells)	Composition			X			
Ecology	Monitoring programme					X	For first 3-years, thereafter 5-yearly
Reporting							
Annual Report (By 30 Nov)	As per consent – all inspection, monitoring data, effects assessment, complaints and incidents etc.					X	

The table below provides more detail on the reporting and monitoring obligations under the consents.

Monitoring Type	**Reporting and/or monitoring requirements**
Ecology	The ecological monitoring programme, which is described in the conditions of consent no. [x], is to be carried out by an independent suitably qualified and experienced person. This monitoring is to occur annually, between the months of October to March, for the first three years of the commencement of consent no. [x], and thereafter once every five years.
Surface water bodies (Water Quality)	The monitoring locations are identified in the plans contained in Appendix 8.5. The three monthly (Jan, Apr, Jul and Oct) monitoring, at sampling locations SW1 to SW7, or relocated sampling locations confirmed by suitably qualified persons, are analysed for: • Salinity • Dissolved oxygen • BOD_5 • Total ammoniacal nitrogen • Temperature • Conductivity • pH • Calcium • Magnesium. • Sodium • Potassium • Chloride • Alkalinity • Sulphate • Nitrate • Phosphorus • Dissolved Reactive Phosphorus • Iron • Zinc • Lead Following each monitoring round, the following observations shall also be undertaken: • Estimate of flow in the Kaikorai Stream • Water level • Tidal stage • Previous 7 days rainfall • Whether the estuary mouth is open or not
Groundwater	The monitoring locations are identified in the plan contained in Appendix 8.5. Three monthly level monitoring, in Jan, Apr, Jul and Oct, is to be carried out at LGS1, LS2, LS6, LS9, LS14, LD5, LGS7, LS10, LS13, LS15, LS19, LS21A, LS22, LD8, LD11, LD17 and LD20. Six monthly, in January and July, groundwater collected from sampling locations LGS1, LGS7, LS10, LS13, LS15, LS19, LS22, LD8, LD11, LD17 and LD20 are to be analysed for: • pH • Conductivity • Temperature • Total ammoniacal nitrogen • Phosphorus • Dissolved reactive phosphorus • Chloride (**Note:** For the July monitoring round, the annual monitoring analysis applies to the samples collected from sampling locations LD8, LD11, LD17 and LD20) Annually, in July, groundwater collected from sampling locations LD5, LD8, LD11,

Monitoring Type	**Reporting and/or monitoring requirements**
	LD17 and LD20 are to be analysed for: • COD • BOD_5 • Total ammoniacal nitrogen • Temperature • Conductivity • pH • Calcium • Magnesium. • Sodium • Potassium • Chloride • Alkalinity • Sulphate • Nitrate • Phosphorus • Dissolved Reactive Phosphorus • Iron • Zinc • Lead
Leachate	The monitoring locations are identified in the plan contained in Appendix 8.5. **Leachate quantity and levels** A system to monitor and record the instantaneous abstraction rate of take, and water/leachate levels at EPS42, at 15-minute intervals are in place. Three monthly level monitoring, in Jan, Apr, Jul and Oct, is to be carried out at LS23, LS24, LS25, LS26, LGS27, LS28, LGS29, LS30, LS31, LS32, LS33 and EPS42. **Leachate quality** Six monthly, in January and July, leachate collected from sampling locations LS24, LS26, LS28, LS30 and LS32 are to be analysed for: • pH • Conductivity • Temperature • Total ammoniacal nitrogen • Phosphorus • Dissolved reactive phosphorus • Chloride Annually, in July, leachate collected from sampling location EPS42 are to be analysed for: • COD • BOD_5 • Total ammoniacal nitrogen • Temperature • Conductivity • pH • Calcium • Magnesium. • Sodium • Potassium • Chloride • Alkalinity • Sulphate • Nitrate • Phosphorus • Dissolved Reactive Phosphorus

Monitoring Type	**Reporting and/or monitoring requirements**
	• Iron • Zinc • Lead • Cation/anion ratio As required by the trade waste consent, the leachate shall also be analysed for: • USEPA priority pollutants • Whole effluent toxicity screening test
Gas	The monitoring locations are identified in the plan contained in Appendix 8.5. **Gas quantity** Monthly (at a minimum) measuring and recording of the flow rate of the landfill gas being flared. **Gas quality/composition** Monthly, while gas is being flared, monitoring from landfill gas flare/s and passive vent/s are to be analysed for: • Methane • Carbon dioxide • Oxygen • Carbon monoxide • Hydrogen sulphide Three monthly (Jan, Apr, Jul and Oct) monitoring, at sampling locations SW1 to SW7, from sampling locations LGS1, LD5, LGS7, LS21A, LGS27, LGS29, LS31, LS32, G34, G37, G38, MW1, MW2 and MW3, are to be analysed for: • Methane • Carbon dioxide • Oxygen • Carbon monoxide • Hydrogen sulphide

5.2 Contingency and Response Guidelines

Groundwater & surface water	• Annual report on all inspection and monitoring requirements. • Corrective actions take place to investigate and remedy or mitigate any adverse changes to groundwater or surface water. Outcomes of any corrective action taken reported to the ORC in the annual report. • A significant increase in leachate levels may be mitigated by checking pump performance and undertaking maintenance as required. The option of increasing the pumping rate by installing a higher capacity pump will be investigated.
Leachate	• Annual report on all inspection and monitoring requirements. • Biennial report with detail on USEPA priority pollutants and toxicity to DCC • Corrective actions take place to investigate and remedy or mitigate any adverse changes to leachate volumes or contaminant levels. Outcomes of any corrective action taken reported to the ORC in the annual report.
Gas – surface emission	• Annual report on all inspection and monitoring requirements. • Monthly inspections for evidence of landfill gas such as odours, gas bubbling in puddles, or fissures in the landfill cover are recorded. • Corrective actions take place to investigate and remedy or mitigate any adverse nuisance or hazard arising from landfill gas emission. Outcomes of any corrective actions taken reported to the ORC in the annual report.

Methane levels	• Annual report on all inspection and monitoring requirements. • Monitoring of methane levels at the each of the gas monitoring sites is undertaken quarterly while LFG is being flared. • Notify ORC, in a timely manner and no longer than 5 working days, after becoming aware of sudden adverse change in gas levels or if a trend of increasing gas is indicated. • Corrective actions take place to investigate and remedy or mitigate any adverse nuisance or hazard arising from landfill gas emission. Outcomes of any corrective action taken reported to the ORC in the annual report (unless notification noted above applies).

5.3 Complaints

During the aftercare period, OWS will continue to be the respondent to any complaint about the closed landfill. Provision will be made to make a complaint in a number of ways including in person, telephone, written form, SMS text, and email. The contact details for the regional manager and the site supervisor will be provided on a sign at the gate.

Any complaint received directly by OWS, or by ORC/DCC and relayed to OWS, requires a formal investigation regarding the likely causes and remedial actions, and a subsequent response from OWS. Where a complainant opts to contact ORC or DCC rather than OWS directly, the timeframe of 3 days for a verbal response (as set out below) might not be met given the potential for delays in having the message relayed to OWS from ORC/DCC.

The essential elements of the OWS's response procedure will be:

- Recording of details of the complainant, and time, date, and nature of complaint in OWS's incident record and response tracking system
- Investigation of the cause
- Remedial action
- Verbal response to the complainant within 3 days
- Recording of the outcome in an Incidents and Complaints Register which will be available to the ORC and DCC on request

A summary of details of any complaint will be recorded in an Incidents and Complaints Register, in accordance with the requirements of the consent conditions, and the register will be made available to ORC upon request. The annual report, to be provided to ORC, will contain the record of any complaints received, or incidents that have occurred, over the past 12-months.

5.4 Site Emergency Management Plan

The site maintains a SEMP to cover environmentally significant events such as fire, cyclone, landslip, and flood. The SEMP for the site is contained in Appendix 8.8.

5.5 Health and Safety

The site will maintain its own separate health and safety procedures as they are outside the mandate of this Aftercare Management Plan.

5.6 Reporting

Monthly
Every month a return of leachate volumes discharged will be forwarded to the Trade Waste Division, DCC.

Annual
The results of all monitoring must be provided to ORC as part of an annual report.

6. FUTURE USE

6.1 Activities

The site may potentially be available for use by sport, recreation, and hobby groups which would be able to use the site for low-impact recreation. Other recreational activities could be enabled and supported after consultation with the community, for example:

- *horse-riding*
- *off-leash dog walking*
- *bird-spotting*
- *bike-riding*
- *model aircraft*
- *archery*
- *outdoor entertainment events*
- *education and hobby science*

The site operator may allow access for a low-impact commercial enterprise such as grazing that is managed as a co-use with the public, with preference for activities that do not require resource consents.

Heavy grazing by cattle would not be allowed on the Eastern Landfill. Use of recreational firearms and fireworks will not be permitted due to dangers relating to landfill gas.

6.2 Community engagement

Waste Management will contact organisations and individuals who are likely to be interested in having a say on future use, including:

- *Dunedin City Council*
- *Kai Tahu*
- *The Saddle Hill Community Board*
- *Owners of adjoining properties*

6.3 Access control

Public access will be considered in the Aftercare period.

During Aftercare, parts of the site may be fenced off and locked to prevent casual pedestrian access where there is a risk of harm for example deep ponds, gas well heads, the flare, protected bush and leachate pump stations.

A visible sign will be retained at the site entrance to provide contact details for anyone who wants either to organise an event, or to start a commercial enterprise, or to discuss any issue about the site.

6.4 Progressive handover

There is potential for the land to be transferred to other parties on agreed terms, subject to a handover report that addresses residual environmental risks and liabilities, if any, and costs. The timing and final use of the land is dependent on negotiation and consultation with interested parties.

The site is not expected to be opened to the public in the early phases of the aftercare period.

Parts of the site may be considered for earlier handover depending on the progress of restoration, but no earlier date is guaranteed.

7. REFERENCES

IMPORTANT NOTE:

As this draft plan has yet not been finalised, or certified, in accordance with requirements of any new regional resource consents, this reference list has also not been updated. The following reference list may be updated when this plan is finalised, and certified, following the grant of the new regional resource consents for the site.

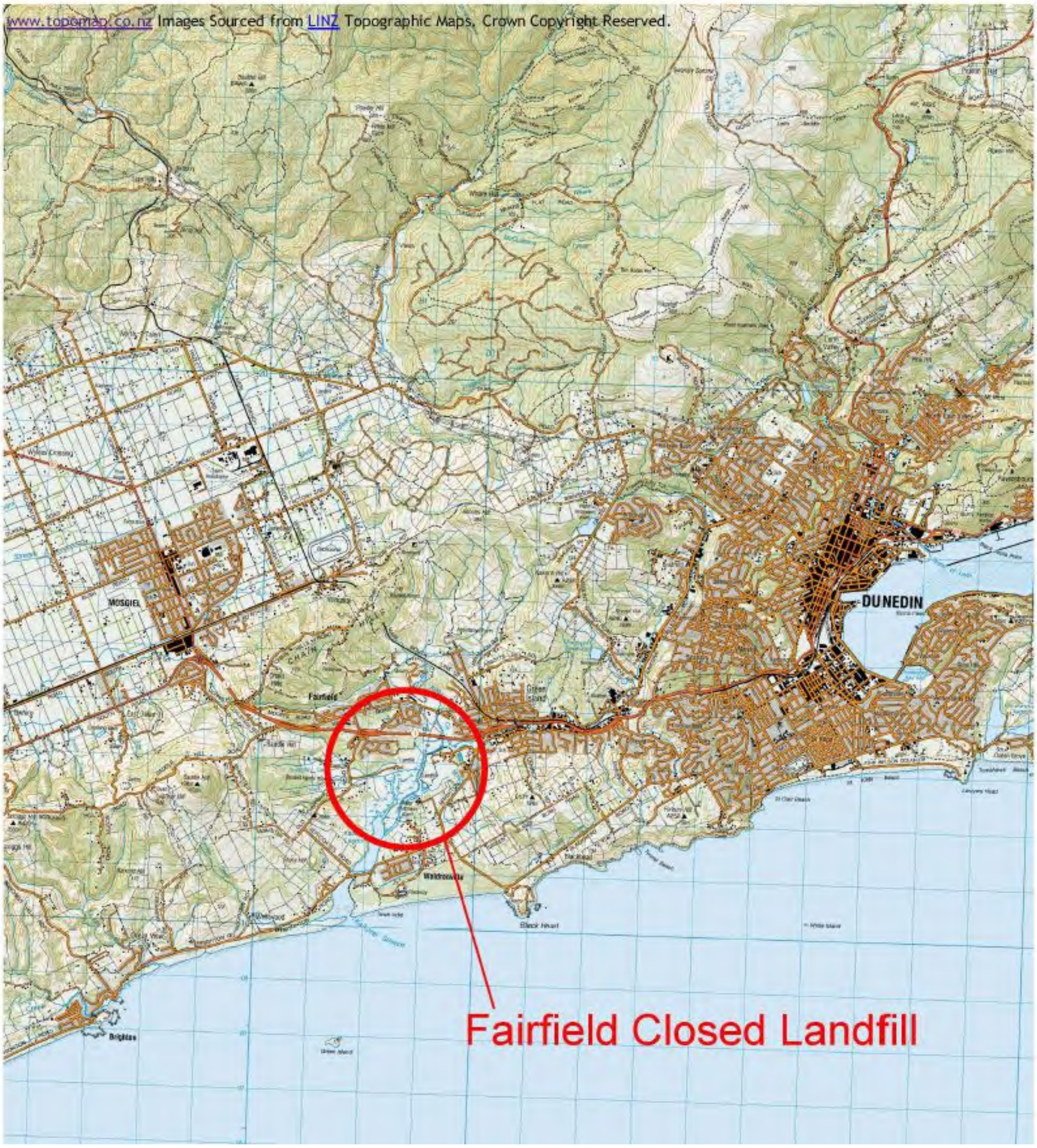
1	Beca Steven, 1993: Fairfield (Maxwells) Landfill Assessment of Environmental Effects. Supporting Documentation for Water and Discharge Permit Applications.
2	Ministry for the Environment, May 2001: A Guide for the Management of Closing and Closed Landfills in New Zealand.
3	WasteMinz Technical Guidelines for Disposal to Land (Rev 3.1 September 2023).

8. APPENDICES

8.1 Site location plans

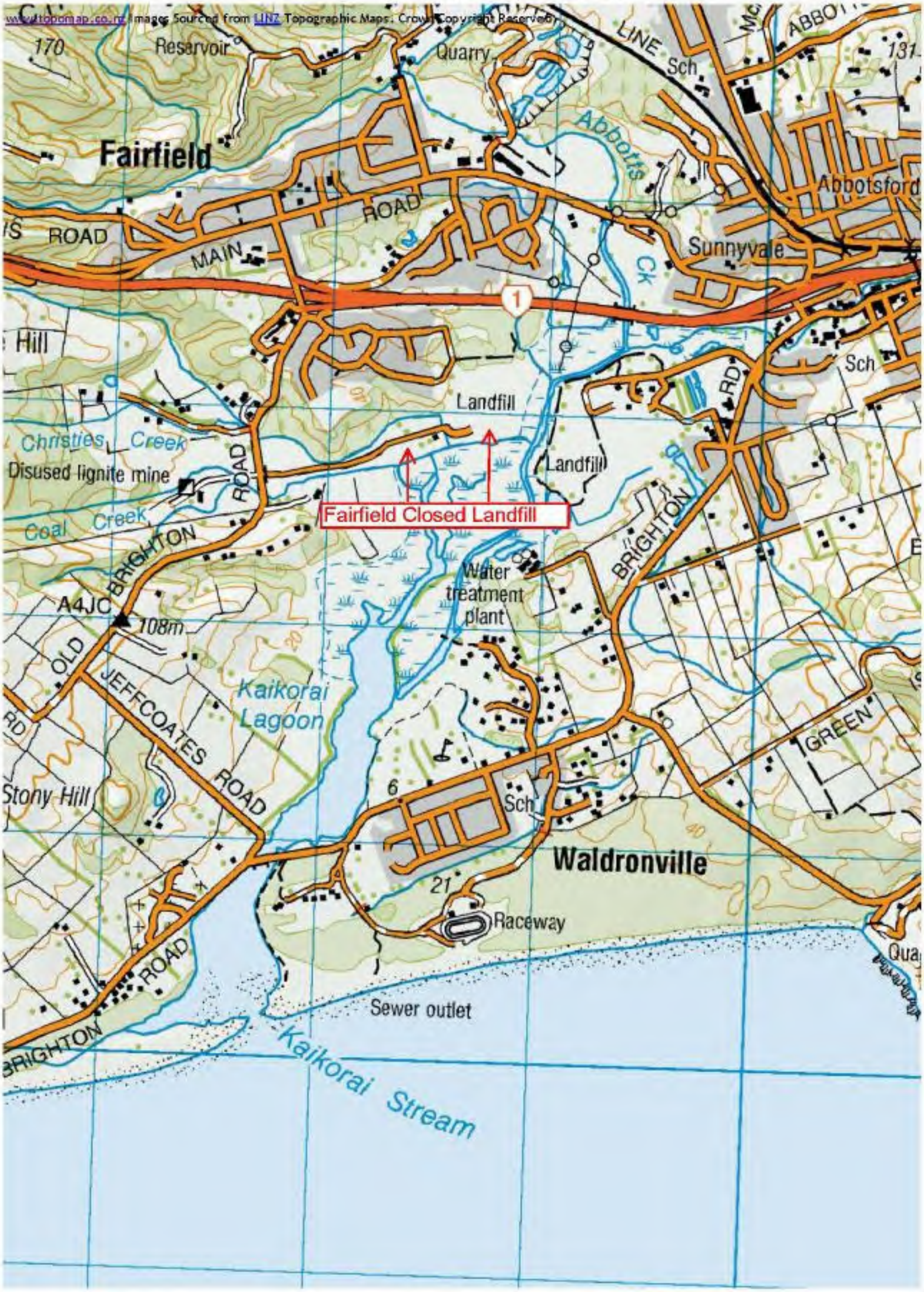
8.1.1 Regional site plan

10/30/2015 Printer Friendly Map Area - NZ Topo Map



8.1.2 Local site plan

10/30/2015 Printer Friendly Map Area - NZ Topo Map



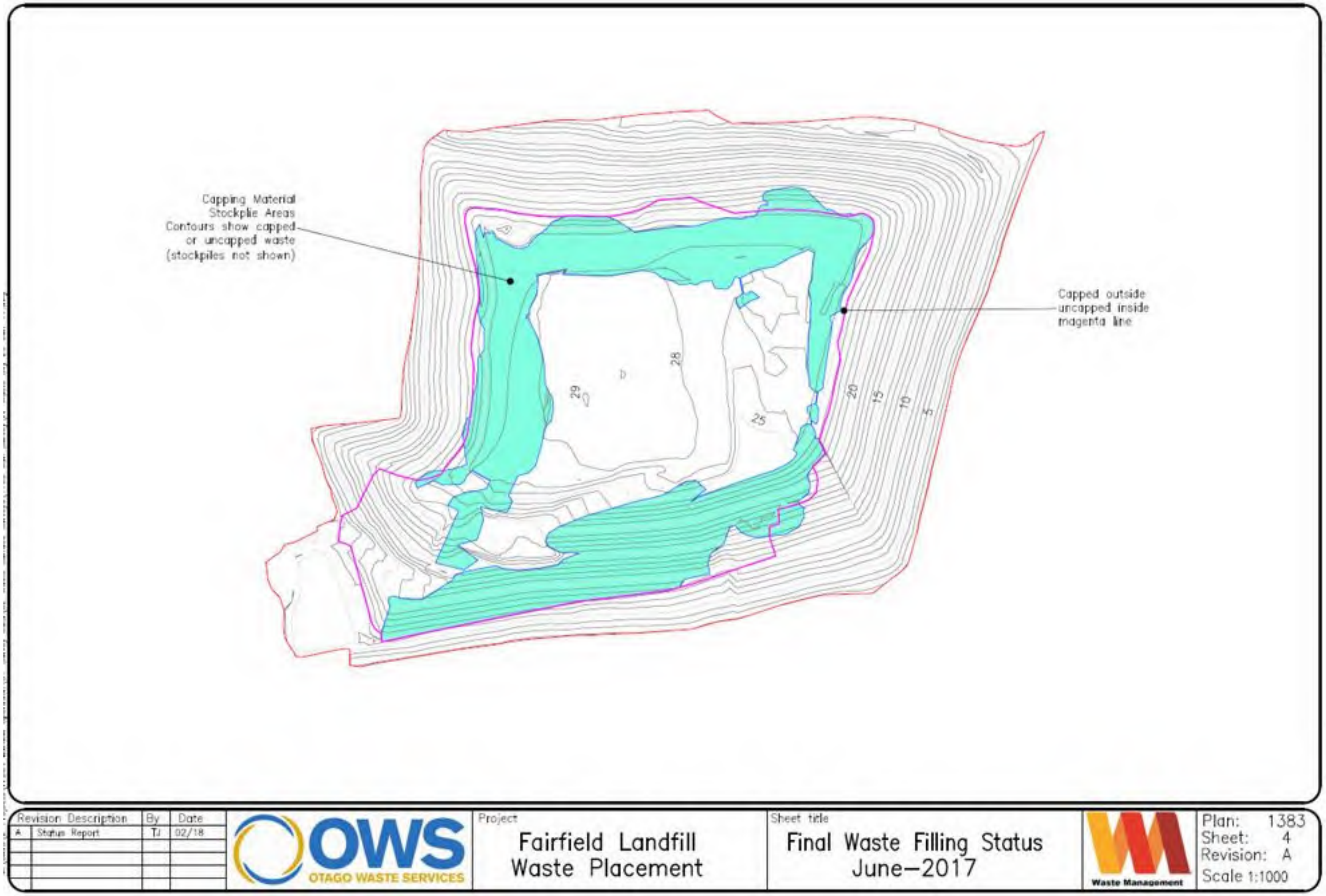
www.topomap.co.nz Images Sourced from LINZ Topographic Maps. Crown Copyright Reserved

8.1.3 Location of Western and Eastern Landfills

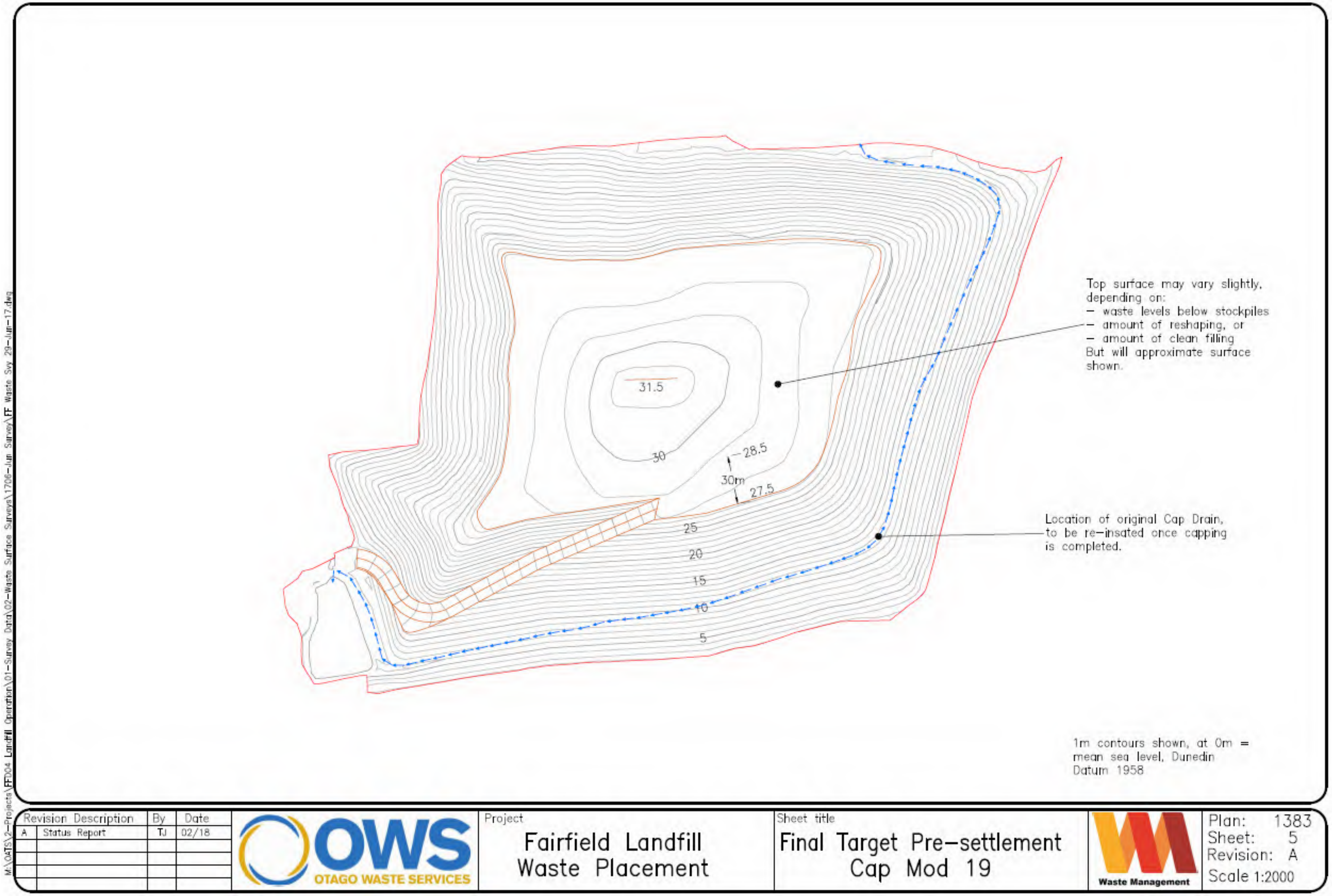

87
Dunedin
SUNNYVALE
ABBOTTS CREEK
FAIRFIELD
1
EASTERN LANDFILL
CHRISTIES CREEK
PUMP STATION
KAIKORAI STREAM
WESTERN LANDFILL
KAIKORAI LAGOON SWAMP 'WETLAND'
COAL CREEK
WALDRONVILLE
OCEAN OUTLET
PUMP STATION
LEACHATE INTERCEPTION DRAIN
SITE BOUNDARY
WESTERN LANDFILL EXTENT
EASTERN LANDFILL EXTENT

8.2 Final cap plans for the Eastern Landfill

8.2.1 Revised final cap (Dec 2017)



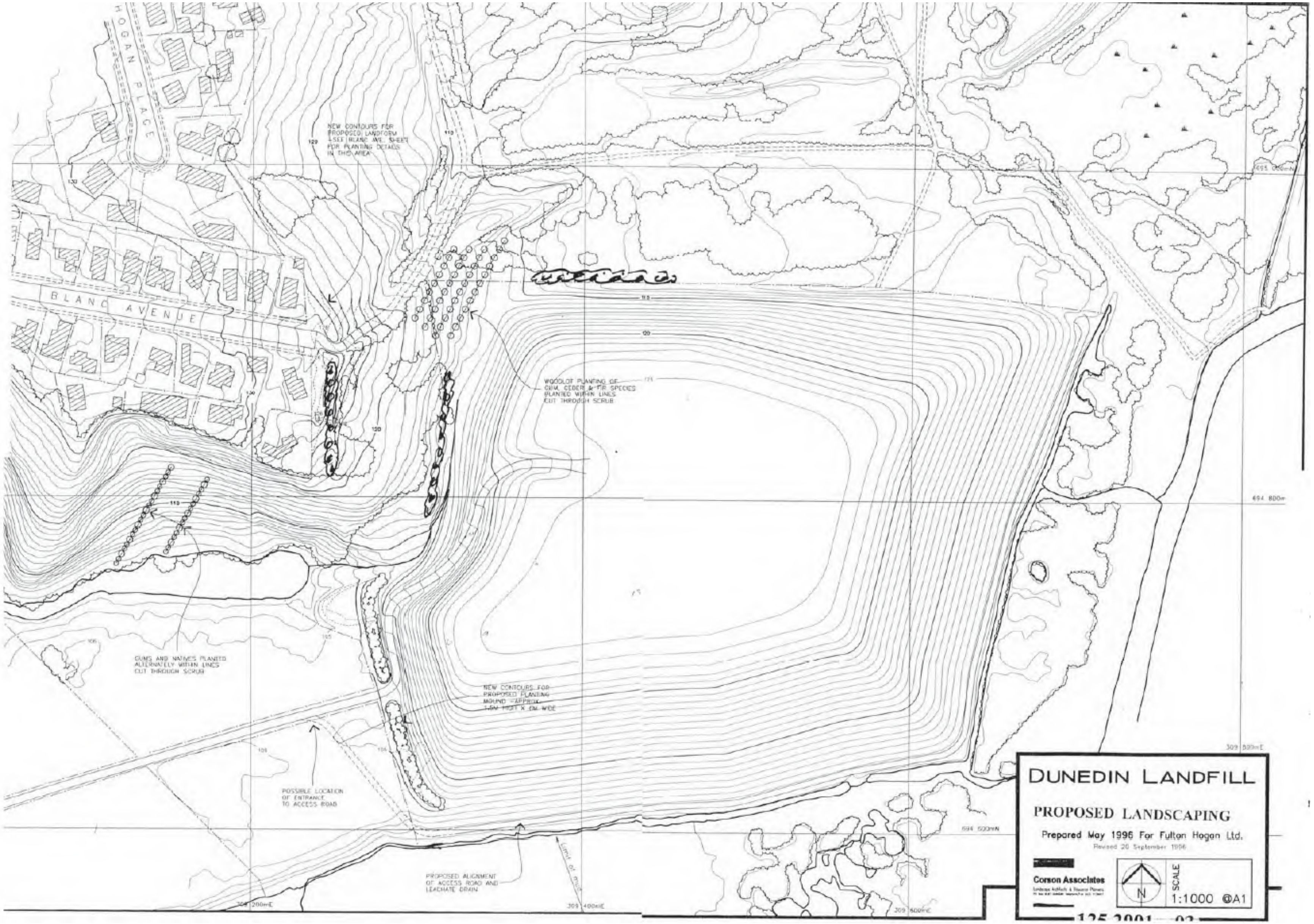
8.2.2 Pre-settlement cap (2018)



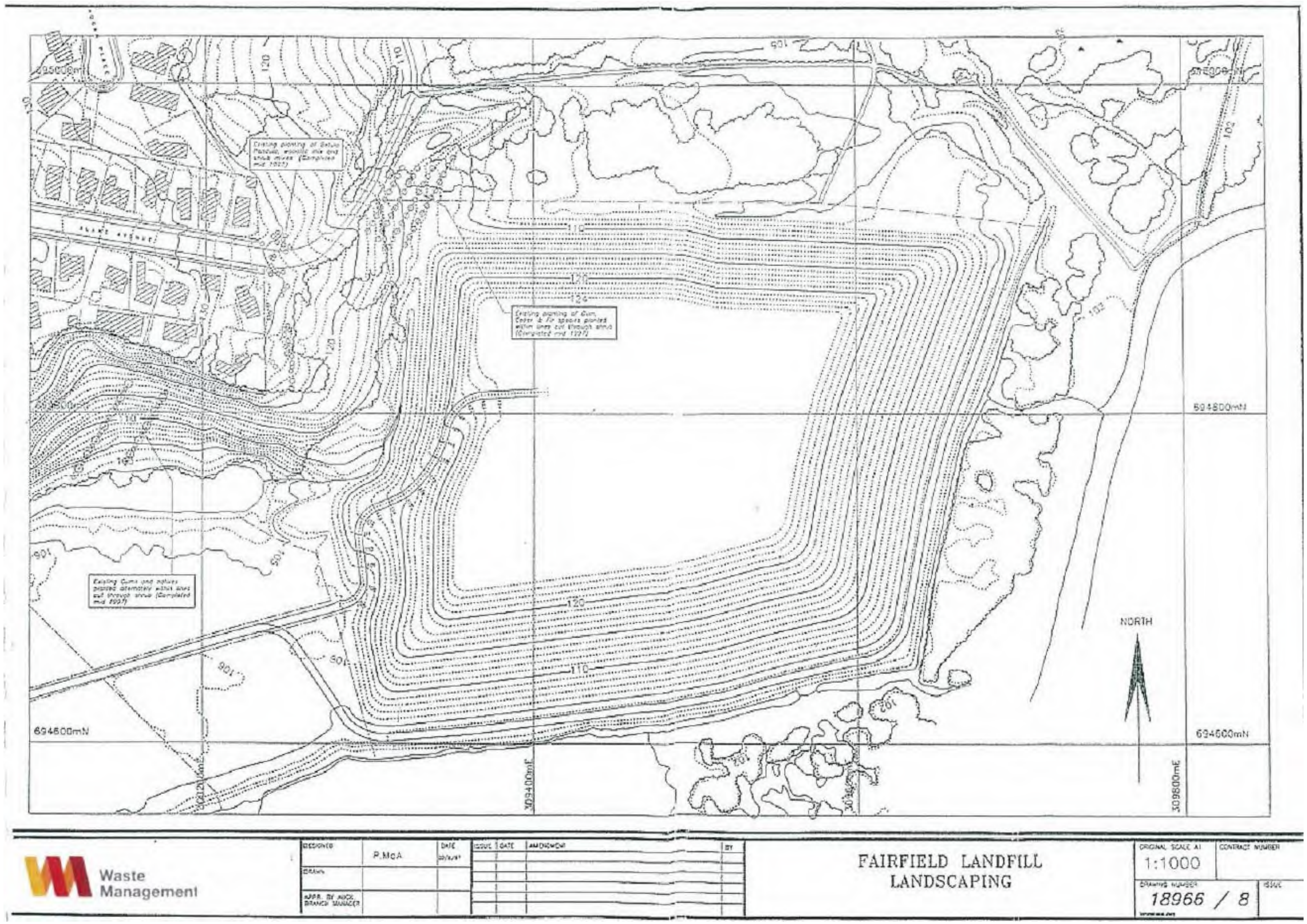
8.2.3 Pre-settlement cap (2019)

8.3 Landscape plans for the Eastern Landfill

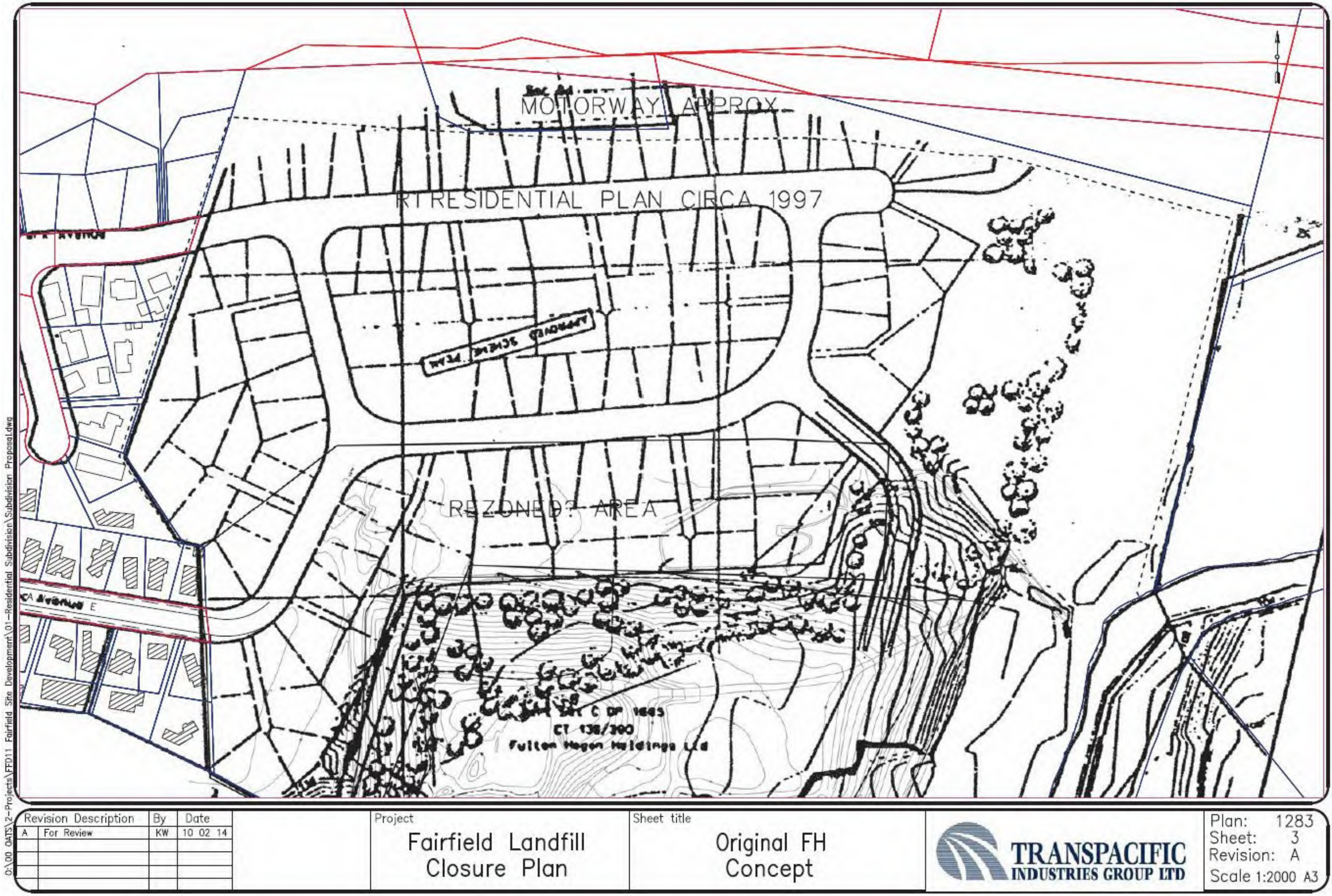
8.3.1 Landscape plan (1996)



8.3.2 Landscape plan (1997)

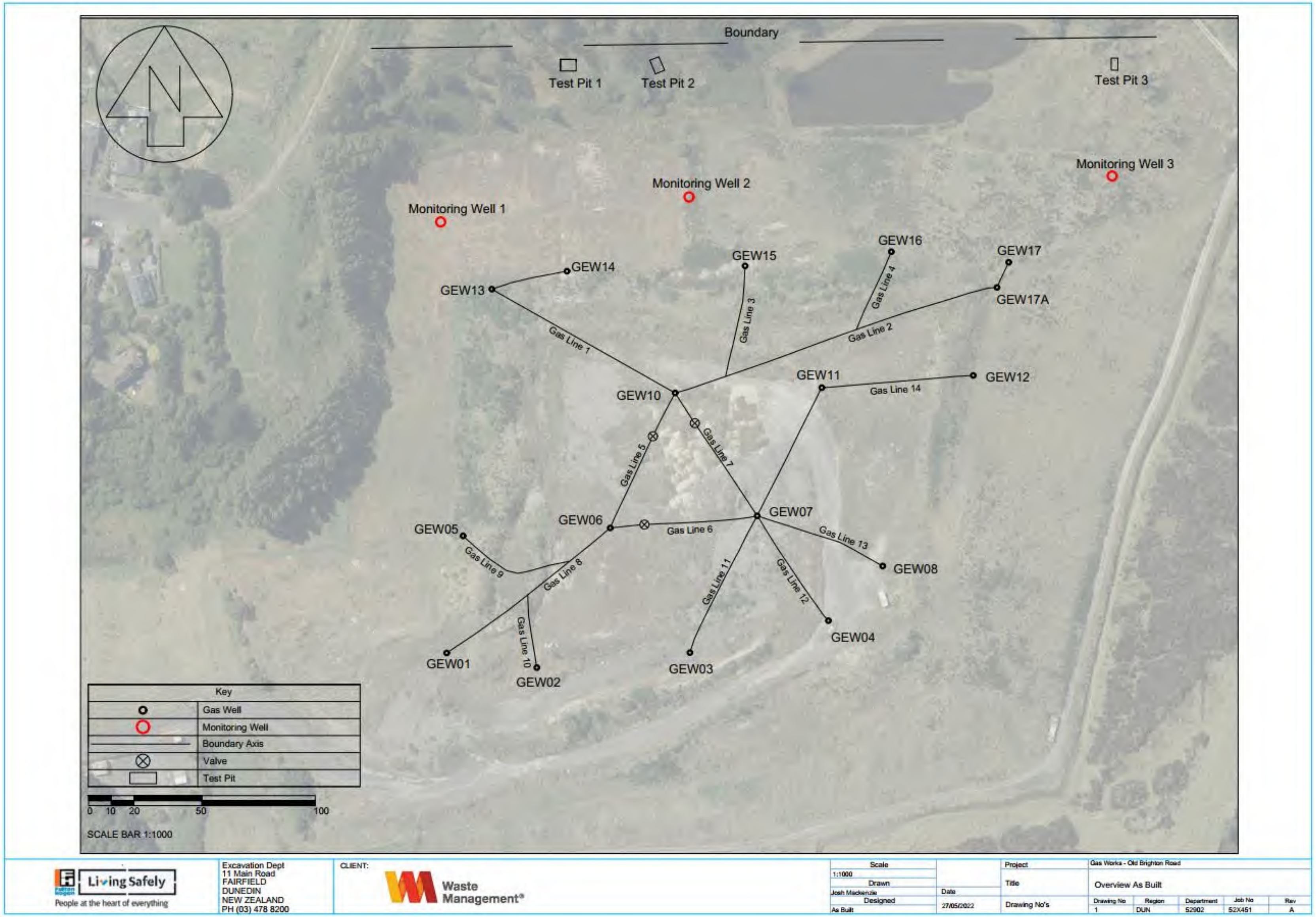


8.3.3 Landscape plan - Landscaping of area between Walton Park and the Eastern Landfill (2014)



8.4 Gas reticulation plans

8.4.1 Reticulation Layout (2022)



8.5 Site monitoring plans

IMPORTANT NOTE:

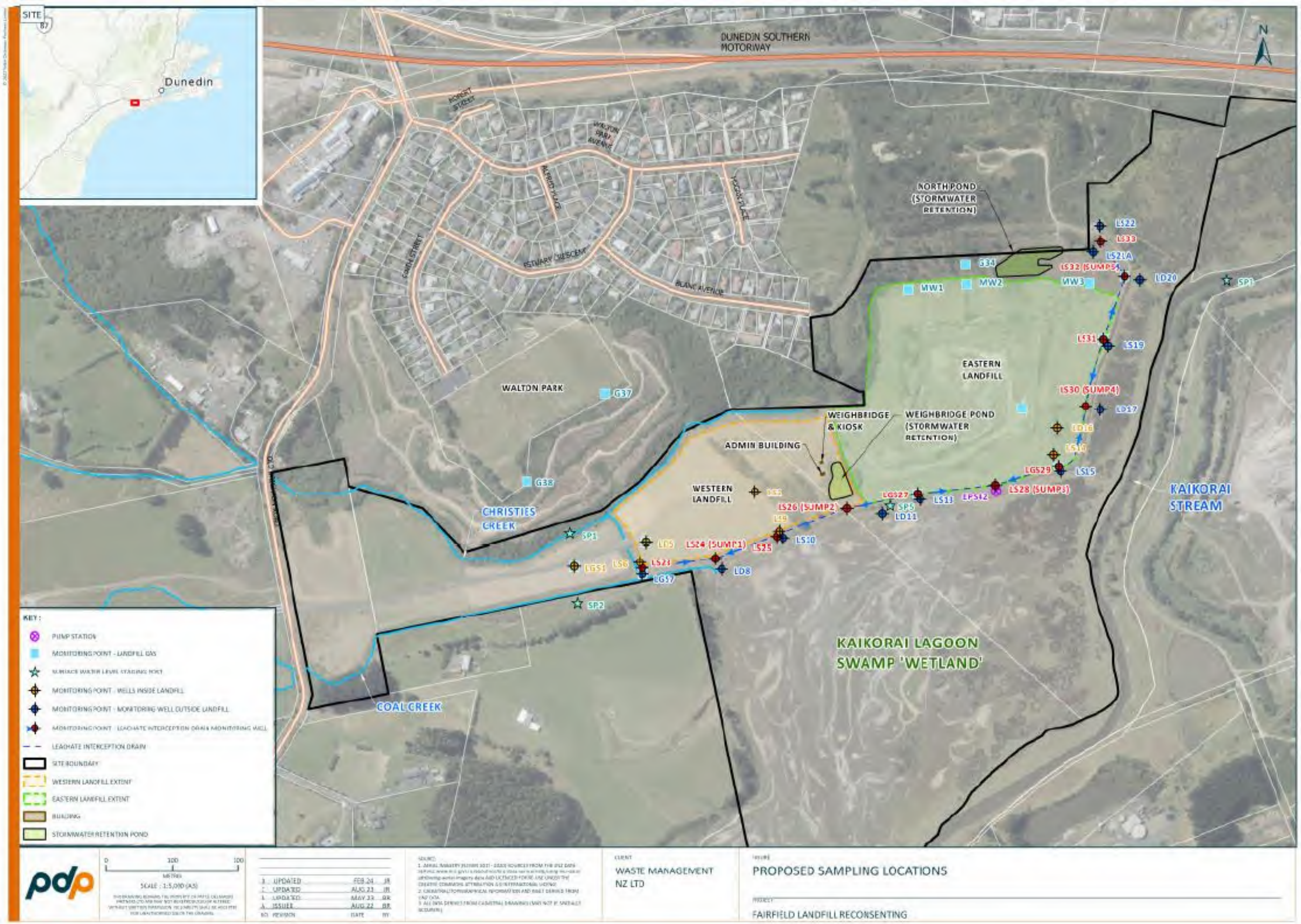
The following monitoring information reflects the proposed monitoring programme contained in the resource consent application for the landfill's new resource consents.

It is also noted that as the application for the new regional resource consents has been lodged six months prior to the expiry of the site's existing resource consents, in accordance with section 124 of the Resource Management Act 1991, Waste Management NZ Limited will continue to monitor the site in accordance with the site's existing resource consents until a final on decision on the new regional resource consents has been made.

The monitoring frequency and the sampling locations and analysis to be carried out in summarised in Section 5.1 of the AMP.

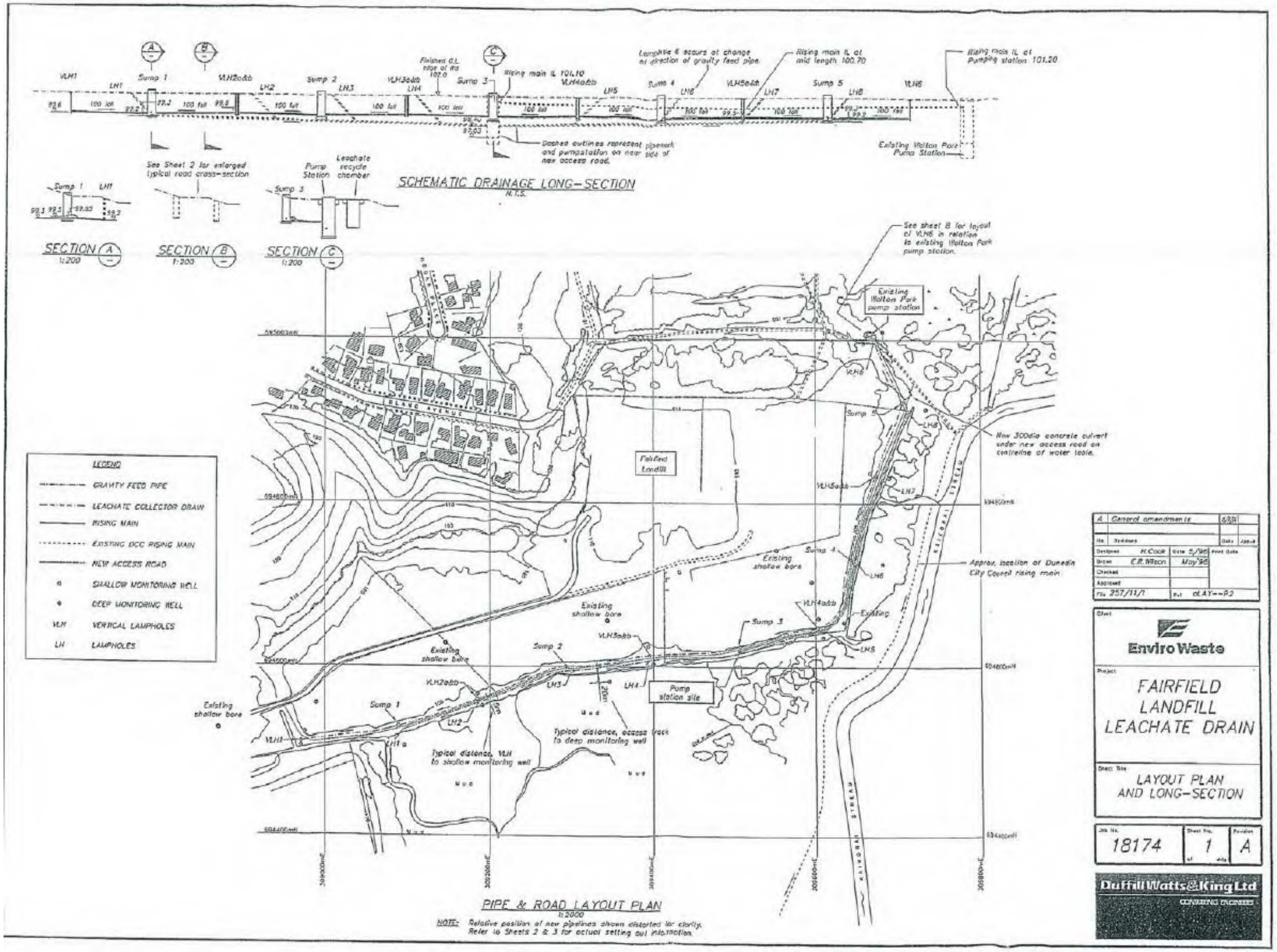
Appendix 8.7 contains a table with all of the consent conditions, including monitoring requirements.

8.5.1 Site monitoring plans

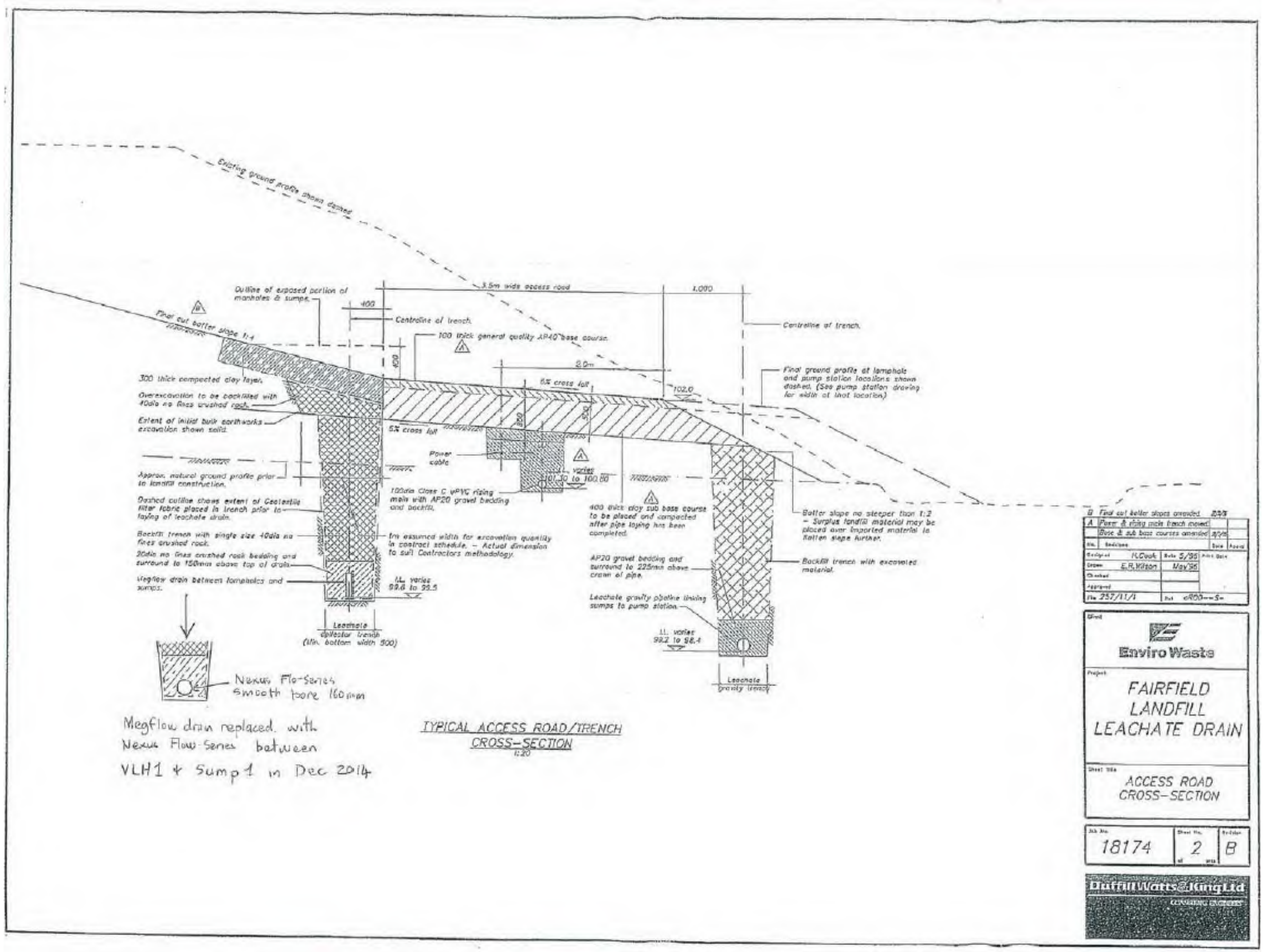



SITE
Dunedin
FAIRFIELD
SUNNYVALE
ABBOTTS CREEK
EASTERN LANDFILL
WESTERN LANDFILL
SW1
SW2
SW3
SW4
SW5
SW6
SW7
CHRISTIES CREEK
KAIKORAI STREAM
KAIKORAI "WETLAND" SWAMP
COAL CREEK
KAIKORAI LAGOON 'ESTUARY'
WALDRONVILLE
KAIKORAI LAGOON SWAMP
KEY :
REGIONALLY SIGNIFICANT WETLANDS
WESTERN LANDFILL EXTENT
EASTERN LANDFILL EXTENT
PROPOSED SURFACE WATER SAMPLING LOCATION
pdp
METRES
SCALE : 1:12,500 (A3)
E UPDATED FEB 24
D UPDATED AUG 23
C UPDATED MAY 23
B REVISED FEB 23
A ISSUED NOV 22
NO. REVISION DATE
CLIENT
WASTE MANAGEMENT NZ LTD
FIGURE
PROPOSED SURFACE WATER SAMPLING LOCATIONS
PROJECT
FAIRFIELD LANDFILL RECONSENTING

Leachate system plan (i.e., identifying sump/wells which are sampling locations, denoted as ‘LS’ sampling location and ‘EPS42’ for the leachate pump chamber).



Leachate drain cross section



8.6 Consents conditions index

IMPORTANT NOTE:

The table contains the proposed consent conditions contained in the resource consent application seeking new resource consents for the closed landfill.

It is also noted that as the application for the new regional resource consents has been lodged six months prior to the expiry of the site's existing resource consents, in accordance with section 124 of the Resource Management Act 1991, Waste Management NZ Limited will continue to monitor the site in accordance with the site's existing resource consents until a final on decision on the new regional resource consents has been made.

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
ORC Discharge Permit – To discharge landfill leachate, to groundwater, by seepage.									
[x]	1	The discharge of landfill leachate, to groundwater, by seepage, through the 21 hectare base of the Fairfield closed landfill which is bounded by the leachate interception drain, must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert]. a) [References to be inserted]. If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.					X		Address in Annual Report
[x]	2	The Consent Holder must ensure that the closed landfill is maintained in a manner that ensures that the structural integrity of the closed landfill is maintained, and that ensures leachate generation is being effectively controlled. The key components of the site that must be maintained in accordance with this condition, include, but are not limited to: a) Structurally sound landfill cap on the Eastern Landfill, and landfill surface over both the Western and Eastern Landfills, including ensuring there is no evidence of surface cracks, slope instability, erosion, seepages, inundation and/or flooding. b) Appropriate vegetation coverage of the landfill surface, which includes ensuring that trees and shrubs are not present on the landfill surface. c) Appropriate drainage systems, including surface drains and the stormwater management system (where required).	X				X		4.2 Address in Annual Report
[x]	3	The Consent Holder must inspect the site to confirm that structural integrity of the closed landfill is being maintained and that leachate generation is being effectively controlled, and the Consent Holder must maintain a record of the inspections that have been carried out. The inspections are to be carried out at the following frequency: a) While active management of site's landfill leachate system is occurring, at least every six months; and				X			5.1

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		b) At least annually once passive management of landfill leachate is occurring, as provided for by the conditions of Consent [to insert]; and c) In a timely manner, and no more than two weeks after, any significant storm / rainfall event, significant seismic event or inundation from a tsunami or storm surge. The Consent Holder must maintain a record of the inspections that have been carried out.							
[x]	4	Where issues are identified in relation to the structural integrity of the closed landfill or the systems that control leachate generation during these inspections, the Consent Holder must: a) register the issue as an incident in the Complaints and Incidents Register in accordance with Condition 9. b) investigate and then implement actions, in a timely manner, that remedies or mitigates the issues identified during the inspection. These actions and outcomes must also be recorded in the Complaints and Incidents Register required by Condition 9.					X		5.2 Address in Annual Report
[x]	5	Within two years of the commencement of this resource consent, and every five years thereafter, the Consent Holder must reassess the slope stability of the Eastern Landfill only. The purpose of this reassessment is to ensure that climate change considerations and potential seismic effects have been appropriately identified, considered and assessed. At a minimum, the reassessment must consider: a) Update peak ground accelerations in line with the most recent guidance and New Zealand standard documents; b) The static stability of the slopes assuming elevated groundwater within the landfill mass and the associated risks from increased or upward seepage; and c) The static performance of the slope from inundation of the toe of the landfill slope by a range of flood inundation levels and residence times. Where a risk, or risks, are identified from the reassessment, the Consent Holder must register the risk as an incident in the Complaints and Incidents Register in accordance						X	5.1 and 5.2

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		with Condition 9. The Consent Holder must also implement actions or recommendations identified during this assessment, in a timely manner, that remedies or mitigates the risk identified. These actions, recommendations or outcomes must be recorded in the Complaints and Incidents Register required by Condition 9.							
[x]	6 and 7	6. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 8(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified. 7. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 8 of this consent.						X	4.3 This document is the AMP.
[x]	8	The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert]. The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address: … Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.						X	4.3 and 4.4 This document is the AMP.
[x]	9	The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert],						X	5.2 and 5.3

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to: a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred. b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred. c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information. d) A description of the area's environmental conditions that are relevant to the matter detected by the complainant or the incident that occurred, including, but not limited to, the weather conditions. e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again. The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 10, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.							
[x]	10	By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report related to the closed landfill activities authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to: a) The results of all inspections and assessments undertaken over the preceding 12 months; b) An assessment of the current state of effects on the receiving environment; c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill					X		5.1 and 5.6

Consent / Regs	**Condn**	**Text**	**Frequency**						**Comment and/or AMP section**
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		leachate, or landfill gas, to a passive system as described in the AMP required by Condition 8 of this consent; and d) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.							
[x]	11	The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority in relation to the exercise of this consent, for the purpose of: a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements; c) Reviewing the frequency of monitoring or reporting required under this consent.						X	-
ORC Water Permit – To take underground water containing leachate and other groundwater									
[x]	1	The take of groundwater containing leachate and other groundwater, for the purpose of controlling landfill leachate and to maintain groundwater within the area bounded by the Fairfield closed landfill's leachate interception drain, must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert]. a) [References to be inserted]. If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.					X		Address in Annual Report
[x]	2	Until written notice has been provided to the Consent Authority in accordance with Condition 3, the Consent Holder must operate and maintain the leachate management system associated with the site in a manner that ensures the effective control of landfill	X				X		4.2 Address in Annual Report

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		leachate and to maintain the groundwater level depression within the interception drain system. The key components of the leachate management system that must be maintained in accordance with this condition including, but are not limited to: a) Lateral drainage network; b) Interception drainage trench; c) Sumps and pumping station; d) Water level monitoring system within the interception drainage trench, sumps and pumping station; e) Alarm systems notifying of any operations issues or when the pump station/s switches off; and f) Connection to the Dunedin City Council's wastewater network for disposal of the groundwater containing leachate. ***Advice Note:*** *Maintenance of the leachate management system to achieve the purpose of this condition includes maintaining a groundwater level depression in the phreatic zone (zone of saturation). The depression of the phreatic surface must be sufficient to cause the drain to intercept phreatic groundwater which would, ordinally, have flowed outward from the drain to adjacent groundwater and the Kaikorai Stream / Kaikorai Lagoon Swamp. The slope of the phreatic groundwater level must be inward towards the interception drain/trench.*							
[x]	3	The Consent Holder may change to a passive leachate management system where the landfill leachate at the site is no longer intercepted and removed from the site, provided: a) The criteria, or trigger levels, specified in the AMP for changing to a passive leachate management system are met; and b) Written notice of the intended change has been given to the Consent Authority at least one month prior to changing to a passive leachate management system.						X	1.8 and 3.4
[x]	4	The Consent Holder must inspect the site to ascertain that site's leachate management system is operating as required, and the Consent Holder must maintain a record of the inspections that have been carried out. The inspections are to be			X				5.1

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		carried out in conjunction with the monitoring, required by Conditions 10 and 11, at the following frequency: a) While the site's leachate is being actively managed, at least quarterly; b) Thereafter, once passive management of leachate commences, at least annually. Where evidence of uncontrolled leachate discharges beyond the site boundary is identified during these inspections, the Consent Holder must register the discharge as an incident in the Complaints and Incidents Register in accordance with Condition 8. The Consent Holder must also investigate and then implement actions, in a timely manner, that remedies or mitigates the uncontrolled landfill gas discharge. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 8.							
[x]	5 and 6	5. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 7(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified. 6. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 7 of this consent.						X	4.3 This document is the AMP.
[x]	7	The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert]. The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address: …						X	4.3 and 4.4 This document is the AMP.

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.							
[x]	8	The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert], including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to: a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred. b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred. c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information. d) A description of the area's environmental conditions that are relevant to the matter detected by the complainant or the incident that occurred, including, but not limited to, the weather conditions. e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again. The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 22, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.						X	5.2 and 5.3
[x]	9	Unless stated otherwise, the results of all monitoring carried out in accordance with Conditions 10 to 18 must be provided to the Consent Authority annually as part of the annual report required by Condition 22, and at all other times must be available for inspection upon request by the Consent Authority.					X		5.6

Consent / Regs	**Condn**	**Text**	**Frequency**						**Comment and/or AMP section**
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
[x]	10	While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must have in place a system, or systems, to continuously monitor (at 15-minute intervals) the water/leachate levels in the leachate pumping chamber (EPS42 as identified on Plan [to insert]). This monitoring data is to be downloaded at least quarterly, during January, April, July and October. ***Advice Note****: The purpose of this monitoring is to confirm that the pumping system has remained operational.*	X		X				5.1
[x]	11	While groundwater containing leachate is being taken in accordance with this consent, discrete water/leachate level monitoring must be carried out at least quarterly, during January, April, July and October, at the following monitoring locations identified on Plan [to insert]: a) Leachate interception drain wells (LS23, LS24, LS25, LS26, LGS27, LS28, LGS29, LS30, LS31, LS32 and LS33); b) Leachate pumping chamber (EPS42); c) Groundwater wells within the landfill footprint (LGS1, LS2, LS6, LS9, LS14 and LD5); d) Groundwater wells outside the landfill footprint (LGS7, LS10, LS13, LS15, LS19, LS21A, LS22, LD8, LD11, LD17 and LD20); and e) Surface water locations (SP1, SP2, SP3 and SP5)			X				5.1
[x]	12	While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must have in place a system, or systems, to monitor and record the instantaneous abstraction rate of the leachate, and associated groundwater, that is taken from the site. The monitoring data is to be: a) Accurately recorded at an average rate of 15 minutes; and b) Provided to the Consent Authority within the annual report required by Condition 22, and available to the Consent Authority upon request.	X				X		5.1 and 5.6
[x]	13	While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must collect samples, at least every six months during January and July, from the leachate interception drain wells, at sampling locations LS24, LS26,				X			5.1

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		LS28, LS30 and LS32 (as identified on Plan [to insert]). The samples must be analysed for the following parameters: a) pH, conductivity, temperature, total ammoniacal nitrogen, phosphorus, dissolved reactive phosphorus, chloride.							
[x]	14	While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must collect a sample, annually in July, from the leachate pumping chamber (EPS42 as identified on Plan [to insert]). The sample must be analysed for the following parameters: a) COD, BOD_5, total ammoniacal nitrogen, temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, bicarbonate, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, copper, lead and cation/anion ratio.					X		5.1
[x]	15	The Consent Holder must monitor the quality of groundwater from samples collected from wells LGS1, LGS7, LS10, LS13, LS15, LS19, LS22, LD8, LD11, LD17 and LD20, as identified on Plan [to insert] attached to this consent, at the following frequency: a) At least every six months, during January, and July each year, unless Condition 19 of this consent applies; b) The samples must be analysed for pH, conductivity, temperature, total ammoniacal nitrogen, phosphorus, dissolved reactive phosphorus, chloride.				X			5.1
[x]	16	The Consent Holder must monitor the quality of deep groundwater from samples collected from wells LD5, LD8, LD11, LD17 and LD20, as identified on Plan [to insert] attached to this consent, at the following frequency: a) At least annually, in July each year, unless Condition 19 of this consent applies; b) The samples must be analysed for COD, BOD_5, total ammoniacal nitrogen, temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, lead.					X		5.1

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
[x]	17	The Consent Holder must monitor the quality of surface water, upstream and downstream of the site, as follows: a) At either: - The preliminary surface water sampling locations SW1, SW2, SW3, SW4, SW5, SW6 and SW7 shown on Plan [to insert]; or - The relocated and confirmed surface water locations SW1, SW2, SW3, SW4, SW5, SW6 and SW7, which have been confirmed by suitably qualified persons, following site inspection to confirm access and their suitability with respect to the area of groundwater upwelling. If the sampling locations are relocated, as provided for by this condition, this will be advised in the annual report required by Condition 22. b) At least quarterly, during January, April, July and October, unless Condition 19 of this consent applies; c) The samples must be analysed for salinity, dissolved oxygen, BOD_5, total ammoniacal nitrogen, temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, lead.			X				5.1
[x]	18	The Consent Holder must ensure that an ecological monitoring programme, consisting of habitat assessment, macroinvertebrate community composition, vegetation survey, birds counts and fish surveys, is carried out at the following frequency: a) Annually, between the months of October to March, for the first three years following the grant of this consent; and b) Thereafter, unless Condition 19 applies, once every five years, between the months of October to March. At a minimum, sampling locations for the ecological monitoring programme must align with the locations for surface water monitoring required by Condition 17.						X	5.1 Annually for first three years, thereafter every five years
[x]	19	The frequency of monitoring required by Conditions 10 to 18 may be reduced, or monitoring may cease, provided that the following requirements have been met: a) A review of the last two years of monitoring data, and an associated assessment of						X	Review at two yearly intervals following grant

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		adverse effects on the environment, has confirmed that the risks associated with the generation of landfill leachate and migration beyond the site boundary are minimal as determined by a suitably qualified and experienced person; and b) Written notice of any proposed amendments to the monitoring programme under this condition, including provision of the assessment carried out under part (a), has been provided to the Consent Authority and the Consent Authority certifies that the proposed amended monitoring programme is appropriate; and c) The review to reduce or cease monitoring can only be undertaken by the Consent Holder at two yearly periods following the grant of this consent. If the Consent Holder has not received a response from the Consent Authority either certifying the proposed amendments or refusing to certify the proposed amendments within one month from the date of submission of the written notice being provided under (b), the proposed amendments are deemed to be certified.							of consent.
[x]	20	Within two years of the grant of this resource consent, the Consent Holder must complete an assessment and/or modelling, and a design, for proposed mitigation works. The purpose of these mitigation works is to minimise the inundation of the leachate management system and to protect the landfill toe and landfill stability from the adverse climate change effects associated with the increased occurrence of high estuary levels and/or wave generated erosion. ***Advice Note:*** *At the time this resource consent was processed, an identified solution for the mitigation works is to increase the level of the site's perimeter access road and put in place associated protection/armouring works. An alternative solution/s, that achieves the purpose of this condition, maybe identified as part of the assessment and/or modelling required by this condition. For this reason, a specific solution has not been identified within this condition.*						X	Within two years of the grant of consent

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
[x]	21	The outcomes, in terms of the identified design, required by Condition 20 must be provided to the Consent Authority within three months of completion of the required assessment. The Consent Holder, in providing the Consent Authority with the assessment carried out, must identify the timeframes for completing the construction of the design identified by the assessment. ***Advice Note**: Additional resource consents for the construction works (i.e., soil disturbance and/or earthworks) may be required to authorise the proposed works. If this is the case, the resource consents will need to be in place prior to construction works commencing.*						X	Within three months of completion of the assessment required by Condition 20.
[x]	22	By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report related to the closed landfill activities authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to: a) The results of all inspections and monitoring undertaken over the preceding 12 months; b) An assessment of the current state of effects on the receiving environment; c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill leachate, or landfill gas, to a passive system as described in the AMP required by Condition 7 of this consent; d) Proposed and / or agreed amendments to the monitoring programme; and e) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.					X		5.1 and 5.6
[x]	23	The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority						X	-

Consent / Regs	**Condn**	**Text**	**Frequency**						**Comment and/or AMP section**
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		in relation to the exercise of this consent, for the purpose of: a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements; c) Reviewing the frequency of monitoring or reporting required under this consent.							
ORC Discharge Permit – To discharge treated stormwater into the Kaikorai Stream and Kaikorai Lagoon									
[x]	1	The discharge of discharge stormwater runoff diverted from the Fairfield closed landfill into the Kaikorai Stream and Kaikorai Lagoon Swamp, after treatment through the stormwater treatment ponds, must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert]. a) [References to be inserted]. If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.					X		Address in Annual Report
[x]	2	Until written notice has been provided to the Consent Authority in accordance with Condition 3, the Consent Holder must operate and maintain the site's stormwater system at the site in a manner that ensures the effective control and treatment of the site's stormwater. The key components of the stormwater management system that must be maintained in accordance with this condition include, but are not limited to: a) Stormwater drainage network; b) The two stormwater retention / treatment ponds; and c) The discharge outfalls.	X				X		4.2 Address in Annual Report
[x]	3	The Consent Holder may cease active management of the site's stormwater system and/or change the nature and purpose of the two stormwater ponds, provided: a) The criteria, or trigger levels, specified in the AMP for ceasing or changing the						X	1.8 and 3.3

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		nature of stormwater management are met; and b) Written notice of the intended change has been given to the Consent Authority at least one month prior to ceasing or changing the nature of stormwater management. ***Advice Note:*** *An example of changing the nature or purpose of the stormwater ponds, could be the planting of the ponds and creating two wetlands on the site.*							
[x]	4	The Consent Holder must inspect the site to ascertain that site's stormwater management system is operating as required, and the Consent Holder must maintain a record of the inspections that have been carried out. The inspections are to be carried at the following frequency: a) While the site's stormwater is being actively managed, at least quarterly; b) Thereafter, once active management of the stormwater ceases or is changed, at least annually. Where evidence of issues with the site's stormwater management system is identified during these inspections, the Consent Holder must register the issue as an incident in the Complaints and Incidents Register in accordance with Condition 8. The Consent Holder must also investigate and then implement actions, in a timely manner, that remedies or mitigates the issue with the stormwater management system. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 8.			X				5.1
[x]	5 and 6	5. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 7(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified. 6. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 7 of this consent.						X	4.3 This document is the AMP.

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
[x]	7	The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert]. The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address: … Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.						X	4.3 and 4.4 This document is the AMP.
[x]	8	The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert], including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to: a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred. b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred. c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information. d) A description of the area's environmental conditions that are relevant to the matter detected by the complainant or the incident that occurred, including, but not limited to, the weather conditions. e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again.						X	5.2 and 5.3

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 9, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.							
[x]	9	By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report related to the closed landfill activities authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to: a) The results of all inspections undertaken over the preceding 12 months; b) An assessment of the current state of effects on the receiving environment; c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill leachate, or landfill gas, to a passive system as described in the AMP required by Condition 6 of this consent; d) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.					X		5.1 and 5.6
[x]	10	The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority in relation to the exercise of this consent, for the purpose of: a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements; c) Reviewing the frequency of monitoring or reporting required under this consent.						X	-

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
ORC Discharge Permit – To discharge landfill gas, and associated odour, to air									
[x]	1	The discharge of landfill gas, and associated odour, to air must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert]. a) [References to be inserted]. If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.					X		Address in Annual Report
[x]	2	The discharge of odour shall not cause a noxious, dangerous, offensive or objectionable effect beyond the site boundary. ***Advice Note:*** *For the purposes of this consent, whether an odour is objectionable and has, or is, causing an adverse effect is determined by a Council Officer, or delegated Council Officer, having regard to the frequency, intensity, duration, nature, location of the odour, and any previous odour complaints relations to the subject site.*	X						5.2 and 5.3
[x]	3	Until written notice has been provided to the Consent Authority in accordance with Condition 4, the Consent Holder must operate and maintain the gas management system associated with the Eastern Landfill in a manner that ensures that adverse effects on the environment are minimised. The key components of the landfill gas management that must be maintained in accordance with this condition include, but are not limited to: a) The landfill cap. b) The landfill gas conveyance pipe network. c) The landfill gas well/s and flare/s. d) Any passive venting system, following the decommissioning of the flare/s, as provided for by Condition 4.	X				X		4.2 Address in Annual Report
[x]	4	The Consent Holder may change to a passive landfill gas management system where the landfill gas at the Eastern Landfill is no longer flared, provided: a) The criteria, or trigger levels, specified in the AMP for changing to a passive landfill gas management system are met; and b) Written notice of the intended change has been given to the Consent Authority at						X	1.8 and 3.5

Consent / Regs	**Condn**	**Text**	**Frequency**						**Comment and/or AMP section**
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		least one month prior to changing to a passive landfill gas management system.							
[x]	5	The Consent Holder must inspect the landfill site for evidence of uncontrolled landfill gas discharges and maintain a record of the inspections that have been carried out. The inspections are to be carried out in conjunction with the monitoring, required by Conditions 9 to 12, at the following frequency: a) While flaring of the landfill gas is occurring, at least monthly; b) Thereafter, at least quarterly. Where evidence of uncontrolled landfill gas discharges is identified during these inspections, the Consent Holder must register the discharge as an incident in the Complaints and Incidents Register in accordance with Condition 13. The Consent Holder must also investigate and then implement actions, in a timely manner, that remedies or mitigates the uncontrolled landfill gas discharge. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 13. ***Advice Note:*** *Evidence of uncontrolled discharges may include, but is not be limited to, the presence of landfill gas odours, gas bubbling within puddles and/or the leachate cut-off drain and from the development of fissures in the landfill cap.*		X					5.1, 5.2 and 5.6
[x]	6 and 7	6. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 8(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified. 7. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 8 of this consent.						X	4.3 This document is the AMP.

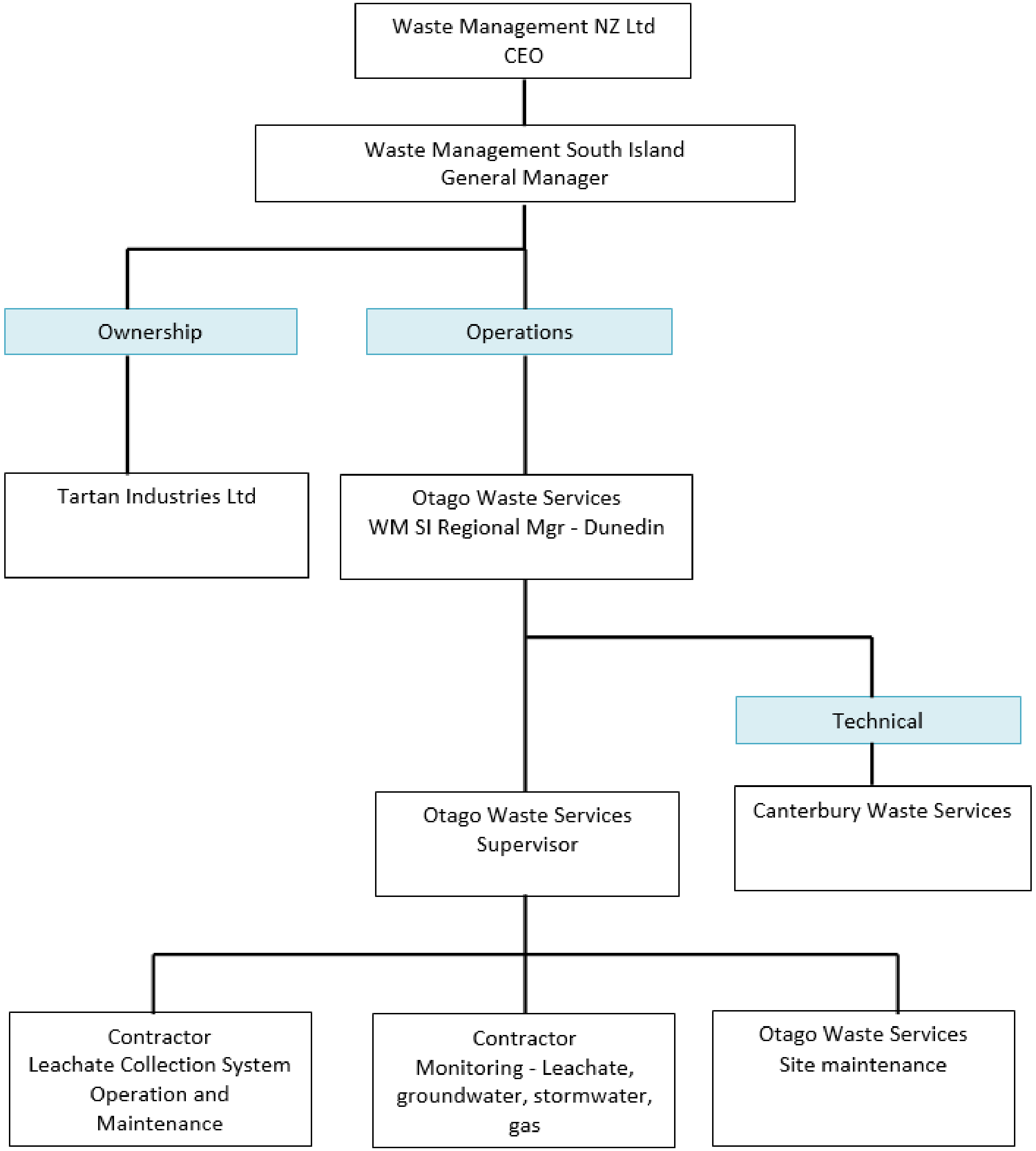
Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
[x]	8	The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert]. The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address: … Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.						X	4.3 and 4.4 This document is the AMP.
[x]	9	While landfill gas is being flared at the Eastern Landfill, the Consent Holder must have in place a system, or systems, to monitor and record the flow rate of the landfill gas generated from the site. At a minimum, the landfill gas flow rate must be measured at least monthly.		X					5.1
[x]	10	The Consent Holder must monitor the composition of the landfill gas within the gas conveyance pipe network to the landfill gas flares/s and/or the passive vent/s at the following frequency: a) While flaring of the landfill gas is occurring, at least monthly; b) Thereafter, at least quarterly, during January, April, July and October each year, and only from the landfill gas well embedded in the landfill. The landfill gas parameters to be monitored are methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.		X					5.1
[x]	11	The Consent Holder must monitor the composition of the landfill gas at wells LGS1, LD5, LGS7, LS21A, LGS27, LGS29, LS31, LS32, G34, G37, G38, MW1, MW2 and MW3, as identified on Plan [to insert] attached to this consent, at the following frequency: a) At least quarterly, during January, April, July and October each year, unless Part			X				5.1

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		(b) of this condition applies; b) The frequency of monitoring may be reduced, or monitoring may cease, provided that the following requirements have been met: - A review of the last two years of monitoring data, and an associated assessment of adverse effects on the environment has confirmed that the risks associated with landfill gas generation and/or migration are minimal as determined by a suitably qualified and experienced person; and - Written notice of the proposed amendments to monitoring programme required by this condition, including provision of the assessment carried out, has been provided to the Consent Authority and the Consent Authority certifies that the proposed amended monitoring programme is appropriate; and - The review to reduce or cease monitoring can only be undertaken by the Consent Holder at two yearly periods following the grant of this consent. c) The landfill gas parameters to be monitored are methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.							
[x]	12	The results of all monitoring carried out in accordance with Conditions 9 to 11 must be provided to the Consent Authority annually as part of the annual report required by Condition 15, and at all other times must be available for inspection upon request by the Consent Authority.					X		5.6
[x]	13	The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert], including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to: a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred. b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred.						X	5.2 and 5.3

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
		c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information. d) In relation to discharges to air, a description of the weather conditions, including approximate wind speed and direction when the discharge was detected by the complainant or when the incident occurred. e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again. The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 15, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.							
[x]	14	a) The Consent Holder must notify the Consent Authority in a timely manner, and no longer than five working days, after the Consent Holder becomes aware of any sudden adverse change in gas levels, or if a trend of increasing gas concentrations of flow rates is indicated. b) The Consent Holder must also register such events as an incident in the Complaints and Incidents Register in accordance with Condition 13. c) The Consent Holder must investigate and then implement actions, if feasible, in a timely manner, that remedies or mitigates the incident. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 13, and must also be reported to the Consent Authority within one month of the action or outcome being resolved by the Consent Holder. ***Advice Note:*** *Sudden adverse change is where there is a significant increase in gas concentrations or flow rates which is inconsistent with previous monitoring data and/or the results are unexpected.*						X	5.2 and 5.6

Consent / Regs	Condn	Text	Frequency						Comment and/or AMP section
			Continuous	Monthly	Quarterly	Six Monthly	Annually	N/A	
[x]	15	By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report related to the closed landfill activities authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to: a) The results of all inspections undertaken over the preceding 12 months; b) An assessment of the current state of effects on the receiving environment; c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill leachate, or landfill gas, to a passive system as described in the AMP required by Condition 8 of this consent; d) Proposed and / or agreed amendments to the monitoring programme; and e) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.					X		5.1 and 5.6
[x]	16	The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority in relation to the exercise of this consent, for the purpose of: a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements; c) Reviewing the frequency of monitoring or reporting required under this consent.						X	-

8.7 Organisation chart



8.8 Site Emergency Management Plan

WASTE MANAGEMENT NZ LIMITED

Fairfield Closed Landfill

EMERGENCY MANAGEMENT PLAN

ADDRESS: **Access via Old Brighton Road**

Project Manager: Conor Mulcahey

TELEPHONE: 021 592584

REGIONAL MANAGER: Greg Nel

TELEPHONE: 03 477 1700, or Mob: 027 613 2350

Prepared by: David Fitzmaurice

Date: 27 February 2024

Review due: 27/02/2025

Section 1 – Details and Communication

Site Activities

Activities undertaken at the Branch	• Monitoring and maintenance only
Number and description of buildings	• No building or amenities

Site Emergency Response Team Contact List

Position	Name	Contact	
		Site	After Hours/Mobile
Regional Manager	**Greg Nel**	**03 477 1700**	**027 613 2350**
Project managers for WM	**Conor Mulcahey**	**021 592584**	**021 592584**

Crisis Management First Response Contact List (for Crisis escalation refer to Crisis Management QRG and Plan)

Contact	Function	Mobile	Email
Guy Smith	Chief Risk Officer	021 430 950	gsmith@wastemanagement.co.nz
Ian Kennedy	Executive Technical Advisor	021 854 899	ikennedy@wastemanagement.co.nz
Lawrence James	Chief Engineering and Development Officer	021 332 566	ljames@wastemanagement.co.nz
Evan Maehl	Managing Director	027 702 5103	emaehl@wastemanagement.co.nz
Ingrid Cronin Knight	GM Strategy, Customer & Sustainability	021 536 790	icroninknight@wastemanagement.co.nz

External Emergency Contacts

Service Provider	Name	Work Number
Crisis Counsellor	**RAISE**	**0800 735 353**
WHS Regulatory Authority	**WORKSAFE NZ**	**0800 209 020**
Environmental Regulatory Authority	**Otago Regional Council**	**0800 800 033**
Emergency services - Police / Fire / Ambulance	**Telephone 111 Fixed line and Mobile telephones**	
Poisons Information Centre	**New Zealand**	**0800 764 766**
Local Regulatory Council/s	**Otago Regional Council – 0800 764766**	
Environmental Protection Authority (EPA)	**0800 225 537 or 04 916 2426**	
Ministry of Business Innovation & Employment (MBIE)	**04 901 1499**	
Ministry of Health (Health Department)	**0800 400 569**	

Service Provider	Name	Work Number
Waka Kotahi	**0800 44 44 49**	
Absorption Material Emergency Equipment	**Alsco –** 0272745087, 03 4792591, 0800 425 726 **Blackwood NZ Safety –** 0800 660660 **Dunedin@NZSafetyblackwoods.co.nz**	

Section 2: Emergency Equipment Register

Response Equipment	Type of Part	Location	Signage	Last Inspection/Test
Fire Fighting				
Extinguisher	Dry Powder	All mobile plant/vehicles	No	
First Aid stations	Kits	All vehicles	No	
Spill Response	Spill Kits	All vehicles.	Yes	Monthly WP inspection

Section 3: Training

All WM personnel who may access the site, shall be provided with general Emergency Awareness Training as part of the induction process within 6 months of their employment, which will cover at a minimum;

- Location of all emergency equipment, in vehicles/plant that may be present on the site, and training in its use (if required);
- Provide awareness of the types of emergencies that may occur at this site and appropriate response plans for these.

Personnel who have assigned emergency team responsibilities shall be provided with additional Emergency response training specific to their roles and responsibilities. This must be included in the Training needs analysis and on the training matrix.

Section 4: Raising the Alarm

In the event of an emergency at this site the following range of communications systems shall be utilized, verbal communication, cellphone, or R/T.

Section 5: Testing and Recording Drills

The implementation of this plan shall be assessed on a minimum 6 monthly basis by the WM Project Manager.

The assessment shall include, but not be limited to, the following aspects;

- Effectiveness of any site emergency warning systems
- Evacuation processes, where relevant, including timing of evacuation times
- Include a variety of scenarios applicable to this site i.e fire, flood etc.

A record shall be kept of the assessment, including the date, and recorded in the Vault (Risk Management Module, Emergency Management, Checks and Registers, Facility/Site Evacuation).

Appendix 1: Emergency Response Guidance

FIRE/ EXPLOSION Response

All attempts to respond to an emergency situation should at all times ensure personal safety and only be attempted if within the capabilities of the individual.

Upon discovering a Fire, the First Responder should:

- Raise the alarm
- Alert and evacuate nearby personnel located in the vicinity of the affected area.
- Immediately notify Project Manager/Emergency Warden and Emergency Services (dial **111**) (if required).
    - When contacting Emergency Services, state the following:
    - Your name
    - Company name
    - Type of incident
    - Address of incident and nearest cross street, state and suburb
    - Types of injuries
    - Any other relevant information
- Where safe, if it applies to the site at the time, shutdown plant as per shutdown procedure.
- Where safe, if it applies to the site at the time, isolate power source and ignition sources.
- Stay in communication until told otherwise.
- Attempt to contain, control and extinguish the fire (if safe and you are trained to do so).
- Any site personnel present on the site will proceed with evacuation if necessary.
- From the emergency assembly point ensure the safety and well-being of personnel and whether the injured can be safely moved attend to their injuries.
- Secure the scene and assist external emergency services.
- Institute a roll-call of personnel, contractors and visitors.
- Project Manager to contact WM Crisis Management First Response Team if local emergency services unable to control.

Terminating Emergency:

- After all clear is given from emergency services and Project Manager.
- The Project Manager in conjunction with personnel present on the site at the time to debrief staff.
- Controlled / Orderly return to work.
- Damaged and affected areas to be barricaded or locked out until repairs are carried out.
- Ensure preservation of evidence and provide cooperation with statutory investigations.
- Notify local authorities including EPA, Local Council, Health Department, MBIE (where required).

FIRES

A. FIRE ON Landfill

1. Assess the scale of the fire.
2. If possible, excavate and isolate affected area.
3. Report to Team Leader no matter the size the incident.
4. If required call 111.

B. FIRE ON Surrounding Site

1. Call 111.
2. Exit site to emergency assembly point, if safe to do so.

Correct Extinguishers for Classes of fires

	Water / Hose Reel	Dry Powder	Foam	CO₂	Wet Chemical / Fire Blanket
Class A Solids	✓✓ Best	✓	✓	✓	✓
Class B Liquids	✗ No	✓	✓✓ Best	✓	✗ No
Class C Gases	Cooling only	✓ Only to reach valve and **turn Gas off**	Cooling only	Cooling only	✗ No
Class D Metals	✗ No	✓	✗ No	✓	✗ No
Class E Electrical	✗ No	✓	✗ No	✓✓ Best	✗ No
Class F Fats & Waxes	✗ No	✓	✗ No	✓	✓✓ Best

MEDICAL EMERGENCY

All attempts to respond to an emergency situation should at all times ensure personal safety and only be attempted if within the capabilities of the individual.

- Check for threatening situation and remove persons from danger if required.
- Remain with the casualty and provide support.
- Immediately call the Emergency Response Team (specifically First Aid Personnel) for assistance.
- Where required, call emergency services (dial **111**).
- When contacting emergency services, state the following:
    - Your name
    - Company name
    - Type of incident
    - Address of incident and nearest cross street, state and suburb
    - Types of injuries
    - Any other relevant information
- Stay in communication until told otherwise
- If conscious, try to ascertain what condition the affected person is suffering.

Cardio-pulmonary resuscitation (CPR)

In the event of a cardiac arrest or an unconscious person you may be required to perform cardiopulmonary resuscitation (CPR).

D	**DANGER**	Only approach the collapsed person if you believe that it is safe to do so. Check for any danger to you, the patient, or bystanders and make the area safe, especially traffic, electrical hazards, etc.	
R	**RESPONSE**	Check for response by asking a simple question and grasp/squeeze the shoulders. Use simple commands such as ‘Can you hear me?’, ‘Open your eyes’, ‘What’s your name?’, ‘Squeeze my hand; let it go’ to find whether they can respond to you in any way. Moving or making a noise is regarded as a response. If the patient responds, then gently and quietly assess the cause of the apparent collapse.	
S	**SEND FOR HELP**	Call 111 for an ambulance or send someone else to call.	

A	**AIRWAYS**	Open the airway by tilting the head back, lifting the chin and gently opening their mouth to check for any obstruction.	
B	**BREATHING**	Check normal breathing for at least 10 seconds: • Look (for chest rise and fall) • Listen (for sounds) • Feel (breath against your face or hand on stomach for movement)	
C	**CPR**	Perform chest compressions and breaths. • Apply compressions (pushes) in the centre of the chest, level with the armpits 30 times (push down 1/3 chest depth) at a rate of 2 every second. • Once you have completed 30 compressions (pushes) on the chest, breathe into the patient's mouth 2 times. • Chest compressions are the most important part of CPR so focus on continuous compressions if it is not possible to deliver breaths. • Swap with another first aid trained bystander every 2 minutes or earlier if you are exhausted. Continue CPR until: • The patient recovers. • The ambulance officers take over. (Fire brigades in some areas will also arrive to perform CPR while waiting for ambulance) • A medical professional advises you to stop. • You are unable to continue, usually due to exhaustion.	 
D	**DEFIBRILLATOR**	Apply an AED (Automated Electronic Defibrillator), if available, and follow the verbal instructions.	

If the patient is breathing but unconscious put them in the 'recovery position' as shown below – ensure their head remains tilted to keep airways open. Provide support and reassurance until help arrives.

EMERGENCY FIRST AID

Control of bleeding 1. Apply direct pressure to wound – use your hand(s) (wear gloves) 2. Elevate (raise) the limb 3. Apply a pad and firm bandage 4. If necessary, use clean rags or clothing **REMEMBER** • Always check circulation below the bandage • If there is tingling, numbness or blueness, loosen the bandage.	**Poisoning** 1. Seek medical advice or call an ambulance **Poison Centre:** **0800 POISON / 0800 764 766** **REMEMBER** • **DO NOT** make the person vomit without advice from a medical professional • **DO NOT** give fluids without advice from a medical professional
Foreign bodies in the eye(s) 1. Wash the eye(s) with clean cool water 2. If the foreign body is stuck to the eye surface, **DO NOT** attempt to remove it 3. Place a covering over both eyes and send for, or take the person to, medical aid	**Chemicals in the eye(s)** 1. Wash the eye(s) with clean cool water for at least 15 minutes 2. Wash from near the nose outwards and always wash under the upper eyelid 3. Send for, or take the person to, medical aid **(Refer Safety Data Sheet or Product Label for chemical)**

Management of minor wounds 1. Clean the wound with soap and water 2. Cover lightly with clean dressing 3. Seek medical help, if necessary	**Breathing difficulties** 1. If a person is breathing but unconscious, turn them onto their side 2. Clear airway of obstructions, such as tongue or vomit 3. Seek medical help, if necessary
Management of burns 1. Cool the burnt area with cool water for 10-15 minutes 2. If necessary, cover the burn with a clean dressing or plastic wrap before removing person to medical aid **REMEMBER** • Do not burst blisters • Do not remove clothing that is stuck • Do not apply creams	**Management of chemical burns** 1. Protect yourself from the substance 2. Avoid skin and eye contact 3. Brush off dry chemicals, flush liquids from the skin using cool running water for 15 minutes or more 4. Remove any contaminated clothing 5. If faint, pale, shallow, rapid breathing (signs of possible shock) then lie the person down rather than sitting them upright and if possible loosen any tight clothing and slightly raise the legs. Stay with them and provide comfort as best you can. 6. Wrap area with a dry sterile dressing or clean cloth 7. Protect from pressure and friction 8. If the skin has blisters or if there is any overall body reaction, get medical help immediately

Personal Threat

In the event of a civil disturbance:

- Ensure your Project Manager is notified immediately
- Notify the Police by dialing “**111**” and request assistance
- Do not say or do anything that may encourage irrational behaviour
- Remove any objects in accessible locations that could be used as weapons or missiles by aggressive trespassers
- Alert other personnel in your vicinity of the threat
- Evacuation should be considered (if safe to do so)

External Emergency impacting on Premises

All attempts to respond to an emergency situation should at all times ensure personal safety and only be attempted if within the capabilities of the individual.

- Make the area safe.
- Contact Emergency Services if necessary;
- When contacting Emergency Services, state the following:
    - Your name.
    - Company name.
    - Type of incident.
    - Address of incident and nearest cross street, suburb, town/city.
    - Types of injuries, property damage or environmental harm sustained.
    - Any other relevant information.
- Stay in communication until told otherwise.
- Implement any other applicable emergency procedure.

Terminating Emergency:

- After all clear is given from emergency services and the Project Manager.
- The Project Manager in conjunction with personnel present on the site at the time, to debrief staff.
- Controlled / Orderly return to work.
- Damaged and affected areas to be barricaded or locked out until repairs are carried out.
- Ensure preservation of evidence and provide cooperation with statutory investigations.

Bomb / Substance Threat

Any person who receives a bomb / substance threat should remain calm and take the following steps:

Ask the following questions

- Where did you put the bomb/substance?
- When is the bomb going to explode?
- When did you put it there?
- What does the bomb/substance look like?
- What kind of bomb/substance is it?
- What will make the bomb explode?
- Did you place the bomb/substance?
- Why did you place the bomb/substance?
- Is the substance a liquid, powder or gas?
- What is your name?
- Where are you now?
- What is your address?

Try to record the exact wording of the threat.

Try to keep the caller talking and complete the ***Bomb Threat Checklist*** (do not hang up because the call may be traced).

In the event of a Product Spill or Environmental incident

1. Incident Identified

It is the responsibility of each worker to be vigilant in the recognition of potential environmental conditions that may lead to environmental incidents. On identification contact the Project Manager. The Project Manager will assess the situation and contact the HSEQ Partner if required.

2. Can the Incident be contained locally?

In determining whether the incident can be contained locally, employees involved must consider the risks to personal health and safety, protection of plant and property and protection of the environment including blocking drains, covering pits and stopping any product entering the sediment ponds. If there is any doubt as to local containment, the appropriate Emergency Services must be called.

3. Call Emergency Services (111)

In the event of an incident that is beyond local containment capability, notify the emergency services. If required by legislation, WMNZ (through the Chief Risk Officer and Environmental Specialist) will notify the relevant government authorities of the incident, including how the incident occurred, measures that have been undertaken to rectify the situation and any impacts that the incident has had on the environment. Government Authorities to be notified are:

- EPA (Environmental Protection Authority)
- Local Council
- Health Department
- Fire and Rescue
- MBIE (Ministry of Business, Innovation and Employment)

4. Employ Containment Procedures

Once an incident has been identified, all efforts must be undertaken to contain and minimise the effect of the incident on the environment. In many cases there are actions that can be implemented to control, isolate or eliminate the cause.

Protect the nearby site stormwater system and the site's adjoining streams and wetland-estuary, wherever possible.

5. Notify the Project Manager

Every environmental incident must be reported to the Project Manager as soon as is practically feasible; no matter how insignificant the incident may appear. The Project Manager is required to contact & liaise with the nominated Environmental Specialist, so that they can identify the actions to be taken to avoid, remedy or mitigate the incident, if there are residual issues to address.

HAZARDOUS SUBSTANCE SPILLS

- **Raise the alarm** by (for example: shouting):
- Evacuate, if necessary.
- Consider wind direction and impact of the direction of wind.
- Identify the nature of the spilled substance.
- Put on personal protective equipment (for example: overalls, boots, gloves, eye protection).
- Close off the source of the spill, if it is safe to do so.
- Remove sources of ignition if a flammable substance is present.
- Identify dangers posed by the spill – only respond if it is safe to do so.
- Refer to the safety data sheet or call an approved handler or other specialist for advice.
- If necessary, call emergency services (**dial 111**) and advise the local council.
- Use your spill kit. Contain the spill if it is safe to do so by using a drip tray, oversized container or an absorbent to soak up a small spill.
- Dispose of waste safely as set out in the safety data sheet

AFTER THE EVENT

- Replenish your spill kit.
- Complete an incident report.
- Review the effectiveness of the emergency plan.

MOBILE PLANT (VEHICLE) STRIKES A POWER LINE OR ELECTRICITY CABLE

ASSUME ALL WIRES ARE LIVE

WHEN IT IS SUSPECTED THAT THE PLANT/VEHICLE HAS MADE CONTACT WITH AN OVERHEAD WIRE OF ANY TYPE THE DRIVER AND ANY OTHER OCCUPANTS ARE TO REMAIN INSIDE THE CABIN:

If a power line or cable strike occurs when using mobile plant (vehicle), act very cautiously and deliberately to minimise adverse effects from the occurrence. Key actions include:

- **Warn others** in the area to move away at least 10 metres from the vehicle and not to touch any part of vehicle; (Those who are close should jump with feet together).
- **Driver/operator** should stay in the cab or on the platform if they are there when the contact occurs, otherwise they must not approach the plant/vehicle.
- DO NOT step from the mobile plant/vehicle to ground, to avoid risk of electrocution.
- DO NOT attempt to move or disentangle the vehicle from the overhead wire; If possible, and it can be achieved without causing further damage, move/drive the plant well clear of the power line.
- If it becomes necessary to leave the vehicle leap well clear, keep both feet together as you leap (like a kangaroo) away from the plant.
- DO NOT touch the vehicle and the ground at the same time.
- Staff in an elevated bucket, or on the mobile plant/vehicle, remain there until the power line owner advises it is safe to descend to ground level.
- All ground staff should remain well clear of the plant/vehicle, or if standing on a conductive mat, remain there, until the power line owner advises that the hazard has been removed from the worksite.
- Contact the power line owner immediately and advise them about the strike. PowerNet **0800 808 587**
- **Emergency Services dial (111)**
- **Contact your Project Manager. The Project Manager will contact the HSEQ Partner who will notify the correct authorities, if required**
- **Prior to driving the vehicle from the incident site, a mechanic must deem the vehicle is roadworthy and in a safe condition to drive.**

Vehicle Accident

The driver must report the accident to the Project Manager and emergency services. The following procedures should be followed:

1. Stop immediately
2. Take steps to prevent another accident at the scene
3. Contact Project Manager to:
    - Call emergency services (**dial 111**) doctor or ambulance, if necessary and notify police
    - Escalate the accident through Manager to relevant Executive General Manager and HSEQ Partner
4. Provide first aid assistance to injured parties
5. Get name, address and contact number of each witness
6. Provide the other involved parties with your name, address, place of employment, and the name of your Project Manager; upon request, show your operator's license, vehicle registration, and insurance card
7. Secure the following information:
    - Registration information for other vehicle(s) (owner's name, license plate number, expiration date and state, vehicle serial number)
    - Information on other driver(s) (name, address, operator's license number and expiration date)
    - Name and address of the company insuring other vehicle(s)
    - Name and address of each person involved and extent of injury, if any
    - General information such as location, time, road condition, weather, property damage, and estimated damage to other vehicles
8. If the vehicle is unsafe to operate, after contacting Mechanic/Transportation Services, have it towed to the nearest workshop; after hours, call Project Manager, for connection with the appropriate person
9. In consultation with the Project Manager complete the insurance paperwork.
10. The Project Manager will contact the HSEQ Partner. If required the HSEQ Partner will notify the correct authority
11. If the incident occurs on site the process is the same with the exemption of bullet points 4 – 7

Natural Events

In the event of a flood, severe storm, earthquake, bushfire:

- If safe to do so, and where relevant to site activities, shut down any site facilities that pose a risk to the environment in the context of the situation.
- Contact Emergency Services if necessary.
- When contacting Emergency Services, state the following:
  - Your name
  - Company name
  - Type of incident
  - Address of incident and nearest cross street, state and suburb
  - Types of injuries, property damage or environmental harm sustained
  - Any other relevant information
- Stay in communication until told otherwise.
- Implement any other applicable emergency procedure.

When the natural event occurs outside hours, where safe to do so the Project Manager or their representative (Team Leader) should visit the site to isolate any site risks and provide access to emergency services where required.

EARTHQUAKE

IF YOU ARE OUTDOORS

- Move away from structures, streetlights, and overhead wires.
- Once in the open **"DROP, COVER, and HOLD On".**
- Stay there until the shaking stops.
- Expect aftershocks and repeat safety procedures outline above.

WHEN THE SHAKING STOPS

- When the shaking stops the Emergency Warden (senior person on the site at the time, or other responsible person) will direct everyone to the assembly point.
- Once at the assembly point the Emergency Warden will complete a roll call of all staff on the site and ensure everyone is accounted for.
- The Emergency Warden will communicate with the Project Manager and no one is to return to the site until the Project Manager and HSEQ Partner have given the go ahead.
- The Project Manager will assess whether further inspection is required depending on the event. If agreed the Emergency Warden can return to site to assess any possible damage.
- This outcome will be communicated back to the Crisis Management First Response team and if required further action will be actioned by them.

TSUNAMI

If you are near the coast, you need to act immediately if you experience any of the following:

- Feel a strong earthquake that makes it hard to stand up, or a weak rolling earthquake that lasts a minute or more.
- See a sudden rise or fall in water level.
- Hear loud and unusual noises from the water.

For a local-source tsunami which can arrive in minutes, there is not enough time for an official warning. It is important to recognise the natural warning signs and act quickly.

- First, protect yourself from an Earthquake. Remember, LONG or STRONG, GET GONE.
- Get to high ground as far inland as possible.
- Be alert to signs of a tsunami, such as a sudden rise or draining of ocean waters.
- Listen to emergency information and alerts.
- Evacuate: DO NOT wait!

WHEN THE EVENT HAS FINISHED

- The Emergency Warden (senior person on the site at the time, or other responsible person) can use emergency information to assess the situation.
- Radio stations, websites, and social media can be used to gain access to this information.
- The Emergency Warden will communicate with the Project Manager, and no one is to return to the site until the Project Manager and HSEQ Partner have given the go ahead.
- The Project Manager will assess whether further inspection is required depending on the event. If agreed the Emergency Warden can return to site to assess any possible damage.

  This outcome will be communicated back to the Crisis Management First Response team and if required further action will be actioned by them.

FLOODING

- Avoid walking or driving through flood waters (*just 6 inches of moving water can knock you down, 2 feet of water can sweep your vehicle away*).
- Project Manager or Team Leaders - Close the site if roadways flooded.
- Vehicles - Pull over where safe to do so.
- Proceed when safe to do so.

LANDSLIDES

- Remain vigilant for signs of ground movement – Small slips, rock falls and subsidence at the bottom of slopes.
- Be alert when driving especially where there are embankments along roadsides. Watch the road for collapsed pavements, mud and fallen rocks.

IF YOU THINK A LANDSLIDE IS ABOUT TO HAPPEN

- Act quickly getting out of the path of a landslide.
- Pull over where safe to do so warning approaching traffic of danger, look for and report broken utility lines to appropriate authorities.

AFTER A LANDSLIDE

- Keep in mind that further landslides may occur.
- Stay away from affected sites until it has been properly inspected and authorities give the all-clear.
- Contact Base advising of location, situation and assistance.

APPENDIX 3:

Aukaha Letter

Letter titled ‘Fairfield Landfill Closure Resource Consents: Cultural Impact Assessment by Aukaha on behalf of Te Rūnanga o Otakou’’
prepared by Aukaha, received on 20 February 2024

Aukaha

Aukaha ref: **J004771**

Waste Management NZ Ltd

c/o Carmen Taylor

Planz Consultants

8 Stafford Street

Dunedin Central

DUNEDIN 9016

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Kia ora Carmen

FAIRFIELD LANDFILL CLOSURE RESOURCE CONSENTS: CULTURAL IMPACT ASSESSMENT BY AUKAHA ON BEHALF OF TE RŪNANGA O OTAKOU

Aukaha is in the process of preparing a Cultural Impact Assessment ("CIA") on behalf of Te Rūnanga o Ōtākou in relation to the closed Fairfield Landfill for Waste Management. The assessment will:

a. Provide Te Rūnanga o Ōtākou with information on the proposed aftercare of the Fairfield landfill and the anticipated effects on the Kaikorai Stream and Estuary and Abbotts Creek.

b. Identify mana whenua cultural values that are relevant to the location and operation of the Fairfield Landfill.

c. Identify the effects of this proposal on the relationship of Te Rūnanga o Ōtākou with the Kaikorai Stream and Estuary and Abbotts Creek.

d. Identify methods to avoid, remedy or mitigate adverse effects on cultural values and associations with the Kaikorai Stream and Estuary and Abbotts Creek, including proposed conditions of consent.

e. Provide a framework for engagement between Te Rūnanga o Ōtākou and Waste Management on this proposal and to identify opportunities for environmental enhancement as part of the aftercare of the landfill.

f. Assist the Otago Regional Council in decision-making under the RMA.

We understand that Waste Management must lodge its resource consent application to replace existing consents for the closed landfill at least six months before the expiry of the existing consents. The CIA will not be prepared in time to be submitted with the application.

Given the above, we acknowledge that the application by Waste Management will be submitted to the Otago Regional Council without the CIA, and we are comfortable with that approach. This is because Waste Management has agreed that the recommendations of the assessment will be addressed appropriately through the consent process under the RMA.

Nāku noa, nā
Dr Kate Timms-Dean

General Manager, Mana Taiao

cc: Te Rūnanga o Ōtākou

Aukaha (1997) Ltd
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consents@aukaha.co.nz www.aukaha.co.nz

APPENDIX 4:

Air Quality Assessment

Report titled ‘Air Quality Assessment – Fairfield Closed Landfill’
prepared by Tonkin & Taylor Limited, dated February 2024

REPORT

Tonkin+Taylor

Air Quality Assessment

Fairfield Closed Landfill

Prepared for
Waste Management NZ Limited
Prepared by
Tonkin & Taylor Ltd
Date
February 2024
Job Number
1020860 v4

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Document control

Title: **Air Quality Assessment – Fairfield Closed Landfill**					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
Feb. 2023	1	Client Draft	M. Dyer	R. Chilton	J. Ferry
Mar. 2023	2	Final Report	M. Dyer	R. Chilton	J. Ferry
Feb. 2024	3	Final Report with minor updates	R. Chilton	R. Chilton	J. Ferry
Feb. 2024	4	Final Report	R. Chilton	R. Chilton	J. Ferry

Distribution:

Waste Management NZ Limited	1 PDF copy
Tonkin & Taylor Ltd (FILE)	1 electronic copies

Table of contents

1 Introduction

1.1 Background

Waste Management NZ Limited (WMNZ), trading as Otago Waste Services (OWS), operates the Fairfield Closed Landfill (the 'landfill'), located at 127 Old Brighton Road, Dunedin.

WMNZ is seeking resource consents from Otago Regional Council (ORC) in relation to the landfill, which includes a resource consent to continue to discharge contaminants into air during the landfill's aftercare period.

Tonkin & Taylor Ltd (T+T) has prepared this technical report to assessing the potential adverse air quality effects from the combustion of landfill gas (LFG), and any potential effects from odour associated with the closed landfill for the purposes of supporting the consent application in relation to the discharges to air component of the application. This report has been prepared in accordance with T+T's letter of engagement dated 2 September 2022.

1.2 Scope of assessment

Resource consent to discharge contaminants into air from the Fairfield Closed Landfill is required under Rule 7.6.1.3 of the 'Regional Plan: Waste for Otago' (Waste Plan), noting that Section 7.1 of the Waste Plan states:

> "Any landfill closed after 1 October 1994 will be assessed in accordance with Rule 7.6.1 as if it were an operating landfill."

The 'Western Landfill' closed in 1996, while the 'Eastern Landfill' ceased disposal of solid waste in July 2017 (as shown in Figure 2.1). Therefore, it is these two areas within WMNZ's site that trigger the need to seek a resource consent under Rule 7.6.1.3 of the Waste Plan.

Rule 7.6.1.3 states the following:

> *"The discharge of any contaminant into air, as a result of the operation of any landfill (except for a cleanfill landfill, offal pit, farm landfill, or greenwaste landfill covered by Rules 7.6.3 to 7.6.11) are discretionary activities, provided that no burning of waste is undertaken".*

Given the above context, the scope of this report is to assess the potential air quality effects of the Fairfield Closed Landfill, notably odour from LFG and combustion products from the flaring of LFG, in a manner that is consistent with Ministry for the Environment (MfE, 2016) guidance, which includes the following:

- A description of landfill activities as they relate to the generation of discharges to air.
- A description of the nature of discharges to air from the closed landfill.
- A consideration of local topographical and meteorological influences on dispersion of discharges to air.
- A consideration of the sensitivity of activities located in adjacent areas.
- A consideration of the environmental performance of the existing facility in terms of discharges to air, including compliance with consent conditions and assessment of complaints.
- The methodology, results and findings of the assessment of discharges to air.
- Conclusions in relation to the effects of air discharges from the closed landfill.

- The closed landfill is located within the Otago 2 Airshed, which is deemed to be a ‘polluted airshed’ with regards to discharge of fine particulate matter less than 10 microns (PM_{10}). The combustion of LFG will give rise to the discharge of PM_{10}. Consequently, consideration of Regulation 17 of the National Environment Standards for Air Quality (NESAQ) is required and has been included in the scope of this assessment.

2 Activity description

The Fairfield Closed Landfill includes two discrete filling areas, both of which are included in the air discharge consent application, and both of which are covered by this assessment. These two areas are the 'Western Landfill' and the 'Eastern Landfill' as shown in Figure 2.1 below.

The Western Landfill closed in 1996, at which time the Eastern Landfill was developed. The Eastern Landfill was closed to general waste disposal in July 2017, which marked the beginning of the post-closure care period (WMNZ, 2022). Landfill closure and capping activities were completed in August 2022.

The post-closure period comprises the following:

- An 'interim closure period' including completion of the final cap, site 'restoration', and an orderly reduction in operational presence. This commenced on 1 July 2017 and was completed in October 2022.
- An 'aftercare period' that includes maintenance and monitoring.

Figure 2.1: Approximate extent of the western and eastern landfill extents (white shading). Site boundary in red.

This assessment primarily focuses on the discharges to air from the Eastern Landfill during its aftercare period. However, the application to discharge contaminants into air also includes the

Western Landfill where discharges to air are expected to be at very low levels due to the period that has elapsed since landfilling ceased in 1996 (27 years).

The discharge of LFG and leachate will continue from the Eastern Landfill for a considerable period of time after post closure, as the organic material within the landfill slowly decomposes. However, the rate of decomposition will reduce over time.

LFG from the Eastern Landfill is captured using a series of LFG wells and a conveyance pipeline system. The pipeline system operates in a ring main. Three candlestick-style flares (an example of the flare is provided in Figure 2.2) have been installed to control the discharge of the captured LFG. The flares have a maximum capacity of 238 m^3/hr of total LFG each. However, WMNZ expects that only two of the three flares will operate at one time, with an approximate LFG flow rate of 140 m^3/hr per flare. The installation of three flares allows for future proofing of the system and provides contingency for taking a flare offline for maintenance.

WMNZ advises that LFG generated from the Western Landfill is at much lower levels due to the significant period of time following closure of that landfill, with insufficient levels to enable flaring of LFG. Accordingly, LFG from the Western Landfill is discharged passively (i.e., without flaring).

The general layout of the gas wells and flares associated with the Eastern Landfill is provided in Appendix A.

Figure 2.2: Solar Spark® candlestick style LFG flare fitted with a stainless steel visibility shield (shroud) installed at the Eastern Landifll (source WMNZ).

3 Nature of discharges

3.1 Overview

The main potential discharge to air from closed landfills is LFG. LFG is generated as organic waste decomposes. LFG consists mainly of methane (CH_4) and carbon dioxide (CO_2) with trace amounts of odorous reduced sulphur compounds (including hydrogen sulphide) and other volatile organic compounds.

LFG discharges are a potential source of offensive or objectionable odour. LFG also contains gases which may be explosive, toxic or act as asphyxiants under certain conditions.

A key method of managing LFG is for it to be collected and combusted. For larger landfills (those that exceed the criteria set out in Regulation 25 of the NESAQ[1]), this can be achieved using an enclosed flare that meets the specifications given in Regulation 27 of the NESAQ. Due to the large scale of LFG combustion in such instances, quantitative dispersion modelling to predict off-site concentrations of combustion products is often undertaken to assess against relevant air quality standards and guidelines. However, such assessments are not typically undertaken for smaller landfills (i.e., those outside the criteria of Regulation 25 of the NESAQ), such as the Fairfield Closed Landfill, where the generation rate of LFG is much lower and consequently the discharge of combustion products is also lower. LFG generation peaks shortly after closure, therefore, discharges from closed landfills will also be less than at active sites.

Notwithstanding the above, a dispersion modelling assessment has been carried out in this instance that specifically focuses on the discharge of PM_{10} emissions that arise from the combustion of LFG at the Eastern Landfill. This is due to the need to consider compliance with the criteria of Regulation 17 of the NESAQ resulting from the landfill's location in a polluted airshed. The dispersion modelling assessment does not consider other combustion products (such as nitrogen oxides, sulphur dioxides and carbon monoxide) due to the very low level of discharge and expected negligible off-site effects.

Odour emissions may also arise from exposed areas of the landfill, although this is expected to be a rare occurrence associated with possible maintenance of the cap of the LFG collection system. At the time of the preparation of this report no planned maintenance of the cap or the LFG collection system that is expected to expose waste is expected to occur. Based on the environmental setting of the Fairfield Closed Landfill, odour is considered to be the main potential adverse effect from discharges to air beyond the site boundary.

3.2 Odour

During the operation of an active landfill, odour can be discharged as the result of the placement of waste and through the discharge of LFG. However, for a closed landfill, odour is typically only associated with the discharge of un-combusted LFG. The MfE (2001) states that:

> *"The odorous compounds associated with landfill gas (LFG) include ketones, esters, volatile fatty acids, hydrogen sulphide and mercaptans. These compounds are primarily generated during the early stages of anaerobic waste decomposition. The offensiveness of the odour of LFG is reduced as the waste enters the methanogenic biodegradation stage (2-4 years after waste placement). As a result, odours are not generally a significant issue with LFG from closed landfills. However, odour release can be reactivated if oxygen is introduced into the waste; for example, due to exposure of the waste to air, or aerated water intrusion into the waste mass."*

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[1] Where the landfill received putrescible or biodegradable waste and has a capacity of more than 1 million tonnes and contains more than 200,000 tonnes of waste.

Provided that there is an appropriate cap and LFG gas control system, odour emissions can be managed from recently closed landfills so as to not cause offensive or objectionable offsite odour effects. In this instance the landfill cap has been completed to a minimum of 800 mm of intermediate cover plus at least 200 mm of topsoil (WMNZ, 2022) and a LFG collection and flaring system has been installed.

3.3 Landfill gas

LFG monitoring is undertaken at wells at various locations using a portable LFG analyser. PDP (2022) summarises the LFG measurements as follows:

- *The interception drain well LS32 continues to show the presence of elevated levels of LFG (methane 27.5%) ... LFG has been measured at these levels in the past in this well (previously elevated levels measured in 2019). The presence of elevated LFG in the interception drain is not unexpected as these wells are part of the landfill. The landfill has recently been capped, which may explain the increase in LFG in the interception drain wells. A LFG extraction system is also being installed, but is not operational yet.*
- *The basement [of the nearest house (located off-site at 34 Blanc Avenue)] (G36) showed no signs of LFG.*
- *Wells G37 and G38 continue to show low levels of carbon dioxide (2.0% and 3.9% respectively), and within the range of historical data for these two locations. These levels are not considered to be of concern.*

Odorous compounds within LFG are primarily generated from anaerobic decomposition and sulphur reduction processes. The combustion of LFG in a flare controls the odorous compounds and is a primarily means of odour control while LFG generation rates are high. The purpose of installing the LFG collection system and flares is to capture and destroy the methane and odorous components of the LFG.

3.4 Particulate matter

The main discharges to air from the LFG flares comprises combustion products of LFG, which includes PM_{10}. As described in Section 1.2, the discharge of PM_{10} from the flares requires assessment against the requirements of Regulation 17 of the NESAQ. The details of Regulation 17 are discussed further in Section 4.6.

PM_{10} emissions have been estimated using emission factors developed by US EPA (US EPA, 2008). They are calculated for a peak un-combusted LFG rate of 238 Nm^3/hr per flare (the maximum capacity for each flare) and an assumed methane content of 55%. The PM_{10} emission rate is conservative as it assumes all three flares will be operating at their maximum capacity at all times. As discussed in Section 2, normal operating conditions is for two flares to operate with a feed of approximately 140 m^3/hr to each flare.

A high proportion of the PM_{10} discharge is expected to be in the size fraction that is less than 2.5 microns in diameter – this is referred to as $PM_{2.5}$. For the purpose of this assessment, it is conservatively assumed that all PM_{10} emissions will be in the $PM_{2.5}$ size fraction.

The flare discharge parameters used for the assessment are provided in Table 3.1. Emission calculations are provided in Appendix B.

Table 3.1: Stack discharge parameters for each flare

Parameter	Unit	Value
Height	m	3.73
Efflux diameter	m	0.62
Efflux temperature	°C	649
Efflux velocity	m/s	17.8
PM10	g/s	0.0082

Note: Flare efflux diameter and height taken as the top of the flare shroud.

4 Environmental setting

4.1 Site location

Under the Dunedin City's Second Generation District Plan (the 2GP), the Fairfield Closed Landfill is zoned 'Rural'. The landfill is located on the northern edge of the Kaikorai Lagoon, and immediately south and downslope of the State Highway 1 motorway. It is also located immediately west of the still active Green Island Landfill. The location of the site is shown by the blue polygon in Figure 4.1. The red polygon shows the capped landfilling area of the Eastern Landfill.

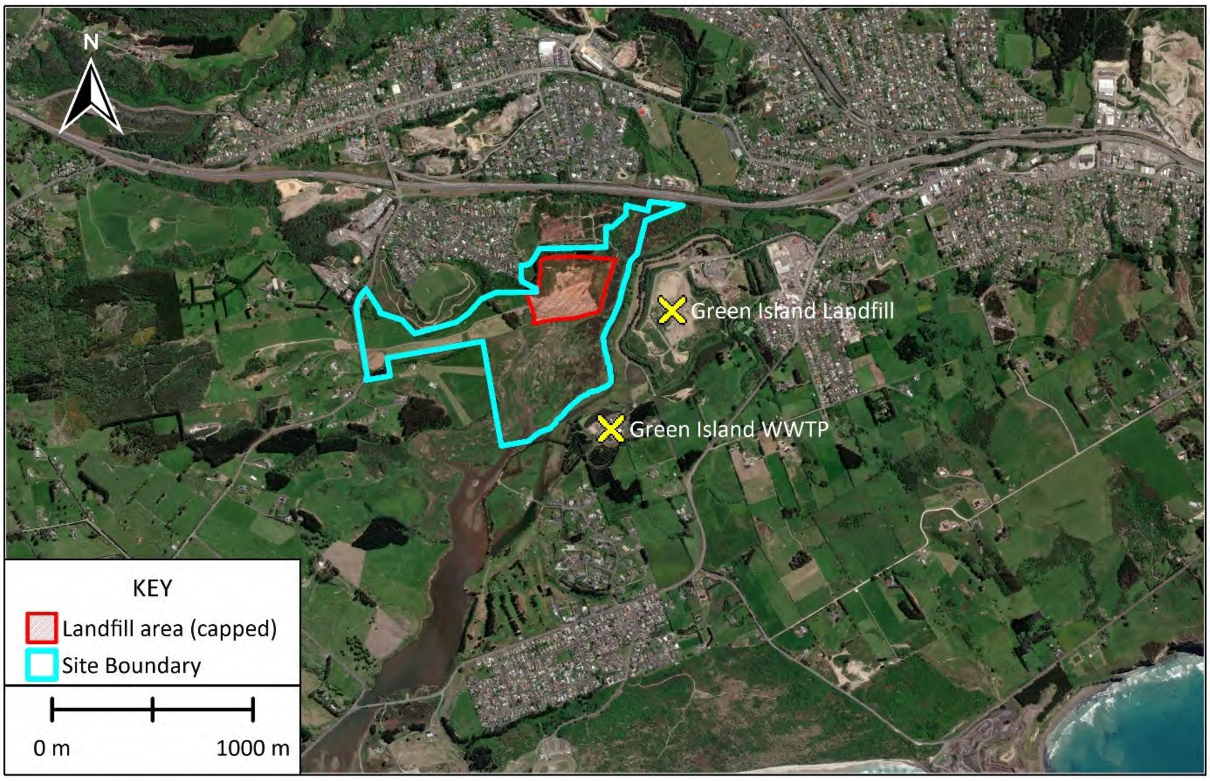

Figure 4.1: Location of the Eastern Landfill outlined in red. Source Image: Global Mapper – World Imagery.

4.2 Surrounding land uses

Land use zoning[2] beyond the landfill helps inform the understanding of the sensitivity of the receiving environment with respect to air discharges from the landfill. In this instance there is a mix of land use zones surrounding the site, as shown in Figure 4.2, and summarised as follows:

- 'General Residential 1' zone is located immediately west and north of the landfill (although land to the north is not at this time developed).
- 'Recreation' zone is located to the immediate west-southwest of the site.
- 'Rural' zones are located to the south (including the Kaikorai Lagoon) and east (including the Green Island Landfill and Green Island wastewater treatment plant).
- 'Industrial' zone is located to the west and to the east of the landfill. The Industrial zoned land to the east includes part of the Green Island Landfill.

The following sub-sections provides further detail of each of these zones and the associated sensitivity of activities in those zones to air quality impacts.

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[2] Dunedin City District Plan (2nd Generation District Plan).

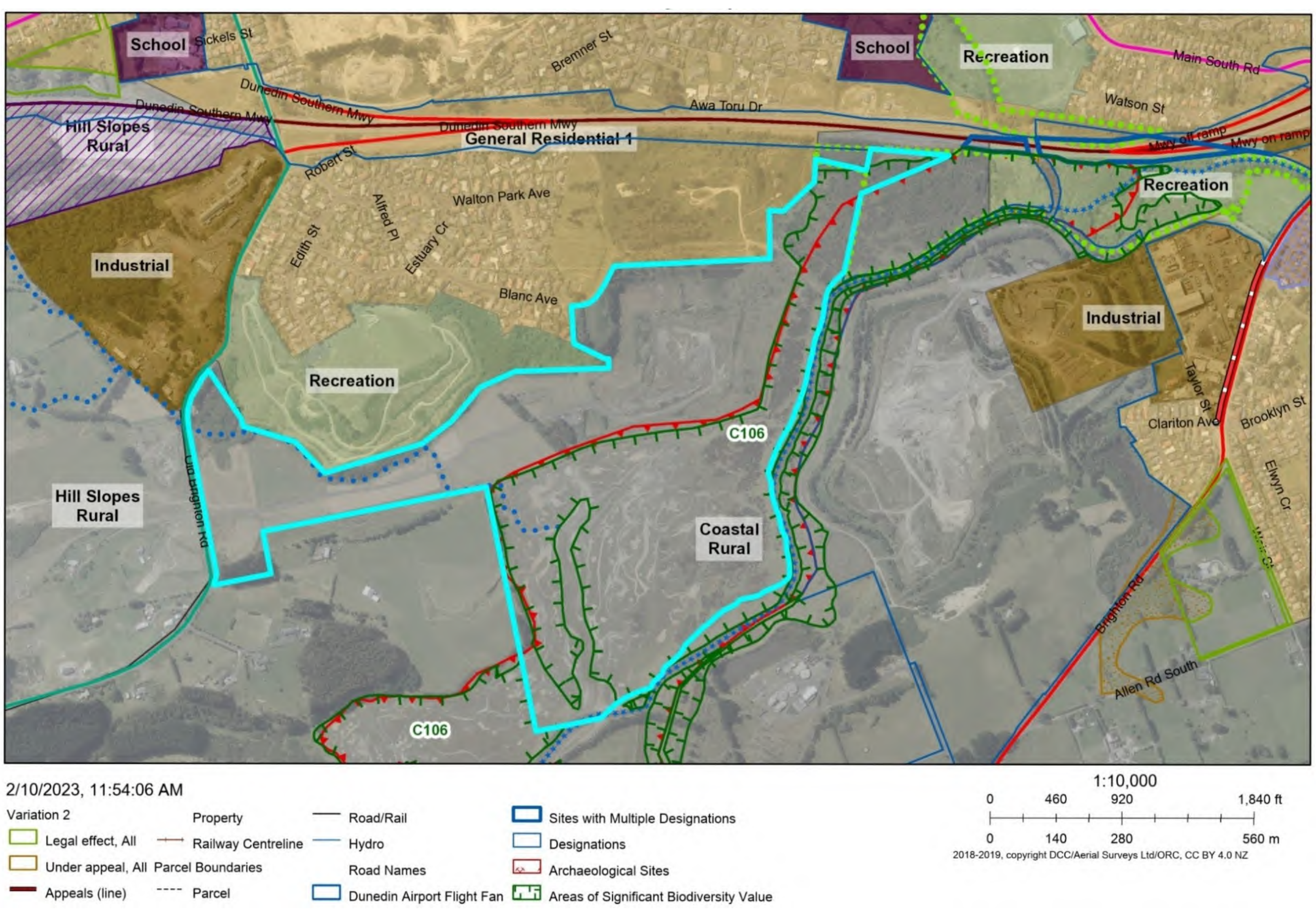


Figure 4.2: 2GP Planning map (Dunedin City Council). WMNZ's landholding associated with the Fairfield Closed Landfill site boundary is outlined in blue.

4.2.1 Residential environments

Residential zones and rural dwellings surrounding the site are considered to have a high sensitivity to air discharges from the landfill. This is due to the following:

- People expect a high level of amenity in their home and immediate environment.
- People may be present all times of the day and night, both indoors and outdoors.

The nearest sensitive locations to discharges from the landfill are the surrounding residences. These are located on the western boundary of the site. Land on the northern boundary is also zoned for residential use. There are also dwellings situated in the Rural zone with the nearest rural residential dwelling located approximately 450 m to the southeast of the site boundary.

4.2.2 Rural environments

The Ministry for the Environment's (MfE, 2016) *'Good Practice Guide for Assessing and Managing Odour'*, describes people living and visiting rural areas generally have a high tolerance to rural activities and their associated effects. Spreading of dairy shed effluent and handling of silage, are relatively common examples of odour sources in rural areas and are typically tolerated by rural residents. However, landfill derived odours are not typical of rural activities and are less likely to be tolerated, especially for rural residences where a high amenity expectation can still be expected. Given this context, rural land (with the exception of rural dwellings) is considered to have a low to moderate sensitivity to air discharges from the landfill.

4.2.3 Recreational environments

The MfE (2016b) describes recreational areas being used for outdoor activities and exercise, in circumstances where people tend to be more aware of the air quality. People of all ages and sensitivity can be present. These areas are considered to have a moderate to high sensitivity to discharges to air from the landfill.

4.2.4 Industrial environments

People who occupy industrial environments are more likely to tolerate adverse effects on amenity values, as long as the effects are not severe (MfE, 2016) and particularly if the source is associated with their employment or is typical of other industry in the area. In addition, people in industrial areas are typically present for less than 24 hours per day and are not using the area for recreation, worship, education or residential purposes.

The sensitivity to odour impacts in the industrial area near the landfill in general is considered to be moderate to low.

4.3 Topography

The topography of an area influences wind and air flow and therefore the dispersion of air discharges from the landfill. The local topography surrounding the Fairfield Closed Landfill is illustrated in Figure 4.3. The landfill is in a valley that slopes down from north to south. Localised drainage air flows down this valley are expected in cool calm conditions. Elevated terrain can cause katabatic drainage winds in cool calm conditions as air flows down from the valley, from higher elevation to lower elevation.

Calm and light wind conditions are of particular interest when assessing odour, as dispersion and dilution of any odours is poor and can result in higher offsite concentrations. This phenomenon is particularly prevalent during inversion conditions, which are experienced at night in cold weather.

Notably, all sensitive activities surrounding the Fairfield Closed Landfill are located on elevated land and will not be downwind under worst case katabatic wind conditions.

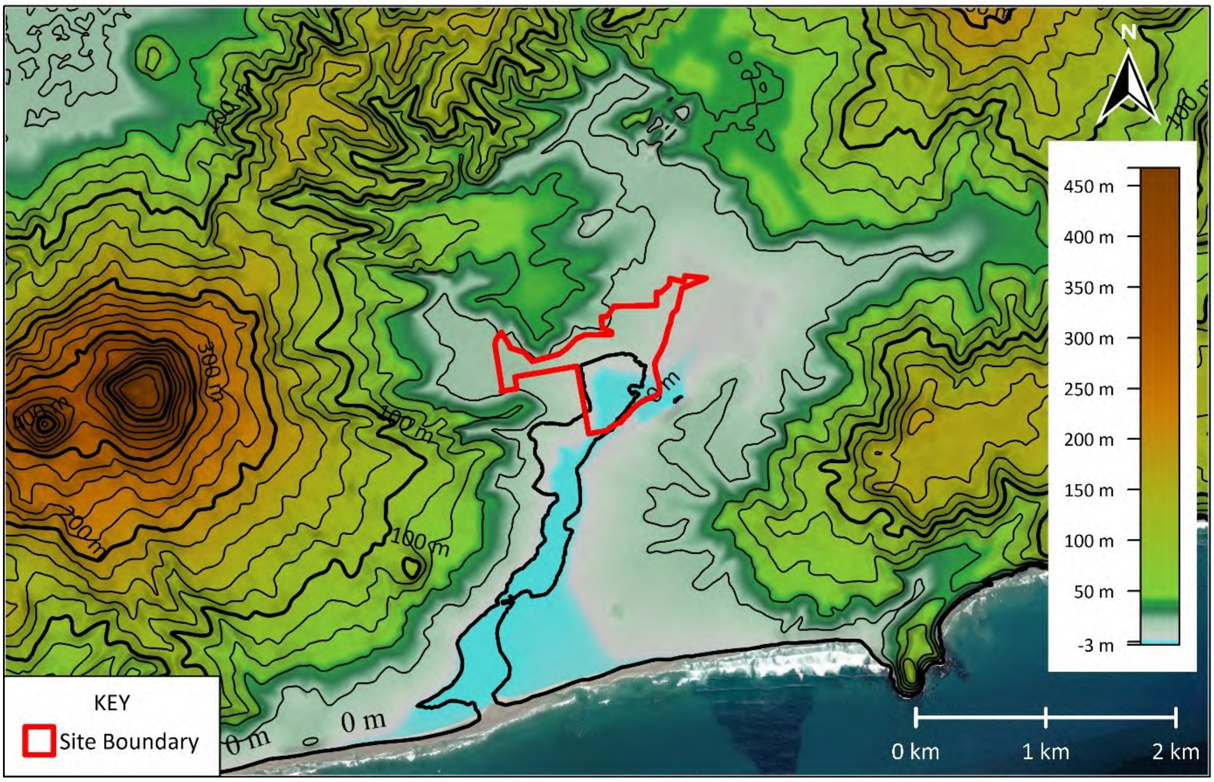


Figure 4.3: Topography surrounding the Fairfield Closed Landfill. Site represented by red polygon.

4.4 Meteorology

Meteorology, particularly wind speed and direction, have a significant influence on how discharges disperse and dilute prior to reaching sensitive receptors and the frequency that a receptor may be exposed to such discharges. Therefore, it is important to have a good understanding of the local wind conditions.

There are nearby meteorological monitoring stations with publicly available data. However, these stations are not considered to be representative of the Fairfield Closed Landfill site due to the distance and terrain between the landfill and the nearest stations, South Dunedin (Musselburgh) or the Taieri Plains (Dunedin Airport) are 8 and 16 km respectively from the landfill.

In the absence of representative local wind data, winds have been predicted using the CALMET model for the period from September 2020 to September 2022. A discussion on the CALMET modelling is provided in Section 5.2. The modelled winds are presented in Figure 4.4 and show a significant channelling of wind from the direction of Taieri Plains and through the gap between Saddle Hill and the Chain Hills. This indicates prevailing winds will transport odours away from high-sensitivity locations near to the landfill.

Figure 4.4: Windrose generated by CALMET for the years 2020 to 2022 – showing the direction the wind is blowing from.

4.5 Other odour sources

The most notable other source of odour in the receiving environment is the municipal landfill operated at Green Island, which is located opposite the Fairfield Closed Landfill on the eastern side of Kaikorai Stream. The Green Island landfill is understood to have resulted in a number of odour related complaints from the wider community and is likely to dominate any odour impacts in the community surrounding the Fairfield Closed Landfill.

The Green Island municipal wastewater treatment plant (WWTP) is also a potential source of odour and is located approximately 550 m to the south-southeast of the site. The location of the Green Island landfill and WWTP are shown in Figure 4.1.

There are no other consented discharges to air close to the Fairfield Closed Landfill.

4.6 Airshed considerations

Regulation 17 of the NESAQ is a relevant consideration for discharges of PM_{10} from activities requiring a resource consent to discharge contaminants into air. It requires the following:

> *"A consent authority must decline an application for a resource consent (the proposed consent) to discharge PM_{10} if the discharge to be expressly allowed by the consent would be likely, at any time, to increase the concentration of PM_{10} (calculated as a 24-hour mean under Schedule 1) by more than 2.5 micrograms per cubic metre in any part of a polluted airshed other than the site on which the consent would be exercised."*

While a flare has been in place on the Eastern Landfill since 2009, taking a conservative approach, no exemption has been applied in relation to Clause 1, under Clause 2 of Regulation 17 to assess discharges of PM_{10}. Furthermore, under Clause 4 of Regulation 17, an airshed is deemed to be 'polluted' where there is 'meaningful data' and the 'airshed's average exceedances of PM_{10} (24-hour average of 50 µg/m³) was more than 1 per year'.

The Fairfield Closed Landfill is located within the gazetted 'Otago 2' airshed as shown in Figure 4.5. The Otago 2 airshed collectively includes the following locations:

- South Dunedin.
- Mosgiel.
- Milton.
- Palmerston.

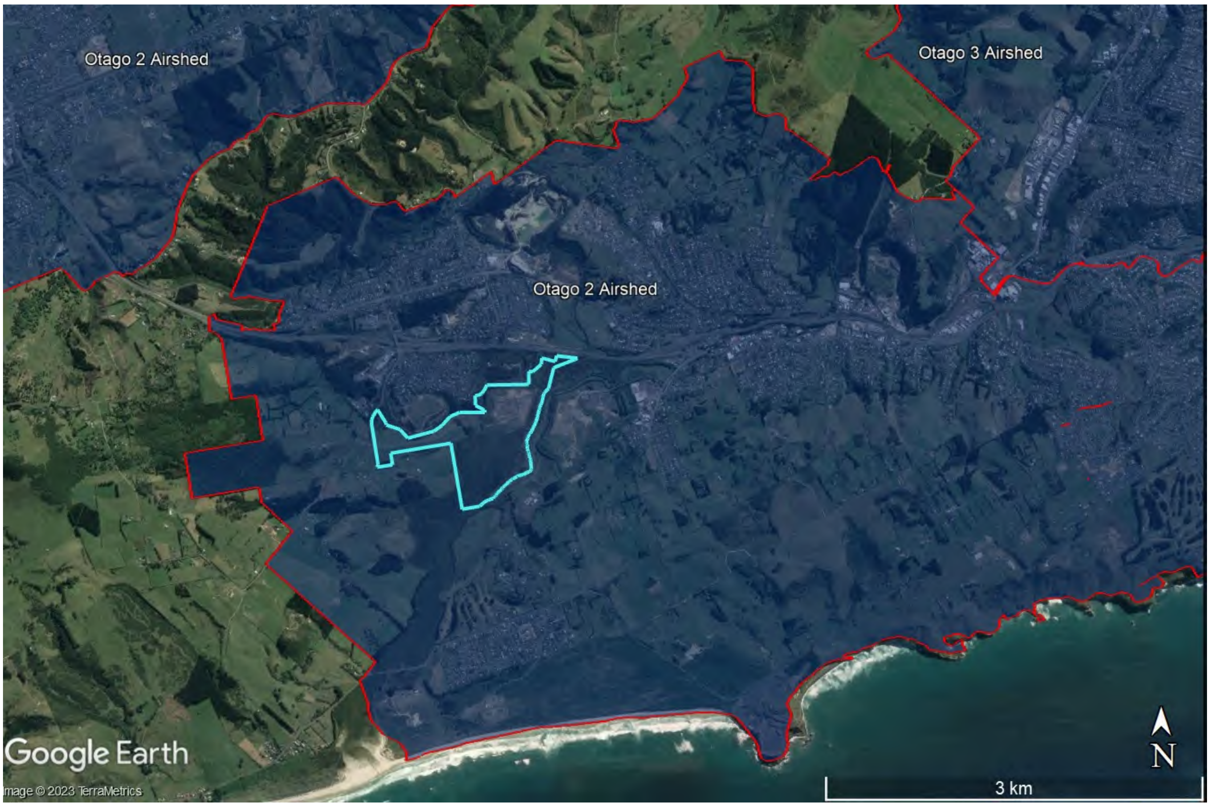
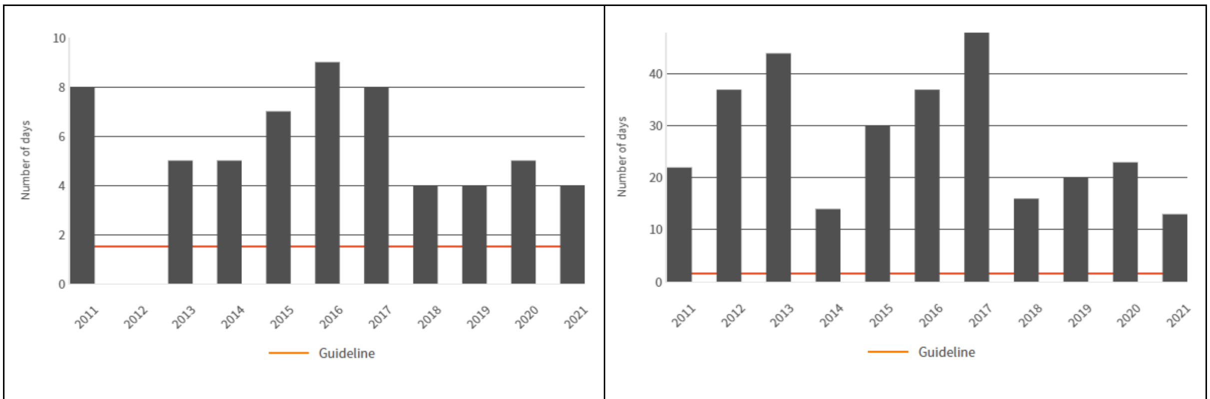


Figure 4.5: Gazetted airshed boundaries relative to the Fairfield Closed Landfill (outlined in light blue).

The monitoring data for Mosgiel and Milton is provided through the Land, Air, Water Aotearoa (LAWA) website. The data for these two sites with regards to the number of annual average exceedances of the NESAQ for PM_{10} for each site is summarised in Figure 4.6. These charts clearly show more than an average of one exceedance has occurred over the last 5 years for each monitoring site. Accordingly, it can be concluded that the gazetted 'Otago 2' airshed, as a whole, is 'polluted' as defined under Clause 4 of Regulation 17 of the NESAQ. It should be noted that there is no monitoring data available that specifically relates to the South Dunedin part of the airshed.



Mosgiel **Milton**

Figure 4.6: Reported annual exceedences of the NESAQ for PM_{10} showing the number of days PM_{10} was greater than 50 µg/m³ for Mosgiel and Milton (source: www.lawa.org.nz).

5 Assessment method and criteria

5.1 Odour

Potential odour and aerosol spray drift effects associated with the closed landfill have been assessed in accordance with the *'Good Practice Guide for Assessing and Managing Odour'* (MfE, 2016). The assessment uses an objective framework for evaluating whether odours are likely to be offensive or objectionable. This involves assessing the potential odour effects in terms of the frequency, intensity and duration of impacts at sensitive locations, taking into account the offensiveness (or character) of the odour – this is known as a FIDOL assessment and is described as follows:

Frequency:	The frequency of exposure to odour impacts experienced at a given location. The frequency of exposure depends on both the frequency of occurrence of discharges and the frequency of weather conditions that could transport any discharge towards the location.
Intensity:	Relates to the strength of an odour at the location of impact. The intensity depends on the degree to which sources are controlled but also the separation distance between a source and the receptor.
Duration:	The duration of exposure depends on how long a location may be exposed to odour from a source.
Offensiveness:	The offensiveness (or character) of odour relates and the hedonic tone, which may vary between pleasant, neutral or unpleasant.
Location:	The location factor relates to the sensitivity of the location being assessed, and is typically expressed as low, medium or high.

The assessment of the FIDOL factors is informed by using a number of information sources/tools. In this regard, MfE recommends a hierarchy of assessment tools for evaluating effects associated with existing operations, as is the case with the closed landfill. In particular, it gives a high priority for tools that evaluate effects based on community feedback, industry/council experience, and meteorological/terrain analysis, with a low priority to tools such as odour dispersion modelling. Given this, and the nature of the proposed activity, a qualitative assessment is considered to be the most appropriate method for assessing odour effects, given the diffuse nature of un-combusted LFG discharged from a closed landfill. Accordingly, the recommended assessment tools are as follows:

- Odour complaint history, experience with the discharge and past compliance.
- Review of the landfill management plan and the management procedures for odour and process controls.
- Analysis of site-specific meteorology and topographical features.

5.2 Particulate matter from flaring of LFG

Air dispersion modelling is used to assess offsite concentrations of PM_{10} arising from the flaring of LFG, specifically due to the need to evaluate PM_{10} concentrations against the requirements of Regulation 17 of the NESAQ. Notably, whether the discharge of PM_{10} from the flares would result in an off-site increase in the concentration of PM_{10} (calculated as a 24-hour mean) by more than 2.5 µg/m³.

In this instance, air dispersion modelling was carried out using the CALMET/CALPUFF (Version 7) dispersion modelling software suite, which is considered appropriate given the site's coastal location and elevated terrain surrounding the site (MfE, 2004).

The configuration of CALPUFF has followed recommended guidance developed by the model developers for the New South Wales Office of Environment and Heritage (TRC Environmental Corporation, 2011). These guidelines are widely referenced and used in New Zealand.

CALPUFF was configured to predict PM_{10} concentrations over a series of nested grids centred on the landfill as follows:

- 600 m by 600 m at 25 m resolution.
- 1 km by 1 km at 50 m resolution.
- 2 km by 2 km at 100 m resolution.

The flares were modelled as 'stack sources', with the discharge and emission parameters provided in Table 3.1. This configuration is considered to best represent the small scale and nature of the discharge from the flares.

The location of the nested receptor grids, the site boundary and the flares are shown in Figure 5.1. Details of the CALPUFF set up are provided in Appendix C and Appendix D.

Meteorological inputs to the CALPUFF were generated using the CALMET model for the area surrounding the Fairfield Closed Landfill. A two-year dataset was developed for the period from September 2020 to September 2022. Notable configuration settings or input data are as follows:

- A high-resolution 50 m resolution meteorological grid, covering an area of 5 km by 5 km centred on the landfill site. This high resolution was used in order to resolve the terrain of the Fairfield area.
- Land use and terrain data were sourced from Land Information New Zealand, with the adjustment for the local terrain elevation of the landfill footprint.
- Prognostic meteorological inputs for surface and upper air conditions were produced using the WRF model, which was run at a 1 km resolution.
- A terrain radius of influence of 1.5 km, representing half the distance of the major terrain features in the model domain.

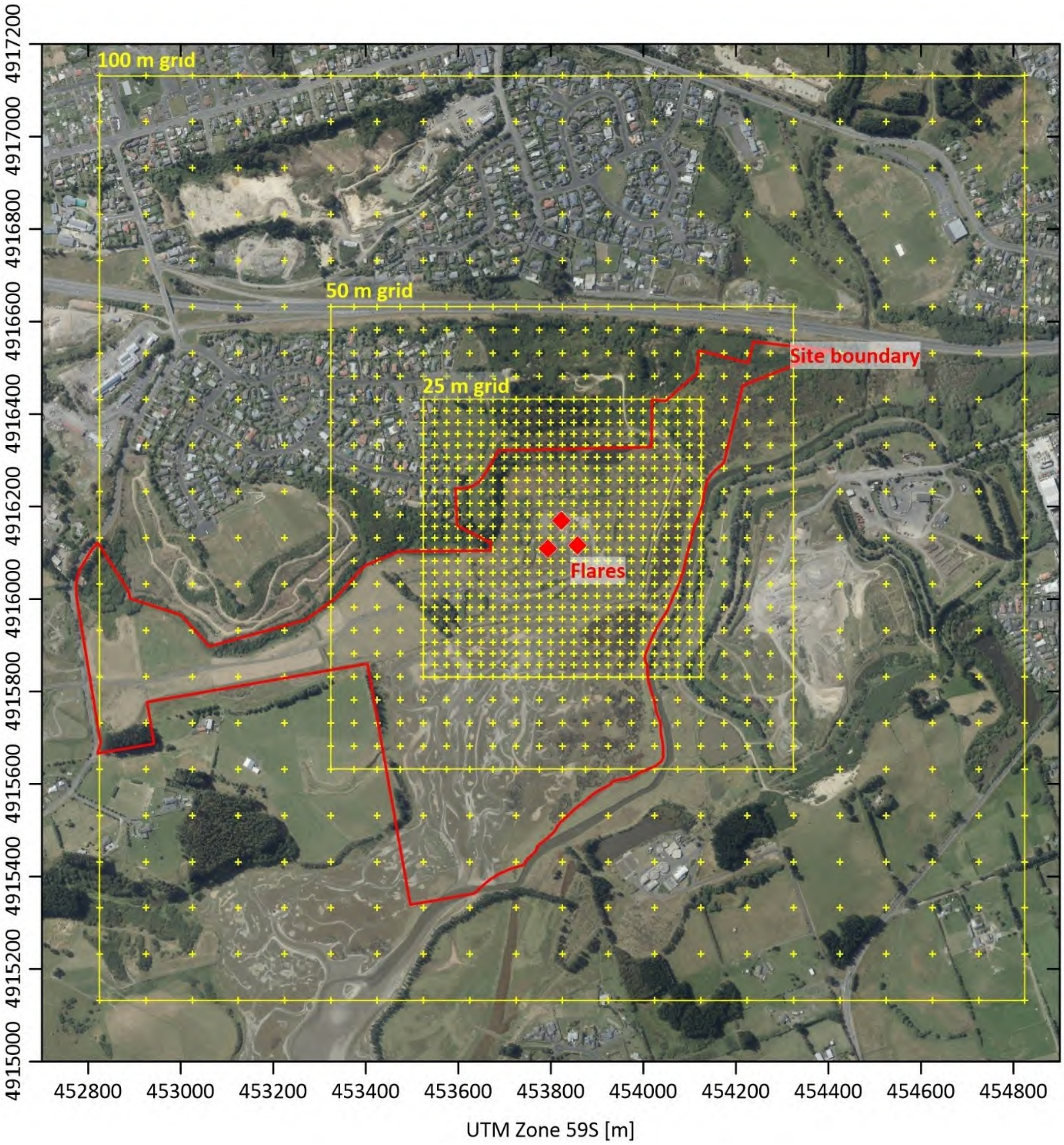


Figure 5.1: The location of the nested receptor grids (yellow), WMNZ's site boundary (red) and the three flares (red diamonds).

6 Assessment of air quality effects

6.1 Odour

6.1.1 Complaint data

WMNZ advises that it has not received any air quality related complaints in relation to the Fairfield Landfill in its closed state.

6.1.2 FIDOL assessment

During normal operation of the closed landfill, LFG will be substantively controlled, with LFG being combusted through the candlestick flares. The venting of LFG to the flares also helps minimise the likelihood of gas migration beyond the landfill footprint and odour effects related to LFG.

The main risk of odour associated with upset conditions relates to the following:

- A failure of the LFG control system, leading to LFG not being controlled and possibly leading to gas migration beyond the footprint of the landfill.
- A failure of the landfill cap, such as significant cracking, where LFG can vent in an uncontrolled manner.

The potential odour effects are assessed using each of the FIDOL factors, as shown in Table 6.1.

Table 6.1: Odour assessment

Frequency	The frequency of odour experienced beyond the boundary of the site depends on the frequency of odour emissions from the site and the frequency of wind conditions that could transport the odour towards sensitive receptor locations. The most significant potential source of odour is uncontrolled LFG from the Eastern Landfill. During normal operation, odour from LFG emissions is not expected as the flares will be in operation. The nearest current or proposed sensitive receptor is adjacent to the western boundary. However, these locations are not frequently downwind of the landfill (see Figure 4.4). Furthermore, due to the topography, sensitive locations will not be downwind of the landfill under worst case katabatic wind conditions. Upset conditions are expected to be very infrequent due to the landfill being closed and capped. Three flares have been installed to allow for contingency of flaring operations during the landfill's aftercare period. Flaring of LFG is expected to continue until such time that there is not enough LFG being generated to sustain a single flare, at which time the issue of LFG odour will also be significantly diminished. **The frequency of odour exposure for the nearest sensitive location is considered to be <u>very infrequent</u> due to the infrequent emission of odour.**
Intensity	The intensity of odour at a receptor depends on emission strength at the source and the degree of dispersion of the emissions between the source and receptor location. Based on industry knowledge, odour emissions are expected to be negligible beyond the boundary. This is due to the capping of the landfill enabling the extraction and flaring of LFG. The topography of the site and surrounding area also means that sensitive activities are uphill of the landfill and will therefore not be downwind during worst case meteorological conditions (katabatic winds) when there is poor dispersion and dilution of any odours.

	Therefore, during normal operations, odour emissions are expected to be of <u>very low intensity</u> at the nearest sensitive receptor location. During upset conditions (such as infrequent failure of the extraction system and flare), the intensity of LFG is expected to be very low beyond the boundary of the site due to the distance between the landfill area (as shown in Figure 4.1 and the site boundary).
Duration	The duration of odour exposure at a receptor location depends on both the duration of the odour discharge and the duration of persistent weather conditions that carry odour towards sensitive receptors. As discussed in the Intensity section, odour emissions from the site are managed through maintaining the landfill cap and LFG control system. **The duration of odour emissions beyond the site is expected to be of <u>very low duration</u> due to the management practices employed on the site**.
Offensiveness	Odour from a closed landfill of this age is expected have a hedonic tone of mercaptans (similar to natural gas tracer) and to be of moderately negative hedonic tone. **Accordingly, the offensiveness of odour associated with LFG is moderately unpleasant.**
Location	The residential receptors immediately surrounding the site are expected to have a high sensitivity to odour emissions. **The nearest existing receptor with a high sensitivity is a residential dwelling located adjacent to the western boundary of the site in a residential zone (approximately 225 m from the flares). The undeveloped land immediately to the north of the site is also zoned for residential use (the nearest zone boundary to the north is approximately 150 m from the flares).**

The Fairfield Closed Landfill is located within a broader environment which also contains the Green Island Landfill and the Green Island WWTP. These activities are likely to have odorous discharges during some operational activities.

6.1.3 Cumulative effects

Cumulative odour effects (such as might occur with discharges from the Green Island Landfill and WWTP) are expected to be negligible due to the very low / negligible odour effect of LFG emissions from the Fairfield Closed Landfill.

6.1.4 Summary of odour effects

Given the above evaluation of the FIDOL factors, the assessment of effects of odour emissions can be summarised as follows:

- The offensiveness or hedonic tone of uncontrolled LFG emitted from the site is expected to be moderately unpleasant.
- However, the frequency, intensity and duration of odour exposure at receptors with high sensitivity is considered to be very low. This is principally due to the fact that the landfill is closed and the management practice of capping the landfill and collecting and flaring the LFG.
- The design of the gas collection and flaring system also provides for a significant degree of redundancy, meaning one of the three flares can be taken off-line for maintenance or repairs without affecting the ability to adequately flare the gas.
- Cumulative odour effects from the nearby Green Island Landfill and WWTP are not expected due to the odour effects from the Fairfield Closed Landfill being very unlikely.

Accordingly, it is concluded that offensive or objectionable odour effects beyond the boundary of the site is very unlikely to occur. This conclusion is supported by the absence of recorded complaints relating to the site and industry experience with other closed landfills with similar controls.

6.2 Particulate matter from flaring of LFG

Modelling was carried out to predict offsite concentrations of PM_{10} (calculated as a 24-hour average) from the flaring of LFG in order to determine compliance with Regulation 17.

The offsite maximum 24-hour average PM_{10} concentration predicted to occur at the site boundary is 0.4 µg/m³ for a scenario where all three flares are combusting LFG simultaneously at their maximum design gas flow rate. A contour plot showing the maximum 24-hour average PM_{10} concentration is provided in Figure 6.1.

The modelling results are based on gas flow rates to support the operation of three flares operating at the same time and at their maximum capacity. However, as described in Section 3.3, only two flares are expected to operate at the same time. Therefore, the model scenario is considered to be very conservative. Notwithstanding this conservatism, the predicted concentration is well below the 2.5 µg/m³ criterion of Regulation 17. Given this result, it is concluded that Regulation 17 does not restrict the granting of a resource consent to discharge PM_{10} emissions from the flaring of LFG at Fairfield Closed Landfill (if the exemption in Regulation 17(2) did not apply).

With regard to cumulative effects, the predicted maximum offsite concentration of 0.4 µg/m³ (24-hour average) is considered to be negligible and is well below the concentration that could be detected using reference standard PM_{10} monitoring instruments. Accordingly, it is considered that any cumulative effects will be negligible. This same conclusion is reached regarding $PM_{2.5}$ emissions.

As described in Section 3.1, the potential effects of other combustion products are expected to be negligible. This conclusion is supported by the very low predicted PM_{10} concentrations.

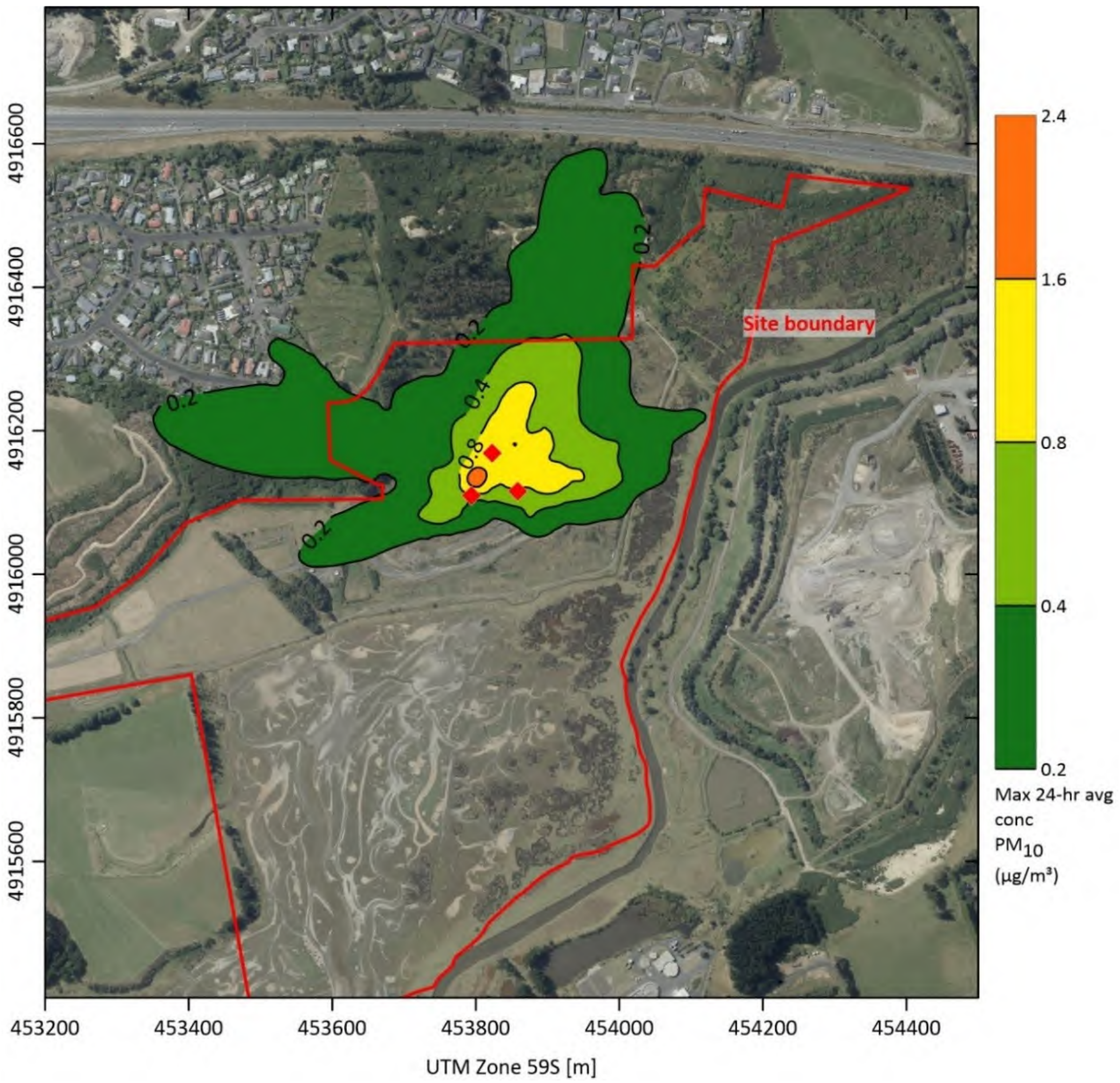


Figure 6.1:Maximum predicted 24-hour average PM_{10} ground level concentration. Regulation 17 criterion = 2.5 µg/m³.

7 Mitigation and management

Several mitigation and monitoring measures are currently in place or proposed for managing LFG and minimising odour from the Fairfield Closed Landfill. A summary of mitigation measures as proposed by WMNZ (2022) detailed in the Aftercare Management Plan and relevant measures for LFG and odour are summarised in Table 7.1. Preventative maintenance and monitoring that is proposed is summarised in Table 7.2.

Table 7.1: Operating controls and mitigation measures

Proposed mitigation measures and controls	Details
LFG capture and flaring	The capture and destruction of LFG using flares is the main mitigation measure minimising odour from LFG emissions. The small scale, and closed nature of the landfill means that enclosed flares of the type required by the NESAQ for much larger landfills is not necessary. In this instance, candlestick type flares with shrouds are used. The design of the flare system, which joins the three flares via a ring main, provides for redundancy, enabling a single flare to be off-line with the other two flares being able to manage the flow of LFG. The flares will continue to operate for as long as there is enough gas to sustain a flame in a single flare. According to the flare manufacturer, this is likely to be when the gas levels drop below 8.5 m^3/hr. When LFG generation at the Eastern Landfill reduces to a level where flaring of the LFG is not viable, then as stated in the Aftercare Management Plan, passive management of the LFG will occur. At the Eastern Landfill this will entail the continued collection of LFG via the piped network installed in the landfill, and the release of LFG to the environment via passive vents.
Existing landfill cap	The landfill cap provides a barrier for fugitive migration of LFG to the atmosphere through the landfill surface, while minimising the ingress of water into the waste mass. The landfill cap is an integral part of the LFG capture and collection system. As detailed in the Aftercare Management Plan, the cap has a minimum thickness of 800 mm of clay with a further 200 mm of topsoil. Leachate is collected and pumped to the Dunedin City Council sewer.

Table 7.2: Monitoring and reporting

Monitoring and reporting requirements	Maintenance, monitoring and reporting
As required	
Complaints	• Recording of details of the complainant, and time, date, and nature of complaint in OWS's incident record and response tracking system. • Investigation of the cause. • Verbal response to the complainant within 3 days. • Recording of the outcome in a register which will be available to the ORC and DCC on request.
Monitoring	
LFG (in gas capture system) The gas extraction system is expected to revert to a passive system approximately 15 years after closure (i.e., once LFG volumes reduce so that flaring is not viable).	• Monitor gas flow rate and composition, including methane: – Monthly while LFG is being flared, and thereafter. – Quarterly monitoring when passive operation commences. • Timely internal corrective actions will take place to investigate and remedy or mitigate any nuisance or hazard arising from LFG emissions.
LFG (at surface)/Landfill cap	• Inspections for evidence of LFG discharges such as odours, gas bubbling in puddles, or fissures in the landfill cap. This monitoring is to take place at the same time as the gas flow rate and composition monitoring of the gas capture system (as above).
LFG (at perimeter)	• Three-monthly monitor gas composition. The frequency of monitoring may be reviewed every 2 years. Monitoring at these locations may be ceased if a risk assessment confirms that risk of gas migration is no longer significant.
Reporting	
LFG	• Notify ORC, within 5 working days, if any sudden adverse change in gas levels is detected or if a trend of increasing gas concentrations is indicated. Advise ORC, within a timely manner, of the subsequent investigation carried out and correction actions implemented, including the effectiveness of these actions. • Annually, within the Annual Report required by the site's regional resource consents, all gas monitoring data and results are to be provided to ORC.

8 Conclusions

Waste Management NZ Limited (WMNZ) is seeking resource consents in relation to ongoing activities at the Fairfield Closed Landfill from the Otago Regional Council (ORC), which includes consent to discharge contaminants into air.

This air quality assessment report has been prepared on behalf of WMNZ to inform its resource consent application for the discharge of contaminants into air from the Landfill. The main discharge to air from the landfill is odour associated with landfill gas. The assessment of potential odour effects has been undertaken in accordance with MfE guidance and concludes that ‘offensive or objectionable’ odour effects are unlikely to occur, given the operation of a LFG collection and flaring system. This system will also reduce the likelihood of offsite LFG migration.

The flaring of LFG will give rise to combustion emissions. Due to the small scale of the landfill (and its associated small scale of generation of LFG), combustion emissions would usually be assessed qualitatively. However, in this instance the location of the landfill is within a polluted airshed (Otago 2 Airshed), which necessitates dispersion modelling of PM_{10} emissions from LFG combustion in order to assess the requirements of Regulation 17 of the National Environmental Standards for Air Quality (NESAQ). The dispersion modelling assessment predicts very low concentrations of PM_{10} that are well within the requirements of Regulation 17 of the NESAQ.

Overall, the discharges to air associated with the Fairfield Closed Landfill are assessed as having ‘less than minor’ air quality effects, and there are no impediments in granting of consent under Regulation 17 of the NESAQ.

9 References

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10 Applicability

This report has been prepared for the exclusive use of our client Waste Management NZ Limited , 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 our client will submit this report as part of an application for resource consent and that Otago Regional Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

....

Richard Chilton
Technical Director Air Quality

Authorised for Tonkin & Taylor Ltd by:

....

Jo Ferry
Project Director

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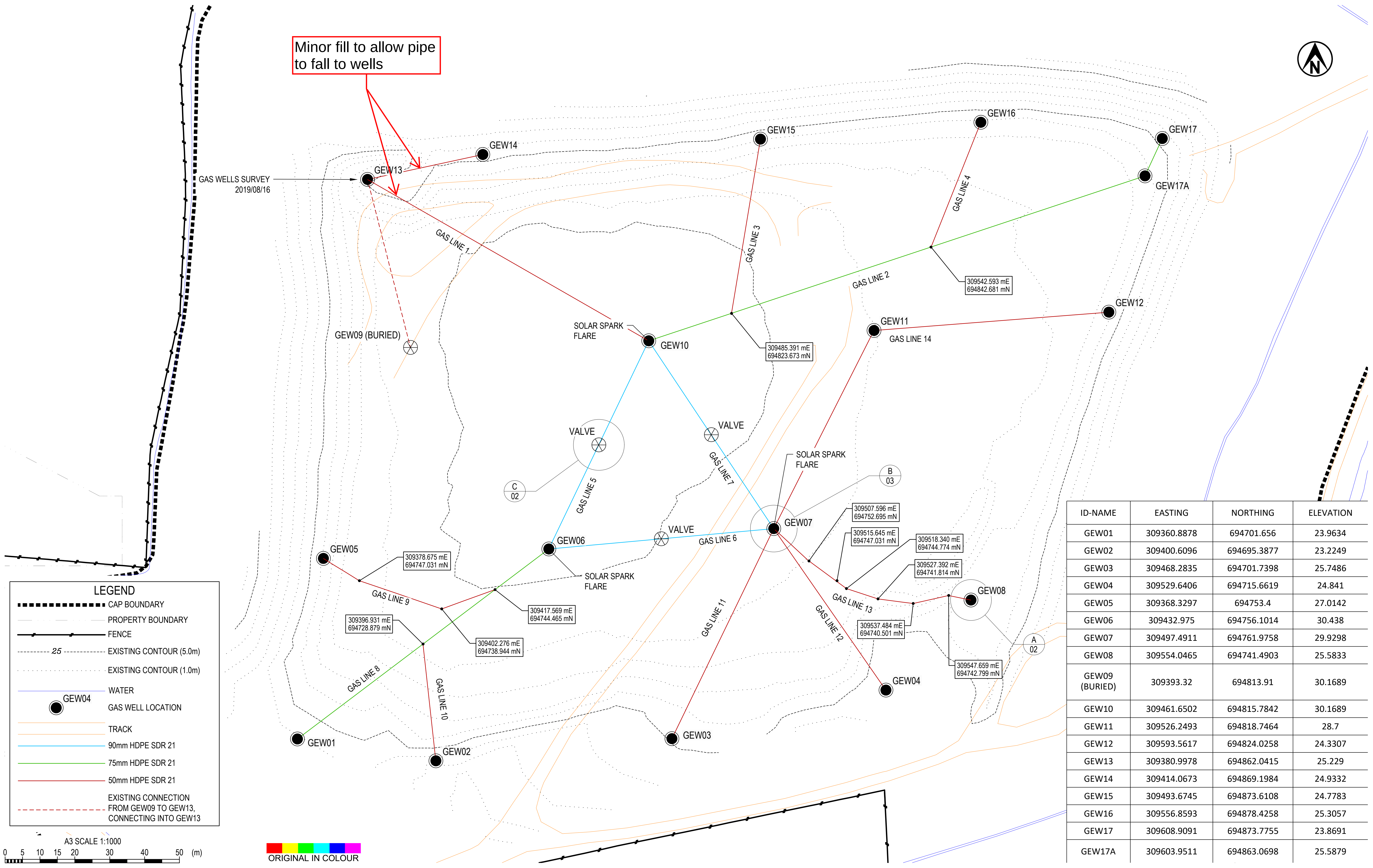
Appendix A Flare locations and gas wells



ID-NAME	EASTING	NORTHING	ELEVATION
GEW01	309360.8878	694701.656	23.9634
GEW02	309400.6096	694695.3877	23.2249
GEW03	309468.2835	694701.7398	25.7486
GEW04	309529.6406	694715.6619	24.841
GEW05	309368.3297	694753.4	27.0142
GEW06	309432.975	694756.1014	30.438
GEW07	309497.4911	694761.9758	29.9298
GEW08	309554.0465	694741.4903	25.5833
GEW09 (BURIED)	309393.32	694813.91	30.1689
GEW10	309461.6502	694815.7842	30.1689
GEW11	309526.2493	694818.7464	28.7
GEW12	309593.5617	694824.0258	24.3307
GEW13	309380.9978	694862.0415	25.229
GEW14	309414.0673	694869.1984	24.9332
GEW15	309493.6745	694873.6108	24.7783
GEW16	309556.8593	694878.4258	25.3057
GEW17	309608.9091	694873.7755	23.8691
GEW17A	309603.9511	694863.0698	25.5879

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REV	DESCRIPTION	CAD	CHK	DATE
1	CLIENT REVIEW ISSUE			

DESIGNED	JOSH	Sep.19
DRAWN	WYHU	Sep.19
DESIGN CHECKED		
DRAWING CHECKED		

DRAWING STATUS
CLIENT REVIEW ISSUE

NOT FOR CONSTRUCTION

THIS DRAWING IS NOT TO BE USED
FOR CONSTRUCTION PURPOSES
UNLESS SIGNED AS APPROVED

APPROVED DATE

CLIENT **WASTE MANAGEMENT NEW ZEALAND**
PROJECT **FAIRFIELD LANDFILL**
TITLE GENERAL ARRANGEMENT

UNDER REVISION

SCALE (A3) 1:1000
DWG No. 1011591.000-01
REV 1

Appendix B Flare PM_{10} emission calculations

Emission Factor:

Parameter	Value	Unit	Comment
PM emission factor	238	kg/1E6 dscm CH4	USEPA AP-42 Table 2.4-4 (Draft version updated 10/08)
	0.238	g/ dscm CH4	Assume all PM = PM10, dscm = dry standard m³

LFG parameters:

Parameter	Value	Unit	Comment
LFG flow rate to flares	238	m³/hr	Max capacity of flare
Temp. un-combusted LFG	15	°C	Assumed
LFG flow rate to flares	225.60	m³/h, STP	Based on 238 m³/hr at 15 °C (max capacity of flare)
Methane content of LFG	55%		Assumes 55% based on MfE (2001) Closed Landfill Guide
CH4 flow rate to flare	124.1	m³/h, STP	
	0.03	m³/s STP	

Emission rate:

Parameter	Value	Unit	Comment
PM10 mass emission rate	0.00820	g/s	

Appendix C CALPUFF model configuration

CALPUFF Parameters

Waste Managment NZ Limited
Fairfield Closed Landfill - 1020860

INPUT GROUP: 0 -- Input and Output File Names

Parameter	Description	Value
PUFLST	CALPUFF output list file (CALPUFF.LST)	CALPUFF.LST
CONDAT	CALPUFF output concentration file (CONC.DAT)	CONC.DAT
DFDAT	CALPUFF output dry deposition flux file (DFLX.DAT)	DFLX.DAT
WFDAT	CALPUFF output wet deposition flux file (WFLX.DAT)	WFLX.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NMETDOM	Number of CALMET.DAT domains	1
NMETDAT	Number of CALMET.DAT input files	12
NPTDAT	Number of PTEMARB.DAT input files	0
NARDAT	Number of BAEMARB.DAT input files	0
NVOLDAT	Number of VOLEMARB.DAT input files	0
NFLDAT	Number of FLEMARB.DAT input files	0
NRDDAT	Number of RDEMARB.DAT input files	0
NLNDAT	Number of LNEMARB.DAT input files	0
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2020-09-01-00-0000-2020-11-01-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2020-11-01-00-0000-2021-01-01-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-01-01-00-0000-2021-03-03-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-03-03-00-0000-2021-05-03-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-05-03-00-0000-2021-07-02-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-07-02-00-0000-2021-09-01-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-09-01-00-0000-2021-11-01-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-11-01-00-0000-2022-01-01-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-01-01-00-0000-2022-03-03-00-0000.DAT

INPUT GROUP: 0 -- Input and Output File Names		
Parameter	**Description**	**Value**
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-03-03-00-0000-2022-05-03-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-05-03-00-0000-2022-07-03-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-07-03-00-0000-2022-09-01-12-0000.DAT

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
METRUN	Run all periods in met data file? (0 = no, 1 = yes)	0
IBYR	Starting year	2020
IBMO	Starting month	9
IBDY	Starting day	1
IBHR	Starting hour	0
IBMIN	Starting minute	0
IBSEC	Starting second	0
IEYR	Ending year	2022
IEMO	Ending month	9
IEDY	Ending day	1
IEHR	Ending hour	11
IEMIN	Ending minute	0
IESEC	Ending second	0
ABTZ	Base time zone	UTC+1200
NSECDT	Length of modeling time-step (seconds)	3600
NSPEC	Number of chemical species modeled	1
NSE	Number of chemical species to be emitted	1
ITEST	Stop run after SETUP phase (1 = stop, 2 = run)	2
MRESTART	Control option to read and/or write model restart data	0
NRESPD	Number of periods in restart output cycle	0
METFM	Meteorological data format (1 = CALMET, 2 = ISC, 3 = AUSPLUME, 4 = CTDM, 5 = AERMET)	1
MPRFFM	Meteorological profile data format (1 = CTDM, 2 = AERMET)	1
AVET	Averaging time (minutes)	60
PGTIME	PG Averaging time (minutes)	60
IOUTU	Output units for binary output files (1 = mass, 2 = odour, 3 = radiation)	1

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**
MGAUSS	Near field vertical distribution (0 = uniform, 1 = Gaussian)	1
MCTADJ	Terrain adjustment method (0 = none, 1 = ISC-type, 2 = CALPUFF-type, 3 = partial plume path)	3
MCTSG	Model subgrid-scale complex terrain? (0 = no, 1 = yes)	0
MSLUG	Near-field puffs modeled as elongated slugs? (0 = no, 1 = yes)	0
MTRANS	Model transitional plume rise? (0 = no, 1 = yes)	1
MTIP	Apply stack tip downwash to point sources? (0 = no, 1 = yes)	1
MRISE	Plume rise module for point sources (1 = Briggs, 2 = numerical)	1
MTIP_FL	Apply stack tip downwash to flare sources? (0 = no, 1 = yes)	0
MRISE_FL	Plume rise module for flare sources (1 = Briggs, 2 = numerical)	2
MBDW	Building downwash method (1 = ISC, 2 = PRIME)	1
MSHEAR	Treat vertical wind shear? (0 = no, 1 = yes)	0
MSPLIT	Puff splitting allowed? (0 = no, 1 = yes)	0
MCHEM	Chemical transformation method (0 = not modeled, 1 = MESOPUFF II, 2 = User-specified, 3 = RIVAD/ARM3, 4 = MESOPUFF II for OH, 5 = half-life, 6 = RIVAD w/ISORROPIA, 7 = RIVAD w/ISORROPIA CalTech SOA)	0
MAQCHEM	Model aqueous phase transformation? (0 = no, 1 = yes)	0
MLWC	Liquid water content flag	1
MWET	Model wet removal? (0 = no, 1 = yes)	0
MDRY	Model dry deposition? (0 = no, 1 = yes)	0
MTILT	Model gravitational settling (plume tilt)? (0 = no, 1 = yes)	0
MDISP	Dispersion coefficient calculation method (1= PROFILE.DAT, 2 = Internally, 3 = PG/MP, 4 = MESOPUFF II, 5 = CTDM)	2
MTURBVW	Turbulence characterization method (only if MDISP = 1 or 5)	3
MDISP2	Missing dispersion coefficients method (only if MDISP = 1 or 5)	3
MTAULY	Sigma-y Lagrangian timescale method	0
MTAUADV	Advective-decay timescale for turbulence (seconds)	0
MCTURB	Turbulence method (1 = CALPUFF, 2 = AERMOD)	1
MROUGH	PG sigma-y and sigma-z surface roughness adjustment? (0 = no, 1 = yes)	0
MPARTL	Model partial plume penetration for point sources? (0 = no, 1 = yes)	1
MPARTLBA	Model partial plume penetration for buoyant area sources? (0 = no, 1 = yes)	0
MTINV	Strength of temperature inversion provided in PROFILE.DAT? (0 = no - compute from default gradients, 1 = yes)	0
MPDF	PDF used for dispersion under convective conditions? (0 = no, 1 = yes)	1
MSGTIBL	Sub-grid TIBL module for shoreline? (0 = no, 1 = yes)	0
MBCON	Boundary conditions modeled? (0 = no, 1 = use BCON.DAT, 2 = use CONC.DAT)	0
MSOURCE	Save individual source contributions? (0 = no, 1 = yes)	0
MFOG	Enable FOG model output? (0 = no, 1 = yes - PLUME mode, 2 = yes - RECEPTOR mode)	0
MREG	Regulatory checks (0 = no checks, 1 = USE PA LRT checks)	0

INPUT GROUP: 3 -- Species List		
Parameter	**Description**	**Value**
CSPEC	Species included in model run	PM10

INPUT GROUP: 4 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
PMAP	Map projection system	UTM
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0
IUTMZN	UTM zone (1 to 60)	59
UTMHEM	Hemisphere (N = northern, S = southern)	S
RLAT0	Latitude of projection origin (decimal degrees)	0.00N
RLON0	Longitude of projection origin (decimal degrees)	0.00E
XLAT1	1st standard parallel latitude (decimal degrees)	30S
XLAT2	2nd standard parallel latitude (decimal degrees)	60S
DATUM	Datum-region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	100
NY	Meteorological grid - number of Y grid cells	100
NZ	Meteorological grid - number of vertical layers	10
DGRIDKM	Meteorological grid spacing (km)	0.05
ZFACE	Meteorological grid - vertical cell face heights (m)	0.0, 20.0, 40.0, 80.0, 160.0, 320.0, 640.0, 1200.0, 2000.0, 3000.0, 4000.0
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	451.3183
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	4913.6159
IBCOMP	Computational grid - X index of lower left corner	23
JBCOMP	Computational grid - Y index of lower left corner	27
IECOMP	Computational grid - X index of upper right corner	76
JECOMP	Computational grid - Y index of upper right corner	77
LSAMP	Use sampling grid (gridded receptors) (T = true, F = false)	F
IBSAMP	Sampling grid - X index of lower left corner	1
JBSAMP	Sampling grid - Y index of lower left corner	1
IESAMP	Sampling grid - X index of upper right corner	2
JESAMP	Sampling grid - Y index of upper right corner	2
MESHDN	Sampling grid - nesting factor	1

INPUT GROUP: 5 -- Output Options		
Parameter	**Description**	**Value**
ICON	Output concentrations to CONC.DAT? (0 = no, 1 = yes)	1
IDRY	Output dry deposition fluxes to DFLX.DAT? (0 = no, 1 = yes)	0
IWET	Output wet deposition fluxes to WFLX.DAT? (0 = no, 1 = yes)	0

INPUT GROUP: 5 -- Output Options		
Parameter	**Description**	**Value**
IT2D	Output 2D temperature data? (0 = no, 1 = yes)	0
IRHO	Output 2D density data? (0 = no, 1 = yes)	0
IVIS	Output relative humidity data? (0 = no, 1 = yes)	0
LCOMPRS	Use data compression in output file (T = true, F = false)	T
IQAPLOT	Create QA output files suitable for plotting? (0 = no, 1 = yes)	1
IPFTRAK	Output puff tracking data? (0 = no, 1 = yes use timestep, 2 = yes use sampling step)	0
IMFLX	Output mass flux across specific boundaries? (0 = no, 1 = yes)	0
IMBAL	Output mass balance for each species? (0 = no, 1 = yes)	0
INRISE	Output plume rise data? (0 = no, 1 = yes)	0
ICPRT	Print concentrations? (0 = no, 1 = yes)	0
IDPRT	Print dry deposition fluxes? (0 = no, 1 = yes)	0
IWPRT	Print wet deposition fluxes? (0 = no, 1 = yes)	0
ICFRQ	Concentration print interval (timesteps)	1
IDFRQ	Dry deposition flux print interval (timesteps)	1
IWFRQ	Wet deposition flux print interval (timesteps)	1
IPRTU	Units for line printer output (e.g., 3 = ug/m**3 - ug/m**2/s, 5 = odor units)	3
IMESG	Message tracking run progress on screen (0 = no, 1 and 2 = yes)	2
LDEBUG	Enable debug output? (0 = no, 1 = yes)	F
IPFDEB	First puff to track in debug output	1
NPFDEB	Number of puffs to track in debug output	1000
NN1	Starting meteorological period in debug output	1
NN2	Ending meteorological period in debug output	10

INPUT GROUP: 6 -- Subgrid Scale Complex Terrain Inputs		
Parameter	**Description**	**Value**
NHILL	Number of terrain features	0
NCTREC	Number of special complex terrain receptors	0
MHILL	Terrain and CTSG receptor data format (1= CTDM, 2 = OPTHILL)	2
XHILL2M	Horizontal dimension conversion factor to meters	1.0
ZHILL2M	Vertical dimension conversion factor to meters	1.0
XCTDMKM	X origin of CTDM system relative to CALPUFF system (km)	0.0
YCTDMKM	Y origin of CTDM system relative to CALPUFF system (km)	0.0

INPUT GROUP: 9 -- Miscellaneous Dry Deposition Parameters		
Parameter	**Description**	**Value**
RCUTR	Reference cuticle resistance (s/cm)	30
RGR	Reference ground resistance (s/cm)	10
REACTR	Reference pollutant reactivity	8

INPUT GROUP: 9 -- Miscellaneous Dry Deposition Parameters		
Parameter	**Description**	**Value**
NINT	Number of particle size intervals for effective particle deposition velocity	9
IVEG	Vegetation state in unirrigated areas (1 = active and unstressed, 2 = active and stressed, 3 = inactive)	1

INPUT GROUP: 11 -- Chemistry Parameters		
Parameter	**Description**	**Value**
MOZ	Ozone background input option (0 = monthly, 1 = hourly from OZONE.DAT)	1
BCKO3	Monthly ozone concentrations (ppb)	80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00
MNH3	Ammonia background input option (0 = monthly, 1 = from NH3Z.DAT)	0
MAVGNH3	Ammonia vertical averaging option (0 = no average, 1 = average over vertical extent of puff)	1
BCKNH3	Monthly ammonia concentrations (ppb)	10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2
MH2O2	H2O2 background input option (0 = monthly, 1 = hourly from H2O2.DAT)	1
BCKH2O2	Monthly H2O2 concentrations (ppb)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
RH_ISRP	Minimum relative humidity for ISORROPIA	50.0
SO4_ISRP	Minimum SO4 for ISORROPIA	0.4
BCKPMF	SOA background fine particulate (ug/m**3)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
OFRAC	SOA organic fine particulate fraction	0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15
VCNX	SOA VOC/NOX ratio	50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00
NDECAY	Half-life decay blocks	0

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
SYTDEP	Horizontal puff size for time-dependent sigma equations (m)	550
MHFTSZ	Use Heffter equation for sigma-z? (0 = no, 1 = yes)	0
JSUP	PG stability class above mixed layer	5
CONK1	Vertical dispersion constant - stable conditions	0.01

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
CONK2	Vertical dispersion constant - neutral/unstable conditions	0.1
TBD	Downwash scheme transition point option (<0 = Huber-Snyder, 1.5 = Schulman-Scire, 0.5 = ISC)	0.5
IURB1	Beginning land use category for which urban dispersion is assumed	10
IURB2	Ending land use category for which urban dispersion is assumed	19
ILANDUIN	Land use category for modeling domain	20
Z0IN	Roughness length for modeling domain (m)	.25
XLAIIN	Leaf area index for modeling domain	3.0
ELEVIN	Elevation above sea level (m)	.0
XLATIN	Meteorological station latitude (deg)	-999.0
XLONIN	Meteorological station longitude (deg)	-999.0
ANEMHT	Anemometer height (m)	10.0
ISIGMAV	Lateral turbulence format (0 = read sigma-theta, 1 = read sigma-v)	1
IMIXCTDM	Mixing heights read option (0 = predicted, 1 = observed)	0
XMXLEN	Slug length (met grid units)	1
XSAMLEN	Maximum travel distance of a puff/slug (met grid units)	1
MXNEW	Maximum number of slugs/puffs release from one source during one time step	99
MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99
NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2
SYMIN	Minimum sigma-y for a new puff/slug (m)	1
SZMIN	Minimum sigma-z for a new puff/slug (m)	1
SZCAP_M	Maximum sigma-z allowed to avoid numerical problem in calculating virtual time or distance (m)	5000000
SVMIN	Minimum turbulence velocities sigma-v (m/s)	0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37, 0.37
SWMIN	Minimum turbulence velocities sigma-w (m/s)	0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06, 0.03, 0.016
CDIV	Divergence criterion for dw/dz across puff (1/s)	0, 0
NLUTIBL	TIBL module search radius (met grid cells)	4
WSCALM	Minimum wind speed allowed for non-calm conditions (m/s)	0.5
XMAXZI	Maximum mixing height (m)	3000
XMINZI	Minimum mixing height (m)	50
TKCAT	Emissions scale-factors temperature categories (K)	265., 270., 275., 280., 285., 290., 295., 300., 305., 310., 315.
PLX0	Wind speed profile exponent for stability classes 1 to 6	0.07, 0.07, 0.1, 0.15, 0.35, 0.55
PTG0	Potential temperature gradient for stable classes E and F (deg K/m)	0.02, 0.035

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
PPC	Plume path coefficient for stability classes 1 to 6	0.5, 0.5, 0.5, 0.5, 0.35, 0.35
SL2PF	Slug-to-puff transition criterion factor (sigma-y/slug length)	10
FCLIP	Hard-clipping factor for slugs (0.0 = no extrapolation)	0
NSPLIT	Number of puffs created from vertical splitting	3
IRESPLIT	Hour for puff re-split	0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0
ZISPLIT	Minimum mixing height for splitting (m)	100
ROLDMAX	Mixing height ratio for splitting	0.25
NSPLITH	Number of puffs created from horizontal splitting	5
SYSPLITH	Minimum sigma-y (met grid cells)	1
SHSPLITH	Minimum puff elongation rate (SYSPLITH/hr)	2
CNSPLITH	Minimum concentration (g/m**3)	0
EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	0.0001
EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-006
DSRISE	Trajectory step-length for numerical rise integration (m)	1.0
HTMINBC	Minimum boundary condition puff height (m)	500
RSAMPBC	Receptor search radius for boundary condition puffs (km)	10
MDEPBC	Near-surface depletion adjustment to concentration (0 = no, 1 = yes)	1

INPUT GROUP: 13 -- Point Source Parameters		
Parameter	**Description**	**Value**
NPT1	Number of point sources	3
IPTU	Units used for point source emissions (e.g., 1 = g/s)	1
NSPT1	Number of source-species combinations with variable emission scaling factors	0
NPT2	Number of point sources in PTEMARB.DAT file(s)	0

INPUT GROUP: 14 -- Area Source Parameters		
Parameter	**Description**	**Value**
NAR1	Number of polygon area sources	0
IARU	Units used for area source emissions (e.g., 1 = g/m**2/s)	1
NSAR1	Number of source-species combinations with variable emission scaling factors	0
NAR2	Number of buoyant polygon area sources in BAEMARB.DAT file(s)	0

INPUT GROUP: 15 -- Line Source Parameters		
Parameter	**Description**	**Value**
NLN2	Number of buoyant line sources in LNEMARB.DAT file	0
NLINES	Number of buoyant line sources	0

INPUT GROUP: 15 -- Line Source Parameters		
Parameter	**Description**	**Value**
ILNU	Units used for line source emissions (e.g., 1 = g/s)	1
NSLN1	Number of source-species combinations with variable emission scaling factors	0
NLRISE	Number of distances at which transitional rise is computed	6

INPUT GROUP: 16 -- Volume Source Parameters		
Parameter	**Description**	**Value**
NVL1	Number of volume sources	0
IVLU	Units used for volume source emissions (e.g., 1 = g/s)	1
NSVL1	Number of source-species combinations with variable emission scaling factors	0
NVL2	Number of volume sources in VOLEMARB.DAT file(s)	0

INPUT GROUP: 17 -- FLARE Source Control Parameters (variable emissions file)		
Parameter	**Description**	**Value**
NFL2	Number of flare sources defined in FLEMARB.DAT file(s)	0

INPUT GROUP: 18 -- Road Emissions Parameters		
Parameter	**Description**	**Value**
NRD1	Number of road-links sources	0
NRD2	Number of road-links in RDEMARB.DAT file	0
NSFRDS	Number of road-links and species combinations with variable emission-rate scale-factors	0

INPUT GROUP: 19 -- Emission Rate Scale-Factor Tables		
Parameter	**Description**	**Value**
NSFTAB	Number of emission scale-factor tables	0

INPUT GROUP: 20 -- Non-gridded (Discrete) Receptor Information		
Parameter	**Description**	**Value**
NREC	Number of discrete receptors (non-gridded receptors)	1217
NRGRP	Number of receptor group names	0

CALPUFF View - Source Parameters
MS Excel - Lakes Format

Type	ID	Base_Elev	Height	Diam	Exit_Vel	Exit_Temp	Moment_Flux	PM10	Num_Coords	X1	Y1
		[m]	[m]	[m]	[m/s]	[K]		[g/s]			
POINT	GEW10_FL	30	3.73	0.62	17.8	922	1	0.0082	1	453822.5	4916169
POINT	GEW07_FL	27.49	3.73	0.62	17.8	922	1	0.0082	1	453858.3	4916116
POINT	GEW06_FL	26.32	3.73	0.62	17.8	922	1	0.0082	1	453793.8	4916109

Appendix D CALMET model configuration

CALMET Parameters

Fairfield Landfill
Otago
MetRun

INPUT GROUP: 0 -- Input and Output File Names

Parameter	Description	Value
GEODAT	Input file of geophysical data (GEO.DAT)	GEO.DAT
METLST	Output file name of CALMET list file (CALMET.LST)	CALMET.LST
METDAT	Output file name of generated gridded met files (CALMET.DAT)	CALMET.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NUSTA	Number of upper air stations	0
NOWSTA	Number of overwater stations	0
NM3D	Number of prognostic meteorological data files (3D.DAT)	24
NIGF	Number of IGF-CALMET.DAT files used as initial guess	0

INPUT GROUP: 1 -- General Run Control Parameters

Parameter	Description	Value
IBYR	Starting year	2020
IBMO	Starting month	9
IBDY	Starting day	1
IBHR	Starting hour	0
IBSEC	Starting second	0
IEYR	Ending year	2022
IEMO	Ending month	9
IEDY	Ending day	1
IEHR	Ending hour	12
IESEC	Ending second	0
ABTZ	Base time zone	UTC+1200
NSECDT	Length of modeling time-step (seconds)	3600
IRTYPE	Output run type (0 = wind fields only, 1 = CALPUFF/CALGRID)	1
LCALGRD	Compute CALGRID data fields (T = true, F = false)	T
ITEST	Flag to stop run after setup phase (1 = stop, 2 = run)	2
MREG	Regulatory checks (0 = no checks, 1 = US EPA LRT checks)	0

INPUT GROUP: 2 -- Map Projection and Grid Control Parameters

Parameter	Description	Value
PMAP	Map projection system	UTM
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0

INPUT GROUP: 2 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
IUTMZN	UTM zone (1 to 60)	59
UTMHEM	Hemisphere of UTM projection (N = northern, S = southern)	S
XLAT1	1st standard parallel latitude (decimal degrees)	30S
XLAT2	2nd standard parallel latitude (decimal degrees)	60S
DATUM	Datum-Region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	100
NY	Meteorological grid - number of Y grid cells	100
DGRIDKM	Meteorological grid spacing (km)	0.05
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	451.3183
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	4913.6159
NZ	Meteorological grid - number of vertical layers	10
ZFACE	Meteorological grid - vertical cell face heights (m)	0.00,20.00,40.00,80.00,160.00,320.00,640.00,1200.00,2000.00,3000.00,4000.00

INPUT GROUP: 3 -- Output Options		
Parameter	**Description**	**Value**
LSAVE	Save met fields in unformatted output file (T = true, F = false)	T
IFORMO	Type of output file (1 = CALPUFF/CALGRID, 2 = MESOPUFF II)	1
LPRINT	Print met fields (F = false, T = true)	F
IPRINF	Print interval for output wind fields (hours)	1
STABILITY	Print gridded PGT stability classes? (0 = no, 1 = yes)	0
USTAR	Print gridded friction velocities? (0 = no, 1 = yes)	0
MONIN	Print gridded Monin-Obukhov lengths? (0 = no, 1 = yes)	0
MIXHT	Print gridded mixing heights? (0 = no, 1 = yes)	0
WSTAR	Print gridded convective velocity scales? (0 = no, 1 = yes)	0
PRECIP	Print gridded hourly precipitation rates? (0 = no, 1 = yes)	0
SENSHEAT	Print gridded sensible heat fluxes? (0 = no, 1 = yes)	0
CONVZI	Print gridded convective mixing heights? (0 = no, 1 = yes)	0
LDB	Test/debug option: print input met data and internal variables (F = false, T = true)	F
NN1	Test/debug option: first time step to print	1
NN2	Test/debug option: last time step to print	1
LDBCST	Test/debug option: print distance to land internal variables (F = false, T = true)	F
IOUTD	Test/debug option: print control variables for writing winds? (0 = no, 1 = yes)	0
NZPRN2	Test/debug option: number of levels to print starting at the surface	1
IPR0	Test/debug option: print interpolated winds? (0 = no, 1 = yes)	0
IPR1	Test/debug option: print terrain adjusted surface wind? (0 = no, 1 = yes)	0

INPUT GROUP: 3 -- Output Options		
Parameter	**Description**	**Value**
IPR2	Test/debug option: print smoothed wind and initial divergence fields? (0 = no, 1 = yes)	0
IPR3	Test/debug option: print final wind speed and direction? (0 = no, 1 = yes)	0
IPR4	Test/debug option: print final divergence fields? (0 = no, 1 = yes)	0
IPR5	Test/debug option: print winds after kinematic effects? (0 = no, 1 = yes)	0
IPR6	Test/debug option: print winds after Froude number adjustment? (0 = no, 1 = yes)	0
IPR7	Test/debug option: print winds after slope flow? (0 = no, 1 = yes)	0
IPR8	Test/debug option: print final winds? (0 = no, 1 = yes)	0

INPUT GROUP: 4 -- Meteorological Data Options		
Parameter	**Description**	**Value**
NOOBS	Observation mode (0 = stations only, 1 = surface/overwater stations with prognostic upper air, 2 = prognostic data only)	2
NSSTA	Number of surface stations	0
NPSTA	Number of precipitation stations	-1
ICLDOUT	Output the CLOUD.DAT file? (0 = no, 1 = yes)	0
MCLOUD	Method to compute cloud fields (1 = from surface obs, 2 = from CLOUD.DAT, 3 = from prognostic (Teixera), 4 = from prognostic (MM5toGrads)	4
IFORMS	Surface met data file format (1 = unformatted, 2 = formatted)	2
IFORMP	Precipitation data file format (1 = unformatted, 2 = formatted)	2
IFORMC	Cloud data file format (1 = unformatted, 2 = formatted)	1

INPUT GROUP: 5 -- Wind Field Options and Parameters		
Parameter	**Description**	**Value**
IWFCOD	Wind field model option (1 = objective analysis, 2 = diagnostic)	1
IFRADJ	Adjust winds using Froude number effects? (0 = no, 1 = yes)	1
IKINE	Adjust winds using kinematic effects? (0 = no, 1 = yes)	0
IOBR	Adjust winds using O'Brien velocity procedure? (0 = no, 1 = yes)	0
ISLOPE	Compute slope flow effects? (0 = no, 1 = yes)	1
IEXTRP	Extrapolation of surface winds to upper layers method (1 = none, 2 = power law, 3 = user input, 4 = similarity theory, - = same except layer 1 data at upper air stations are ignored)	1
ICALM	Extrapolate surface winds even if calm? (0 = no, 1 = yes)	0
BIAS	Weighting factors for surface and upper air stations (NZ values)	-1.0,-0.989,-0.971,-0.937,-0.868,-0.731,-0.479,-0.089,0.427,1.0
RMIN2	Minimum upper air station radius of influence for surface extrapolation exclusion (km)	4
IPROG	Use prognostic winds as input to diagnostic wind model (0 = no, 13 = use winds from 3D.DAT as Step 1 field, 14 = use winds from 3D.DAT as initial guess field, 15 = use winds from 3D.DAT file as observations)	14

INPUT GROUP: 5 -- Wind Field Options and Parameters		
Parameter	**Description**	**Value**
ISTEPPGS	Prognostic data time step (seconds)	3600
IGFMET	Use coarse CALMET fields as initial guess? (0 = no, 1 = yes)	0
LVARY	Use varying radius of influence (F = false, T = true)	F
RMAX1	Maximum radius of influence in the surface layer (km)	0
RMAX2	Maximum radius of influence over land aloft (km)	0
RMAX3	Maximum radius of influence over water (km)	0
RMIN	Minimum radius of influence used in wind field interpolation (km)	0.1
TERRAD	Radius of influence of terrain features (km)	1.5
R1	Relative weight at surface of step 1 fields and observations (km)	0
R2	Relative weight aloft of step 1 field and observations (km)	0
RPROG	Weighting factors of prognostic wind field data (km)	0
DIVLIM	Maximum acceptable divergence	5E-006
NITER	Maximum number of iterations in the divergence minimization procedure	50
NSMTH	Number of passes in the smoothing procedure (NZ values)	2,9*4
NINTR2	Maximum number of stations used in each layer for interpolation (NZ values)	10*99
CRITFN	Critical Froude number	1
ALPHA	Empirical factor triggering kinematic effects	0.1
NBAR	Number of barriers to interpolation of the wind fields	0
KBAR	Barrier - level up to which barriers apply (1 to NZ)	10
IDIOPT1	Surface temperature (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	-1
IDIOPT2	Temperature lapse rate used in the computation of terrain-induced circulations (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
IUPT	Upper air station to use for the domain-scale lapse rate (between 1 and NUSTA)	-1
ZUPT	Depth through which the domain-scale lapse rate is computed (m)	200
IDIOPT3	Initial guess field winds (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
IUPWND	Upper air station to use for domain-scale winds	-1
ZUPWND	Bottom and top of layer through which the domain-scale winds are computed (m)	1.0, 1.00
IDIOPT4	Read observed surface wind components (0 = from SURF.DAT, 1 = from DIAG.DAT)	0
IDIOPT5	Read observed upper wind components (0 = from UPn.DAT, 1 = from DIAG.DAT)	0
LLBREZE	Use Lake Breeze module (T = true, F = false)	F
NBOX	Lake Breeze - number of regions	0

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters		
Parameter	**Description**	**Value**

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters		
Parameter	**Description**	**Value**
CONSTB	Mixing height constant: neutral, mechanical equation	1.41
CONSTE	Mixing height constant: convective equation	0.15
CONSTN	Mixing height constant: stable equation	2400
CONSTW	Mixing height constant: overwater equation	0.16
FCORIOL	Absolute value of Coriolis parameter (1/s)	0.0001
IAVEZI	Spatial mixing height averaging? (0 = no, 1 = yes)	1
MNMDAV	Maximum search radius in averaging process (grid cells)	1
HAFANG	Half-angle of upwind looking cone for averaging (degrees)	30
ILEVZI	Layer of winds used in upwind averaging (between 1 and NZ)	1
IMIXH	Convective mixing height method (1 = Maul-Carson, 2 = Batchvarova-Gryning, - for land cells only, + for land and water cells)	1
THRESHL	Overland threshold boundary flux (W/m**3)	0
THRESHW	Overwater threshold boundary flux (W/m**3)	0.05
ITWPROG	Overwater lapse rate and deltaT options (0 = from SEA.DAT, 1 = use prognostic lapse rates and SEA.DAT deltaT, 2 = from prognostic)	0
ILUOC3D	Land use category in 3D.DAT	16
DPTMIN	Minimum potential temperature lapse rate (K/m)	0.001
DZZI	Depth of computing capping lapse rate (m)	200
ZIMIN	Minimum overland mixing height (m)	50
ZIMAX	Maximum overland mixing height (m)	3000
ZIMINW	Minimum overwater mixing height (m)	50
ZIMAXW	Maximum overwater mixing height (m)	3000
ICOARE	Overwater surface fluxes method	10
DSHELF	Coastal/shallow water length scale (km)	0
IWARM	COARE warm layer computation (0 = off, 1 = on)	0
ICOOL	COARE cool skin layer computation (0 = off, 1 = on)	0
IRHPROG	Relative humidity read option (0 = from SURF.DAT, 1 = from 3D.DAT)	1
ITPROG	3D temperature read option (0 = stations, 1 = surface from station and upper air from prognostic, 2 = prognostic)	2
IRAD	Temperature interpolation type (1 = 1/R, 2 = 1/R**2)	1
TRADKM	Temperature interpolation radius of influence (km)	500
NUMTS	Maximum number of stations to include in temperature interpolation	5
IAVET	Conduct spatial averaging of temperatures? (0 = no, 1 = yes)	1
TGDEFB	Default overwater mixed layer lapse rate (K/m)	-0.0098
TGDEFA	Default overwater capping lapse rate (K/m)	-0.0045
JWAT1	Beginning land use category for temperature interpolation over water	999
JWAT2	Ending land use category for temperature interpolation over water	999
NFLAGP	Precipitation interpolation method (1 = 1/R, 2 = 1/R**2, 3 = EXP/R**2)	2
SIGMAP	Precipitation interpolation radius of influence (km)	100.
CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01

APPENDIX 5:

Groundwater, Surface Water & Ecological Assessment

Report titled 'Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology'
prepared by Pattle Delamore Partners Limited, dated February 2024

Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology

Prepared for

Waste Management NZ Limited

February 2024

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Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Waste Management New Zealand Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Waste Management New Zealand Limited for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

The closed Fairfield Landfill, which ceased waste disposal activities in 2017, currently operates under a number of resource consents for the discharge of leachate to groundwater, the take of groundwater containing leachate (which is then discharged into the Dunedin City Council's (DCC) wastewater network for subsequent treatment and disposal), the discharge of stormwater and discharges to air. These existing resource consents are due to expire in September 2024. As leachate and gas will continue to be generated at the site as the material in the landfill continues to slowly decompose, albeit over time at decreasing rates, new resource consents are required for the on-going management of leachate and gas originating in the landfill. Waste Management NZ Limited (WMNZ) wish to renew these resource consents to ensure ongoing management of the landfill's discharges and take activities, as part of its aftercare plan.

In support of a resource consent renewal application, Pattle Delamore Partners Limited (PDP) was engaged by WMNZ to prepare an assessment of the effects of the landfill on groundwater/surface water quantity, quality, and ecology, as well as the effects of subsurface landfill gas (LFG) migration associated with Fairfield Landfill.

Ecological Values

The closed Fairfield Landfill lies at the head of the Kaikorai Wetland – Estuary complex. The estuary supports a mosaic of saltmarsh plant communities, while the wetland, together with the streams and estuary, provide habitat, food, and passage for a number of 'threatened' and 'at risk' fish and birds. Despite the high degree of catchment modification and impacts, the wetland is recognised as being regionally significant. An assessment of the overall ecological values ranked the Kaikorai Wetland – Estuary complex as being Very High, while Kaikorai Stream was ranked as High.

Leachate Interception Drain and Management

In order to minimise the impacts of any leachate arising from the closed landfill may have on the wetland-estuary complex, a leachate interception drainage system operates at the toe of the landfill between the landfill and wetland area. The interception drain was designed to create a hydraulic depression to prevent the outward flow of groundwater towards the wetland-estuary system. The intercepted groundwater/leachate is pumped into the DCC's wastewater network and treatment plant. Maintaining a hydraulic depression within the interception drainage system is critical to prevent the outflow of groundwater from the landfill towards the wetland-estuary. To reduce the risk of operational failure, a robust maintenance schedule is being carried out by WMNZ and an alarm system to alert of any pump failure installed.

Groundwater Effects

While the majority of leachate impacted groundwater is intercepted and treated, monitoring of groundwater beyond the interception drain indicates that some leachate impacted groundwater is migrating away from the landfill and likely passively entering the wetland-estuary complex. This was not unexpected due to the landfill being unlined. While the area where the groundwater upwells/emerges to the surface of the Kaikorai Wetland-Estuary Complex is currently undetermined, it is anticipated that the furthest downstream upwelling point would be at the point of the Abbotsford Mudstone outcropping (~1.2 km downgradient).

The magnitude of potential contaminant concentrations migrating away from the landfill, together with high level estimates of mass flux and mass discharge were estimated based on available information. The mass discharge of total ammoniacal nitrogen (TAN) from the landfill was estimated to be in the order of 121 to 1,007 g/day. As context, the average mass discharge of TAN in the pumped leachate, which is discharged into the DCC's wastewater network, was calculated at 21,102 g/day. This indicates the interception drainage system is intercepting roughly between 95.4% and 99.4% of the leachate being generated.

Average daily volumes (based on monthly averages) of around 48 to 120 m^3/day of leachate-impacted groundwater are pumped from the leachate interception drain to the DCC's wastewater network and thus the treatment plant. Groundwater monitoring indicates that this pumping is causing a drawdown depression in the local vicinity of the drain within the shallow wells, as per the intent of the system. The drawdown effects do not appear to propagate far into the underlying strata allowing some leachate impacted groundwater to migrate from the site, which is likely a result of the low permeability marine sediments underlying the interception drain. Minimal drawdown effects have been observed within the deeper downstream monitoring wells. There are no recorded nearby groundwater abstraction wells that could be affected by this take.

A reduction in the volume of groundwater naturally discharging to the wetland-estuary is anticipated as a result of the groundwater/leachate abstraction that currently occurs within the interception drain. This would, in turn, result in a reduction in surface water volumes, with the potential loss occurring diffusely over a reasonably large area of the wetland-estuary. The full effect should be evident within a distance of around 1.2 km downstream of the landfill site.

Surface Water Effects

The discharge of leachate into the estuary may result in reduced water and sediment quality, as indicated by elevated concentrations of TAN, boron, and zinc, and reduced dissolved oxygen and pH within the existing monitoring data. This may lead to chronic and non-lethal toxicity effects to aquatic organisms, compositional shifts to pollution tolerate communities and behavioural avoidance of degraded water.

Degradation of several water quality parameters was indicated in the long-term monitoring data for Christies/Coal Creeks and Kaikorai Stream, just prior to discharge into the wetland swamp. However, the wetland-estuary complex has been negatively affected by a wide range of anthropogenic-derived impacts over the last 100 years, including the Green Island Landfill on the eastern side of the estuary, so it is difficult to ascribe the contribution from these activities to the contaminant loading with the existing dataset. Poor water quality in the tributaries suggests that the aquatic biota would be negatively impacted, leading to reduced biodiversity and food sources.

Long term water quality data of both the wetland swamp and its tributaries showed that it, while degraded, was relatively stable. Current ecological values within the swamp and tributaries would be integrated with the long-term stable water quality. On occasions, elevated TAN concentrations may act as a barrier to fish migration. The presence of nationally vulnerable fish and bird species indicate that, at least, parts of the swamp and its tributaries, support high ecological values and high rarity/distinctiveness. Due to the Very High Ecological Value of the wetland swamp, the magnitude of any effects of ongoing leachate seepage (roughly between 0.6% to 4.6% of leachate generated) would be considered to be higher than in the estuary, or the tributaries. However, with uncertainty on the location of where groundwater emerges as surface water in the wetland-estuary complex and the lack of monitoring data, the effects cannot be determined with any accuracy.

Monitoring and Recommended Conditions

To address this, a tentative receiving environment groundwater, surface water and ecology monitoring plan has been proposed to determine the level and magnitude of effects of the ongoing leachate discharge. The sampling locations are preliminary at this stage and will be confirmed following a site inspection and assessment to better understand where groundwater may be upwelling to ensure the monitoring sites reflect the complexity of this system.

The risk to nearby residents from subsurface LFG migration from the landfill areas is acceptably low. Monitoring of the existing LFG wells in the landfill areas and sentinel wells between the landfill and receptors is recommended to continue as a prudent approach and has been included in the proposed monitoring programme.

It is recommended that a review of the monitoring conditions be undertaken every 5 years to ensure the controls and monitoring programme remain suitable for the level of risk identified.

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Appendices

1.0 Introduction

Pattle Delamore Partners Limited (PDP) has been engaged by Waste Management NZ Limited (WMNZ) to prepare an assessment of the groundwater/surface water quantity, quality and ecological effects, as well as the effects of subsurface landfill gas (LFG) migration associated with Fairfield Landfill. This assessment will support a resource consent application to renew existing consents for the site, which is being prepared by Planz Consultants Limited (Planz).

The landfill, which is considered to be “closed” and currently in the “aftercare” stage, is situated immediately south of Fairfield township, Otago, approximately 4 km west of Dunedin. The site location is shown in Figure 1, Appendix A.

The Fairfield Landfill currently operates under the following resource consents:

- Resource Consent 93540 – Discharge leachate to groundwater by seepage;
- Resource Consent 93541 – To take underground water containing leachate and other groundwater;
- Resource Consent 93542 – Discharge of stormwater to the Kaikorai Stream; and
- Resource Consent 95008 – Discharges to air.

These consents are due to expire in September 2024. WMNZ wish to seek new resource consents for the ongoing discharges and take activities associated with the landfill “aftercare” plan.

2.0 Site Details and History

The landfill is located at 127 Old Brighton Road in the suburb of Fairfield, Dunedin. Information provided by WMNZ and other available information, including aerial photographs, indicated the landfill was opened by Walton Park Sand Co (subsidiary of Fulton Hogan) in 1967. Filling then progressed from Old Brighton Road towards the east. There is no evidence to suggest that any earthwork or engineering works were undertaken prior to placement of the waste, in particular in the early stages (i.e. the landfills are unlined). The landfill ceased receiving waste in July 2017 and final contouring and capping works were completed in August 2022.

This application concerns the following filling areas across the site (refer Figure 2).

- The ‘Western Landfill’ adjoins Christies Creek and the Eastern Landfill area, which is visually obvious based on the elevation rise of the Eastern

Landfill's formation. The date filling commenced in this area was unknown, but this area was closed in 1996. Cover material has been placed above the waste and is currently surfaced with grass. However, the nature and thickness of the cover is also unknown. The access road to the Eastern Landfill extends through this landfill area.

- The 'Eastern Landfill' is the eastern most landfilling area and is the most recent operational area. Although there was evidence in historical aerial photographs of some filling in this area in the 1970s, the development of this area commenced in 1996 in accordance with resource consents granted by the Otago Regional Council (ORC) in 1995 and 1997. Disposal of waste material into the Eastern Landfill ceased in July 2017. Landfill closure and capping activities for this area were completed in August 2022 and comprised of at least 0.8 m of compacted clay and at least 0.2 m of topsoil with grass cover. The capping works were undertaken in accordance with Consent No. RM18.066.01.V1.

The Western Landfill area appeared to have been progressively filled via an active landfill tipping face, with up to 4 m of fill being placed directly on the estuary land surface (based on a 5 m RL on the existing top surface of these two landfill areas and water level in the estuary ranging around 1 m RL representing the likely original ground surface). The Eastern Landfill area was formed using a different process and was progressively filled in layers to form a landfill mound/dome above the original estuary surface with the maximum height of this landfill area reaching 31.5 m RL (i.e. approx. 30.5 m above the original ground surface).

2.1.1 Leachate Interception Drainage System

A leachate interception drainage system has been installed on the southern and eastern sides of the Eastern Landfill and the southern side of the Western Landfill, as required under the existing consent conditions. The purpose of this leachate drainage system is to create a hydraulic depression to prevent the outward flow of groundwater from the landfill towards the wetland-estuary system. The intercepted groundwater/leachate is pumped to the Dunedin City Council's (DCC) wastewater network, and thus the Green Island treatment plant.

The interception drainage system comprises a trench system installed on the landfill side of the perimeter access track, which is backfilled with a permeable material (railway ballast), and lateral drainage pipes comprising Megaflo pipe (perforated pipe) wrapped in filter cloth. The access track has a ground surface of approximately 2.3 m RL, with the laterals set at depths of between -0.5 and -1.0 m RL (i.e. up to 3.3 m below ground level - bgl). Lateral pipes extend from each side of a series of manhole sumps (LS24, LS26, LS28, LS30 and LS32, refer Figure 3). Water enters the laterals and flows via gravity towards each respective sump before being directed via a separate gravity pipeline on the opposite side of the access track towards a large sump at the pumping station (EPS42). A pump controlled by level switches maintains the water level within the pumping station sump at a low level to ensure the pipe network flows via gravity and that the depression in the phreatic zone (saturation zone) is maintained.

The pump has an alarm system on it to notify WMNZ, via text message, of any operational issues or when the pump switches off. Regular inspection and monthly maintenance of the pump is also carried out to minimise the likelihood of the pump switching off. The leachate pump system is set to automatically shut down (‘high-high’ alarm) when flooding/inundation of the pump station sump occurs, to avoid pumping estuary water. Flooding/inundation occurs due to the occasional closure of the estuary mouth creating a backwater effect within the estuary-wetland increasing water levels. If the mouth is not opened (naturally or mechanically by ORC), then high water levels can overtop the perimeter access track and enter the top of the interception drainage system or overtop the leachate pump chamber and flood the system. This, in turn, activates the ‘high-high’ alarm shutting the leachate pump down. Mechanical opening of the estuary mouth is controlled by the ORC. Discussions with ORC indicated that there is no formal process, or trigger level (m RL) for opening the estuary mouth to the ocean but it is opened when the water levels get high enough to cause flooding of surrounding land.

2.1.2 Landfill Gas Collection

LFG from the Eastern Landfill is captured using a series of LFG wells and a conveyance pipeline system. The pipeline system operates in a ring main. Three candlestick-style flares control the discharge of the captured LFG. There is no LFG extraction in the Western Landfill area based on its age and insufficient LFG generation to enable flaring. Any LFG generated from this area is discharged passively (i.e., without flaring).

2.1.3 Stormwater Management

Stormwater from the northern and eastern sides of the Eastern Landfill area is directed to a stormwater retention pond on the northern side of the landfill (‘North Pond’). Overflow from the pond is discharged to a small drain that discharges to Kaikorai Stream. Stormwater from the southern side of the Eastern Landfill is directed to a separate retention pond on the south-western corner of the landfill (‘Weighbridge Pond’). This pond has an overflow structure that discharges into Kaikorai Lagoon Swamp.

There is no stormwater control on the Western Landfill area. Any stormwater from this area would soak into the landfill or be directed by land contouring towards the perimeter surface water bodies (Christies Creek) that discharge into Kaikorai Lagoon Swamp, or runoff would enter Kaikorai Lagoon Swamp directly.

2.1.4 Monitoring Programme

A number of groundwater, surface water and LFG monitoring locations have been monitored at approximately quarterly intervals from 1997[1] which has provided a detailed dataset to support this assessment of effects report. The monitoring locations are shown on Figure 2, and the results of the previous monitoring programme is discussed in further detail in Sections 5, 6, 7 and 8 of this report. The sampling locations were based on the requirements of resource consent conditions. However, there has been a number of minor changes over time, as provided for by the 2002 change to consent conditions, with the decommissioning of some wells as the landfill operation progressed and the addition of new monitoring locations, to improve the understanding of the environment and any effects from the landfill.

The monitoring results have been provided to ORC quarterly, with an annual summary report provided after the October sampling round. Five-yearly compliance monitoring reports were also produced in 2013, 2018 and 2023, as required under Condition 14 of Consent 93540. As these reports have been provided to ORC they have not been appended to this report.

2.2 Environmental Setting

The closed landfill lies at the head of the Kaikorai Wetland – Estuary Complex. The wetland, referred to as Kaikorai Lagoon Swamp, is classified as a wetland of regional significance due to its significant conservation and Kai Tahu values. A recent environmental sensitivity ranking of landfills within Otago undertaken by ORC, rated Fairfield as high risk. In support of the resource consent application, an assessment of effects on the surface water and groundwater quality, as well as on the ecology of Kaikorai Wetland-Estuary has been undertaken.

The following names have been used for the waterbodies discussed in this report.

- Upper Kaikorai Stream – refers to the stream to the north of Green Island, above the Kaikorai Stream/Abbotts Creek confluence.
- Kaikorai Stream – refers to the waterway flowing alongside the eastern edge of Fairfield landfill, below the Kaikorai Stream/Abbotts Creek confluence.
- Christies Creek – refers to the creek flowing along the northern edge of the Western Landfill area.
- Coal/Christies Creek confluence – refers to the waterway immediately below the confluence of Coal and Christies Creek.

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[1] Some datasets only date back to 2001 or 2002.

- Kaikorai Lagoon Swamp 'Wetland' (referred to this this report as wetland, swamp, or wetland swamp) – refers to the wetland (swamp marsh) that extends from just north-east of the Fairfield Landfill, to immediately below the landfill (above the costal marine area boundary – refer Figure 4).
- Kaikorai Lagoon 'Estuary' – refers the estuary region in the coastal marine area, downstream of the wetland swamp (refer Figure 4).
- Estuary-wetland refers to Kaikorai Wetland and Estuary complex.

3.0 NES-FM (2020)

The Resource Management (National Environmental Standards for Freshwater) Regulations (NES-F 2020) and the National Policy Statement for Freshwater Management (NPS-FM 2020) were introduced in 2020 to regulate and manage activities that pose risks to the health of freshwater and its ecosystems. The NPS-FM (2020) provides direction on how freshwater should be managed under the Resource Management Act 1991.

When the NES-F (2020) and the NPS-FM (2020) were first introduced, all wetlands were classified under these statutory planning documents, including those located seaward of the coastal marine area (CMA) boundary. However, in January 2023, the definition of wetlands was revised in both the NES-F (2020) and the NPS-FM (2020) to exclude wetlands that were within the CMA.

With respect to the Kaikorai Wetland – Estuary Complex, the CMA includes the entire estuary, as well as a small section of Kaikorai Stream from its mouth upstream to a distance of approximately five times the river mouth width or 1 kilometre upstream from the mouth of the river (as defined in the Resource Management Act 1991). The CMA area of the Kaikorai Wetland – Estuary Complex is indicated by the white hashed area in Figure 4. The Kaikorai Lagoon Swamp is regarded as a natural inland wetland, under the definitions in the NES-F (2020) and the NPS-FM (2020), with the exception of a small area of wetland near the mouth of Kaikorai Estuary, which is designated as being in the CMA. However, all of the wetland areas of the Kaikorai Wetland – Estuary Complex, are mapped as Regionally Significant Wetlands under the Otago Regional Plan (area shaded green in Figure 4).

4.0 Hydrogeological Setting

4.1 Hydrogeology

4.1.1 Lithology

The site is located near the head of the Kaikorai Lagoon Swamp 'Wetland'. The majority of the wetland and downstream estuary area is mapped as Holocene aged river deposits consisting of well sorted sandstone, schist and volcanic derived gravel and sand with minor mud and peat[2]. The 1;250,000 scale geological units by GNS are presented on Figure 5 which shows that the estuary is mainly surrounded by marine deposits of the Onekakara Group. These marine deposits are common in the coastal areas of Otago and were deposited in a range of shallow marine environments ranging from shore-face to outer shelf and offshore bars (Kamp, Vincent, & Tayler, 2015). The main rock in this group mapped by GNS is sandstone, with some conglomerates, siltstone, mudstone, limestone and shell beds. This unit is mapped both immediately north of the site, as well as flanking the estuary downstream of the site. Well logs drilled within the estuary (discussed below) would suggest that the mapped Onekakara Group deposits are more likely to consist of the Abbotsford mudstone, which is an innermost shelf marine deposit. As such, the Onekakara Group deposits have been interpreted as the Abbotsford Mudstone.

Additionally, Late Pleistocene shoreline deposits are present to the south-west of the Western Landfill area. This deposit is primarily mapped as sand and is therefore likely to be a reasonably permeable unit.

Further west of the site within the Christies Creek catchment, the geology is mapped as the Taratu Formation which is a sub-group and non-marine deposit of the Onekakara Group. This unit consists of quartz sand and conglomerate, lignite seams and carbonaceous mudstone. This is consistent with the presence of a historic lignite mines within the Christies Creek catchment. Further detail regarding the local lithology has been supplemented by local boreholes and test pits completed in the vicinity of the site.

Geological logs from borehole and test pit investigations undertaken at the site by various consultants in the 1990s are available. An extract of the hand drawn map showing the investigation locations is presented on Figure 6. As shown, some of the investigations were undertaken on the eastern side of Kaikorai Stream near the neighbouring Green Island Landfill.

There is a borehole located within the Fairfield Landfill (BH105) as well as downstream of the landfill (FB2A). Additionally, three hand auger logs (HA1 to HA3) and a borehole (BH102) were undertaken on the northern boundary of the site.

The log from well BH105 shows 6.35 m of concrete and rubbish representing the landfill material. The remainder of the log shows layers of bluish grey marine silt to the base of the log at 15.45 m bgl.

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[2] GNS Science. (2012). Geological Map of New Zealand [Data set]. GNS Science. https://doi.org/10.21420/QF82-7D42. accessed 23 September 2022.

Borehole FB2A is located just downgradient of the south-east extent of the landfill area and was drilled to a depth of 10 m bgl. The log describes dominantly interbedded layers of clayey silts, with smaller sandy components occurring below a depth of 3.35 m bgl. Sand also occurs at the base of the log from 9.63 to 10 m bgl.

Along the northern boundary, HA1 to HA3 show clay and silt-based material with some rubbish fragments to the termination depths between 2.3 and 3.5 m bgl. BH102 along the northern boundary shows silty clay fill to a depth of 6.3 m followed by greenish grey marine silt to a depth of 11.25 m bgl.

These logs are provided in Appendix B. Overall, the available information indicates that the landfill material overlies dominantly silt based marine sediments, with minor sand lenses. Based on the available logs this strata is up to 10 m thick in places. However, the associated report for BH102 and BH105 indicates that these boreholes were terminated at the interception of underlying bedrock (i.e. 11.25 and 15.45 m bgl respectively). Accounting for the fill material, the underlying marine sediments are around 5 m thick in the vicinity of BH102 and around 9.1 m thick in the vicinity of BH105.

Four boreholes (B1 - B4) were drilled within the vicinity of Kaikorai Stream towards the east and south-east of the site with the locations shown on Figure 6 with the logs also included in Appendix B. These logs describe fill associated with the adjacent Green Island landfill, underlain by recent estuarine deposits to depths between 8 and 16 m bgl. All four logs terminate within strata logged as Abbotsford mudstone (subgroup of the Onekakara Group) which is consistent with the geological map of the area. The mudstone is likely the ‘bedrock’ where boreholes BH102 and BH105 were terminated. As such, the estuarine deposits underlying the landfill as well as the estuary are expected to be reasonably thin, in the order of around 8 to 16 m thick, underlain by mudstone which is expected to be reasonably impermeable.

The strata interpreted as Abbotsford Mudstone that flanks the wetland appears to converge around 1.2 km downstream of the site and it is expected that this constriction would cause groundwater within the shallow estuarine sediments to upwell at this location, if this does not already occur at a more upstream location.

In 2012, PDP undertook a groundwater sampling investigation within the wetland. As part of the works, temporary sampling points were installed at 10 locations within the wetland (shown as SP1 – SP10 on Figure 7). During installation, the sediments were recorded as silty clay to a depth of at least 2 m bgl in the northern portion of the wetland (SP1 to SP4), with a sand lens encountered further south to depths between 1.5 and 1.8 m bgl (SP5 to SP10). While these investigations are shallow, it suggests that dominantly silty material is likely to gradually grade into more sandy material further south within the wetland. This investigation is further discussed in Section 5.5.

While many of the current landfill monitoring wells do not have available logs, the lithology beneath the wetland has been inferred based on the results of hydraulic conductivity testing undertaken in two deep and two shallow monitoring wells installed on the wetland side of the landfill (LS10, LS13, LD8 and LD11, Figure 2). The specific details around the hydraulic conductivity testing are provided in Section 4.1.3. However, the inferred geology indicates that the sediments beneath the wetland are variable and are likely to consist of interbedded layers of low permeability marine silts and higher permeability sands of varying grainsizes. This is consistent with the investigations undertaken in the 1990s.

4.1.2 Groundwater Levels and Flow Direction

Quarterly water level monitoring has occurred within both shallow and deep wells within and outside of the landfill, and also within the leachate interception drain wells as required under Conditions 7 and 8 of ORC Consent No. 93540. In addition, surface water levels have been measured at permanent staging posts within Christies Creek (SP1), Coal Creek (SP2), Kaikorai Stream (SP3) and immediately adjacent to the landfill within the wetland (SP5). Monitoring location SP5 is the most meaningful of these surface water level monitoring points as it represents the level of the wetland, which has the greatest influence on the water levels in the monitoring wells. The locations of the wells and surface water level sites are presented on Figure 2.

The wells are categorised into the following groups by their location[3]:

- Groundwater wells within the landfill (LGS1, LS2, LS3[4], LS4[5], LS6, LS9, LS12[6], LS14, LS18[7], LD5 and LD16);
- Groundwater wells outside the landfill (LGS7, LS10, LS13, LS15, LS19, LS21[8], LS22, LD8, LD11, LD17 and LD20); and
- Leachate interception drain wells (LS23, LS24, LS25, LS26, LGS27, LS28, LGS29, LS30, LS31, LS32 and LS33).

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[3] The grouping of wells differs to that recorded in the consent. This is based on further understanding of their location relative to the landfill.

[4] LS3 was destroyed/covered in 2004 as part of the landfilling operations.

[5] LS4 was destroyed/covered in 2010 as part of the landfilling operations.

[6] LS12 was destroyed/covered in 2005 as part of the landfilling operations.

[7] LS18 was destroyed/covered in 1997 as part of the landfilling operations.

[8] LS21 has recently been decommissioned and a new well LS21A is being installed to replace this well (see Figure 2)

The 'S' in the well name indicates the well is shallow and likewise the 'D' indicates the well is deep. The shallow wells range from 2.9 to 5.5 m deep while the deep wells range from 5.8 to 12.5 m deep (in terms of m below top of casing). No screen information is available for the wells. While the wells from 5.8 to 12.5 m deep are classified as "deep wells" in terms of this report, they are still considered to be shallow wells in an absolute sense. The lack of screen information means it is not possible to determine whether any shallow and deep well screened intervals overlap.

The plots showing the groundwater and wetland level records are presented in Figures 8 to 10. Discussion around the water level trends is provided in the following sections.

Wells Within the Landfill Area

Long term, the majority of the wells within the landfill area have shown reasonably consistent water levels. Well LD16 is the exception and has showed the most variability of any of the wells as further discussed below.

Shallow water levels within the Western Landfill (LS2) continue to show water levels approximately 1.5 m above the level of the surrounding surface water bodies (SP5) indicating that a natural water level gradient towards the surface water bodies exists. There is no obvious trend apparent, and this area appears to be in a natural equilibrium with environmental conditions (i.e. rainfall entering and seepage rates out). It is also noted that LS4, situated within the Eastern Landfill area, showed significantly higher groundwater levels in comparison to the remainder of the wells which are situated closer to the southern and eastern perimeter (and closer to the leachate interception drain). While the record from this well only extends to July 2010, the data suggests that there was likely to be reasonable degree of mounding within the landfill at this time, likely derived from rainfall given the landfill is surrounded by surface waterways. This well has been destroyed during the landfilling operations and it is not known what the current groundwater/leachate levels are further towards the centre of the landfill, although it is possible that mounding may reduce now that the final cap has been placed (i.e. limiting rainfall infiltration).

The water level record in LD16 is particularly interesting in that this is the only well within the landfill that has routinely shown groundwater levels lower in elevation than the wetland water level. The water level record is highly variable including a 2.5 m rise in water levels in 2013. Since 2013 the water levels in LD16 have slowly decreased and were similar to the levels pre-2013, with the exception of a further spike in water levels during 2022.

Well LD16 also regularly displays groundwater levels lower in elevation to the nearby LS14 which could indicate the presence of a downwards gradient within the landfill area. Together with vertical dispersion, this could aid in the migration of leachate indicators to the deeper wells downgradient of the landfill (further discussed in Sections 9.0 and 10). However, it is also noted that there was an apparent rise in water levels within LD16 during the January 2022, April 2022, and July 2022 monitoring rounds. During the July 2022 monitoring round the leachate pump at EPS42 was found to not be operating and once the pump was turned back on groundwater levels in LD16 dropped significantly (by around 3 m) during the subsequent follow up monitoring round approximately eight days later. As shown on Figure 8, this was the most significant drop in water levels as a result of the pump being turned back on out of all wells within the landfill area. Water levels have remined low ever since, including during April 2023 when the leachate pump was again found to be not operating at the time of the sampling round. Given the same response was not noted during the subsequent event, there is uncertainty regarding the exact cause of fluctuations in the well.

This variability means that the leachate/groundwater levels within and beneath the landfill will be complex and there will be some areas with limited mobility and other areas where preferential pathways may exist.

Wells Outside the Landfill Area

Data from the wells outside of the landfill typically show groundwater levels in the range of around -0.5 to 2 m RL (in comparison to a typical range of around 1.5 to 3 m RL for wells within the landfill) which indicates that groundwater levels are lower outside of the landfill area. As such, the general direction of groundwater flow is expected to be towards the south and east from the boundaries of the landfill area due to the mounding effect within the landfill areas, the surface water levels and the impact of the pumped leachate interception drainage system. Some moderate variability (up to 0.7 m between monitoring rounds) continues to be noted due to the close proximity of some wells to the wetland and the apparent hydraulic connection (i.e. LGS7 and LD8). There is an obvious trend of higher groundwater levels within the deep wells compared to the shallow wells (in particular LD11, LD17 and LD20), with groundwater levels in the deep wells consistently above the water level in the wetland (except for LD8 which is generally close to or slightly above the surface water level). This indicates the presence of positive water pressures in the deeper water bearing layer and that the strata provides some resistance to flow between the shallow and deep wells. The deeper wells appear to have remained generally stable since 2018. There are no longer term trends apparent. It is noted that LS22 is the only shallow well to have groundwater levels consistently above the water level in the wetland although this is expected to be a result of the well location on the northern margin of the landfill (furthest from the wetland).

The majority of shallow wells outside of the landfill area show groundwater levels below the surface water level in the wetland, which is expected to be a result of the influence of the leachate interception drain causing a depression in these wells given their close proximity to the interception drain, as per the intent of the system. It is also noted that the shallow wells showed an obvious spike in water levels during the July 2022 and April 2023 rounds when the leachate pump was found to be not operating. Water levels in the shallow wells were measured at levels consistent with the deeper wells and were higher than the surface water level in the wetland during this sampling round. During a subsequent monitoring round eight days later following the original July 2022 event, water levels in the shallow wells, particularly LS10 and LS13 had dropped by around 0.5 to 1 m while water levels in the deeper wells showed much smaller reductions, and wells LD17 and LD11 actually increased. This appears to suggest that static groundwater levels within the deep and shallow wells could be reasonably consistent if it were not for the presence of the leachate interception drain.

It is apparent that the leachate pumping system is having a drawdown effect in the shallow strata, as intended, with a limited drawdown effect in the deeper strata. Screen depth information would have aided the interpretation of groundwater level patterns.

Interception Drain Wells

The results of the historical monitoring rounds show that water levels in the interception drain wells have generally been measured below 0.0 m RL when the pump was operating and subsequently below the water level in the wetland (i.e. creating a depression). The RL of 0.0 m is an arbitrary level that has been adopted as an indicator that the system is operating at its most effective based on the historical records (refer Figure 10). There are a number of occasions that water levels have been recorded above 0.0 m RL and this triggers a response to understand the cause of the water level increase. The July 2022 and April 3023 monitoring rounds showed an increase in all of the monitoring wells (levels of circa 1.75 m RL) corresponding to when the leachate pump was found to not be operating at the time. This provides an indication of what the water levels would be without the influence of the drainage system (refer Figure 10), which shows a true water level would be above the level in the estuary. Individual increases of water levels in wells highlight isolated areas of ineffectiveness in the system. This has been observed in wells LS23, LS25 and LGS27 in the past where water levels were recorded above 0.0 m RL for periods of time (refer Figure 10). These wells are all end points of lateral pipe sections so are reflective of the water level around each lateral pipe section. The progressive increase in water levels in these wells indicates that the effectiveness of the dewatering system was decreasing at those lateral sections. During investigation activities to determine the cause and to improve the effectiveness of these laterals, it was found that the filter cloth wrapped around the Megaflo pipe had become blocked due to bio-fouling, restricting flow into the lateral pipe sections. Remedial works were subsequently undertaken within the following lateral sections:

- Lateral section 'LS23 to sump LS24' – remedial works completed in December 2014 and comprised the complete replacement of the lateral section.
- Lateral sections 'LS25 to sump LS24' and 'LS25 to sump LS26' – remediated in August 2018. A 6 m length of perforated upvc pipe was installed into the existing trench and connected to each sump (no filter cloth). The perforated pipe would enable discharge into the sump, whilst the existing railway ballast in the trench provided the conveyance mechanism for water/leachate to flow along the length of the trench towards each sump.
- Lateral sections 'LGS27 to sump LS26' and 'LGS27 to sump LS28' – remediated in June 2022. Undertaken using a similar approach to the August 2018 remedial works (i.e. 6 m section of perforated upvc pipe connected to each respective sump).

Since the remedial works were undertaken, these sections of the interception drain showed water levels consistently below the level in the wetland indicating the remedial works were successful. Full replacement of the lateral pipeline sections was not required, as the railway ballast backfill in the trenches was found to provide a suitable medium for conveyance of the groundwater/leachate to each of the sumps. Of note, although LS23 is shown on the chart to be still slightly elevated, the monitoring point that is used to measure the level is actually dry at this point, so the level is in fact lower than this.

Overall, the data indicates a hydraulic depression is being created by the leachate interception drain and based on groundwater level monitoring within and outside of the landfill, the drain is expected to be drawing in shallow groundwater from either side (i.e. a reversal of the natural gradient downstream of the interception drain), as intended, to intercept leachate impacted groundwater.

4.1.3 Hydraulic Conductivity Testing

Slug test analysis was undertaken on four groundwater wells located outside of the southern parameter of the landfill in 2012 (LS10, LS13, LD8 and LD11, Figure 2) to provide an indication of the likely hydraulic conductivity of the strata beneath the wetland and the potential rates of migration. The slug tests were carried out using a 40 mm diameter slug and water levels were monitored in each well using a pressure transducer. Barometric pressure changes were also monitored throughout the course of each test so that the pressure transducer data could be compensated for changes in barometric pressure to isolate the water level change. The slug tests involved both a falling head test, where the slug was introduced to the well, and a rising head test, where the slug was removed from the well.

The slug test data was analysed using the (Bouwer & Rice, 1976) method. Given the absence of well installation details some assumptions of the screened interval were made (2 m screens in the shallow wells and 3 m screen in the deeper wells). In addition, an indication of the geology around the screened sections was inferred using the hydraulic conductivity values. The results of the analysis are presented in the following table.

Table 1: Slug Test Analysis Results

Well	Depth to base of well (m below top of casing)	Calculated average hydraulic conductivity (m/day)	Inferred geology
LS10 (shallow)	4.0	0.77	Silty to fine sands
LS13 (shallow)	3.6	6.6	Medium sands
LD8 (deep)	8.1	0.01	Marine silt
LD11 (deep)	9.83	0.75	Silty to fine sands
Average Shallow		**3.69**	
Average Deep		**0.38**	

No well log data describing the geology of each well is available so a comparison of the geology and the calculated hydraulic conductivity could not be made. Therefore, the geology of each well has been inferred based on the hydraulic conductivity values and typical textbook values of various sediments provided by Freeze & Cherry (1979) and Kruseman & de Ridder (1970).

The results show relatively similar hydraulic conductivities for wells LS10 and LD11, despite well LD11 being installed at a greater depth. Hydraulic conductivities for well LS13 are considerably higher than those calculated for the other wells indicating this well is screened in a more permeable sandy lens. Contrastingly the hydraulic conductivity value derived for LD8 was very low indicating that this well is likely to be screened within finer grained silts. The difference in hydraulic conductivities of around two orders of magnitude indicates that the marine sediments below the landfill and wetland are likely to be highly variable and there may be some preferential pathways in more permeable sandy zones through the marine sediments. Overall, the results suggest that the strata is likely to consist of interbedded sandy and silty layers of with varying hydraulic properties.

Further information regarding the conceptual model of groundwater movement near the site is provided in Section 9.

5.0 Leachate and Groundwater Quality

Annual monitoring of the leachate and quarterly monitoring of the groundwater monitoring wells have been undertaken since 1997. A summary of the key findings of the historical monitoring is presented below, covering:

- Performance of the leachate interception drain, including pumping volumes and leachate quality;
- Quarterly groundwater sampling; and
- Annual groundwater sampling.

5.1 Leachate Interception Drain Operational Data

Condition 2 of ORC Consent No. 93541 requires the consent holder to continuously monitor and record the flow of pumped discharge from the installed leachate collection drain. The groundwater take from the leachate collection drain is monitored under Condition 4 of the ORC Consent 93540, which requires a depression in the phreatic groundwater level to prevent the outward flow of groundwater from the landfill. Under Conditions 7 and 8 of Consent 93540, quarterly groundwater level monitoring is required within the leachate collection drain and adjacent wells to ensure the depression in the phreatic groundwater level is maintained. These groundwater monitoring results were discussed in Section 4.1.2.

Tables of the historical leachate drain pumping volumes are provided in Appendix C. A summary of the recorded leachate/groundwater volumes pumped to the DCC reticulated sewer system between July 2003 and October 2023 is presented in Figure 11. Total annual discharge volumes fluctuated between approximately 22,000 m^3 and 37,500 m^3 between 2004 and 2017 and have been generally declining since 2017. The decline in leachate volume is likely related to the closing and progressive capping of the landfill, which is reducing the rainfall entering the landfill generating leachate. The recent increase in discharge in the past two years (2022 and 2023) aligns with periods when the leachate pump was flooded by high levels in the wetland-estuary and immediately following the remedial works on two lateral sections to improve the effectiveness of the system.

Pump hours and discharge volumes are recorded monthly. Interrogating this data indicates that pumping rate is typically between 17 and 22 m^3/hr (i.e. typically between 4.7 and 6.1 L/s) when pumping, with rates calculated up to 33 m^3/hr (9.2 L/s).

The water level information shows that a depression in the phreatic zone (saturation zone) has been maintained along the leachate interception drain for the majority of the time. The exception being when the pump is not operating, or when biofouling causes the lateral pipes to become blocked. This highlights the importance of the leachate pump station remaining operational at all times (critical system) and that there is ongoing monitoring and maintenance of the interception drain to maximise its effectiveness.

While this system has been shown to work effectively at depressing the water table and intercepting the majority of leachate-impacted groundwater, monitoring results from the shallow and deeper groundwater beyond the interception drain indicated that some leachate-impacted groundwater is migrating away from the landfill. It is anticipated that this leachate-impacted water would surface in the wetland-estuary at some point. It is not anticipated this will have a significant impact and is discussed in more detail in Section 10.

5.2 Leachate Sampling

Condition 11a of Consent 93540 requires sampling of the groundwater/leachate pumped from the leachate collector sumps in October each year. The samples are required to be analysed for calcium, magnesium, potassium, sodium, bicarbonate, chloride, sulphate, pH, conductivity, COD, BOD_5, total ammoniacal nitrogen (TAN)[9], nitrate, iron, lead, zinc and cation/anion ratio. In addition, once every two years the leachate is required to be analysed for:

- USEPA priority pollutants (as per 1994 schedule); and
- Whole effluent toxicity screening using appropriate sensitive marine species.

The groundwater/leachate samples are collected from the pumping chamber (EPS42), which is representative of the material pumped to the DCC wastewater treatment plant.

The results for the leachate sampling from June 2001 to October 2023 have been tabulated and graphically presented as the Leachate Chemistry Charts (Appendix C). The following observations are noted:

- TAN concentrations typically ranged between 340 mg/L and 200 mg/L, but showed a declining trend, particularly since 2017. The concentrations were consistently within the range for landfill leachate (between 30 mg/L and 3,000 mg/L; Landfill Guidelines, 2000).
- Nitrate-nitrogen was showing an apparent increasing trend since 2017 (with some fluctuation), although the most recent year showed a decrease in concentration. The concentrations are well within the typical

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[9] Total ammoniacal nitrogen (TAN) has been analysed instead of ammonia as there is no laboratory test for ammonia. Total ammoniacal nitrogen is the sum of ammonia and ammonium which are in equilibrium where the relative proportions are dependent on temperature and pH. Aquatic toxicology is calculated in terms of TAN so is appropriate in this instance.

range for nitrate-N in landfill leachate of between 0.1 and 50 mg/L (Landfill Guidelines, 2000).

- Sulphate concentrations appeared steady at between 100 and 160 mg/L, over the past 12 years.
- The cation/anion ratio had mostly been within the 10 % range outlined in the consent condition. However, some samples had exceeded this range.
- The average pH level was lower than the typical range for pH in landfill leachate (pH 7.5 and 9.0; Landfill Guidelines, 2000).
- Zinc was reasonably consistent within the historical data, with one outlier in 2018.
- BOD_5 and COD had remained relatively consistent since 2010.
- The remaining compounds were either consistently within the range of historical data or show a slight decreasing trend.

Generally, the leachate chemistry was considered typical for a landfill of this age and the stage of decomposition. Based on the concentrations present, the landfill is in the methanogenic phase. The concentrations were generally on the low side of the range of typical landfill leachate concentrations (Landfill Guidelines, 2000). This is not unexpected given the leachate interception system also captures localised groundwater, which would provide some dilution. There is evidence to suggest that since 2017 there was a slight decline in key leachate indicator compounds, particularly TAN, which coincided with the end of accepting waste and the start of the capping programme.

Additional analysis undertaken every 2 years showed no evidence of any of the more toxic compounds in the leachate such as polychlorinated biphenyls (PCBs), organochlorine pesticides (i.e. aldrin, lindane, DDT and dieldrin), chlorinated solvents, petroleum hydrocarbons or dioxins. The whole effluent toxicity screening showed the estimated ‘safe’ concentration of leachate required to mitigate the potential for chronic effects in the receiving water environment required between 28 and 85-fold dilution. The results were generally consistent with very little change in composition over the years of testing. Given the landfill has ceased receiving any additional waste and is now capped, significant changes to the toxicity would be unlikely.

5.3 Quarterly Groundwater Sampling

As required under Condition 11b of Consent 93540, groundwater sampling is completed in the following wells every three months (locations shown in Figure 2):

- Leachate interception drain wells (LS24, LS26, LS28, LS30 and LS32); and

- Groundwater wells outside the landfill (LGS1, LGS7, LS10, LS13, LS15, LS19, LS22, LD8, LD11, LD17 and LD20).

The historical laboratory sampling results from these wells date back to 1997 for pH and conductivity and 2002 for temperature, TAN and chloride. Results have been tabulated and the quality charts are provided in Appendix D1. A summary of the results for each of the parameters is as follows:

- **pH:** Overall little change has been observed in the majority of the wells (both shallow and deep) over the years. Most wells report values within 0.5 ranges, with peaks and troughs tending to be consistent between wells each sampling round, possibly related to equipment calibration at the time of sampling. There does not appear to be any obvious difference in pH values between the leachate interception drain wells and the wells outside of the landfill.
- **Temperature:** temperature readings show the typical seasonal variation throughout the year, with cooler temperatures in the winter months and warmer temperatures in the summer months.
- **TAN:** TAN concentrations remain higher (typically above 100 mg/L) in the leachate interception drain wells. There continues to be some variability between monitoring rounds, however, this is not unexpected given the variables involved. A general decreasing trend is apparent within the interception drain wells, in particular LS24 and LS26 (i.e. located in the area of the Western Landfill).

  With regard to the wells outside of the landfill, TAN concentrations across the deep wells show some fluctuation between months (some more than others), but overall, there is no obvious trend either way.

  The shallow wells located beyond the perimeter of the interception drain adjacent to the wetland (LS10, LS13, LS15 and LS19) show a high degree of variability with LS13 displaying higher TAN concentrations than the other wells. LS10, LS15 and LS19 have generally shown concentrations below 10 mg/L since 2013. LS13 is more variable with concentrations generally in the range of 5 to 25 mg/L, with the exception of higher concentrations in 2022 of up to 182 mg/L. In general, these wells (with the exception of LS13) show lower concentrations than deep wells LD17 and LD11. The hydraulic conductivity measured at LS13 was higher than other locations, which may indicate this well is installed in a high permeability zone.

  The majority of the wells outside of the landfill continue to show the presence of TAN concentrations indicating that landfill leachate impacts are present beyond the landfill, including beyond the influence of the interception drain. As noted in the annual reports submitted to ORC, whilst considered elevated, the concentrations present are relatively stable and have been around this level since 2002 when testing for TAN began (i.e. no obvious change in concentrations). The interaction between groundwater and surface water in the wetland-estuary is not fully known, however, water level monitoring indicates that positive water levels (i.e. water pressures above the surface water level) do exist beneath the wetland. The effect of groundwater discharge to surface water is discussed later in Section 11.

TAN concentrations in the leachate interception drainage wells are typically between 74 mg/L and 400 mg/L, and reflective of the landfill leachate being generated and being pumped off-site for disposal. However, during the July 2022 (and to a lesser extent during the April 2023) sampling rounds when the leachate pump was found to be not operating, the TAN concentrations in the interception drainage system showed a significant decrease (concentrations measured between 3.3 and 19.3 mg/L – July 2022). This is obviously a reflection of groundwater conditions at the time but indicates that there was a significant influence from groundwater/surface water entering the drainage system as opposed to leachate from the landfill. The relative water levels in the wells and wetland at the time of these events indicate a gradient from the landfill towards the estuary, so it is unsure why the lower concentrations were detected. The deep wells, showed no change in TAN concentrations at this time. TAN concentrations in shallow well LS13, which showed a temporary increase over the January and May 2022 sampling rounds (increased up to 182 mg/L in May 2022), also decreased to similar levels measured in the interception drain wells. Other shallow wells did not show the same response supporting the comment above that there is a greater hydraulic connection between the interception drainage system and LS13. The relationship between pump operations (on/off) and TAN concentration changes during the July 2022 event is shown in Appendix D.

- **Chloride and Conductivity:** As reported in the annual reports submitted to ORC, chloride and conductivity are not considered to be key leachate indicator compounds for this site due to the estuarine environment, which makes it difficult to determine if changes in chloride and conductivity are as a result of landfill leachate or from saltwater effects within the wetland-estuary.

5.4 Annual Groundwater Sampling

Condition 11b of Consent 93540requires more detailed annual groundwater sampling (including calcium, potassium, alkalinity, sulphate, conductivity, TAN, iron, zinc, temperature, magnesium, sodium, chloride, pH, BOD5, nitrate, lead) in the following deep groundwater wells during the October monitoring round:

- LD5, LD8, LD11, LD16, LD17 and LD20

Well LD16, located within the landfill has been damaged and as a result has not been sampled since 2015, but water level monitoring is still feasible. The results are presented on the plots in Appendix D2. A summary of the latest results for each of the sampled wells is as follows:

- Well LD5, also located within the Western Landfill, has previously shown different water chemistry to the other deep wells sampled (lower calcium, conductivity, magnesium, sodium and chloride concentrations and higher potassium, alkalinity, TAN and BOD_5). However, over time and, in particular since 2010, LD5 (and LD16 when it was sampled) has shown a gradual change of some compounds trending back towards the other wells including a reduction in potassium, alkalinity, TAN and BOD_5. The concentrations of these compounds are now similar to the other wells being analysed. Of particular note, the TAN concentration in LD5 has reduced from a peak value of 339 mg/L in 2001 to 44 mg/L during the 2021 round, and more in line with the other deep wells. There were still some exceptions to this with sodium, chloride and magnesium showing different concentrations to the other deep wells.
- The remaining deep wells sampled (LD8, LD11, LD17 and LD20) showed heavy metal and TAN (considered the key leachate indicator) concentrations generally within the previous range of values measured, indicating stable conditions (i.e. no trend either way and in a steady-state condition).
- Iron concentrations were most elevated within wells LD11 and LD8, compared to other wells, and were typically in the range of 20 to 55 mg/L.
- Historically, zinc concentrations in wells LD16, LD5, LD20 and LD8 were elevated, up to 2.5 mg/L, with highest concentrations recorded in well LD16. However, since 2015 zinc concentrations have remained relatively stable with concentrations consistently below 0.2 mg/L in all wells.
- Magnesium concentrations were highest in wells LD11, LD8, LD20 and LD17 and have remained relatively stable over time, generally in the range of around 600 to 1,000 mg/L.
- Some minor spikes in lead concentrations have been observed in the past, with up to 0.26 mg/L detected in well LD16 in October 2013. However, concentrations have remained stable and low (0.0021 mg/L or less) since October 2015, in all wells.
- The reduction of the leachate parameters in LD5 indicates that leachate impacts were decreasing at depth beneath the Western Landfill area. However, the deep wells outside of the landfill were not exhibiting the

same degree of change, at this stage and may take longer before such changes occur.

- The continued presence of TAN in the deep wells indicates that leachate impacted groundwater has migrated beyond the influence of the interception drain and is present beneath the wetland (in particular wells LD11 and LD17). There was no obvious trend apparent, with relatively stable concentrations since 2002 indicating this has been occurring for a long period of time and appears to be in a steady state.

5.5 2012 Kaikorai Lagoon Swamp 'Wetland' Investigation

In 2012, a groundwater investigation was undertaken to gather additional data on the groundwater system downgradient of the landfill. This investigation consisted of:

- The installation of 10 temporary well points (SP1 – SP10) in the wetland to enable the collection of shallow groundwater samples to determine the extent that key landfill leachate indicators have migrated beyond the interception drain;
- Completion of slug tests within shallow wells LS10 and LS13 and deep wells LD8 and LD11, to provide an estimation of the hydraulic conductivity and migration rates in the shallow and deep sediments in the area (previously summarised in Section 4.1.3); and
- A survey was carried out by a professional survey company (Terramark) to provide accurate sampling locations and also relative ground and water levels to enable gradients to be calculated.

A site plan showing the location of the sampling locations is presented in Figure 7.

A pressure transducer was placed in the open drain in front of the landfill near well LD11, to measure any changes in water level and determine whether there were any tidal influences over the period the investigations were being carried out. Monitoring identified a rise and fall of groundwater levels in the wetland with a cycle period of between 21 and 25 hours occurring between 12:00 pm and 3:00 pm daily, with a change in water level of approximately 35 mm during each cycle. Based on this cycle period, it is not tidal and was possibly wind induced. The wetland area adjacent to the landfill is often dry for long periods (weeks) which supports that typical daily tidal cycles appear to have no influence around the landfill area(climate change effects excluded).

As noted previously in Section 4.1.1, the soil type encountered during the installation of the temporary well points revealed low permeability silty clay to a depth of at least 2.0 m in the northern portion of the wetland (locations SP1 –

SP4) with a sand lens encountered at depths of between 1.5 m and 1.8 m bgl further to the south (locations SP5 – SP10).

5.5.1 Water Levels

Terramark, a local surveyor, was engaged to survey the sampling locations. An indication of the relative surface water and groundwater levels at each of the sampling locations is presented on Figure 12.

The relative levels show that the elevation drop over the 500 m long length of wetland between SW7 and SW12 is only 49 mm. Considering the distance, this is a relatively flat section of water. In contrast the elevation drop between the top of Christie Creek (SW1) and the wetland (SW7) is 2.38 m. A slightly lower elevation drop was measured from the top end of Coal Creek and the wetland (1.43 m).

Water levels were also measured within a selection of existing monitoring wells along the front of the Western and Eastern Landfills. Wells LGS1, LD8 and LS2 show that water levels including within the Western Landfill area are between 1.5 m and 1.7 m higher than the surrounding water level in the Coal and Christies Creek's. This difference in elevation indicates that a gradient towards, and resulting flow towards, these water bodies exist.

5.5.2 Groundwater Quality Sampling

To enable groundwater samples to be collected from beneath the wetland, ten temporary well points (SP1 – SP10) were installed in a general grid pattern (refer Figure 7). SP1 was installed to the east of the landfill with the remaining locations (SP2 – SP10) installed in the wetland area, to the south. Sample sites were located adjacent to current or recent surface water channels.

At each location, temporary well points comprising a length of ¼ inch polyethylene tubing attached to a metal tip with a discrete screened section (10 mm in length) were driven to depths of between 1.5 m and 2.0 m bgl. Well points SP5 – SP10 were installed to depths of between 1.5 m and 1.8 m bgl within the sand layer encountered. Well points SP1 – SP4 were installed at 2.0 m bgl within the soft silty clay material.

Table E1 (Appendix E) summarise the laboratory results for the groundwater samples analysed. A summary of the results is as follows:

- **pH:** Levels ranged between pH 7.0 and 7.4 in the groundwater samples.
- **Heavy Metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc):** The detection limits for metals in the groundwater samples were higher than normal as a result of severe matrix interference due to elevated chloride, meaning the samples needed to be diluted before analysis. Consequently, no metals were detected in the groundwater samples

because of the high detection limits (between 0.005 and 0.10 mg/L). However, it should be noted that this does not exclude heavy metals from being present in the groundwater samples but reflects analytical issues with the samples.

- **TAN:** Groundwater sampling showed concentrations between 1.4 mg/L (SP7) and 9.9 mg/L (SP5) within the six sampled temporary well point locations. The highest concentrations were recorded with well points SP5 and SP6 located downgradient of the Eastern Landfill with the lowest concentrations measured within the western portion of the estuary downgradient of the Western Landfill. A decrease in concentration with distance further from the landfill was apparent, but the concentrations were still within the same order of magnitude. A figure showing the TAN concentrations within groundwater is presented as Figure 13.

  We cannot be certain that this TAN originates from Fairfield Landfill as there are other potential sources, including Green Island Landfill on the opposite side of Kaikorai Stream. However, given that high TAN concentrations were routinely found in the monitoring wells beyond the interception drain, it is likely that Fairfield Landfill was contributing to the elevated TAN found in groundwater beneath the wetland.

  It is unknown where this groundwater emerges in the swamp/wetland/estuary complex. The low permeability sediments encountered in the wetland are expected to provide some impedance to groundwater seepage up into this area. Elevated concentrations of TAN in the Kaikorai wetland (see below) suggests that at least some of TAN-rich groundwater is influencing concentrations in the wetland/estuary further downstream, particularly at times of low flow in the streams/creeks discharging into this area.

- **Nitrate-N:** Groundwater sampling showed non-detectable (<0.2 mg/L) nitrate-N concentrations within the six temporary well point locations.

- **Dissolved Reactive Phosphorus (DRP):** The groundwater samples showed DRP concentrations between 0.010 mg/L (SP7) and 0.76 mg/L (SP6). These results indicate that groundwater beneath the estuary was generally enriched with DRP. There are potential sources of this from surrounding land use activities, including the landfill operations and other upgradient land use activities in the wider catchment.

5.6 Summary of Historical Groundwater and Leachate Monitoring

Overall, the sampling indicates that the leachate interception drain is intercepting the vast majority of leachate migrating from the site given the elevated parameters (particularly TAN) within the leachate samples in comparison to downgradient wells. However, it was obvious that a smaller component of leachate was migrating into groundwater and not being fully captured by the interception drain, as evident by TAN concentrations in downgradient wells and also during the 2012 survey within the wetland. This was not unexpected due to the landfill being unlined, and higher TAN concentrations in the deeper downgradient wells. This suggests that the interception drain was less effective at capturing the leachate from within the deeper sediments, which is likely passing through underneath the interception drain.

6.0 Landfill Gas Subsurface Migration

Municipal landfills produce appreciable amounts of gas within 1 to 3 years of placement of waste material, with peak gas production occurring around 5 to 10 years. The majority of LFG is produced within 20 years after waste is disposed of, however, small quantities of gas may continue to be emitted from a landfill for 50 or more years. Different portions of the landfill might be in different phases of the decomposition process at the same time, depending on when the waste was originally placed in each area.

The Western Landfill area ceased receiving waste from around 1996 meaning waste in this area is at least 27 years old and near the end of the LFG production cycle. The Eastern Landfill area only ceased receiving waste in 2017 and was recently capped so this landfill area will be in peak LFG production at the moment and will continue to produce high levels of LFG for the next 3 to 5 years, with LFG production likely for the next 20 years requiring management. This landfill area has active LFG collection and destruction (via a flare).

LFG migration occurs as the gases fill and move through the available pore spaces and will follow the path of least resistance. Low permeability soils and water bodies act good barriers to migration. The natural tendency of LFG that are lighter than air, such as methane, is to move upward. The shape of the Eastern Landfill (dome) and presence of the LFG collection system will mean the majority of the LFG produced in this part of the landfill will rise through the waste and will be collected/removed. It is only when the upward movement of LFG is inhibited by densely compacted waste or landfill cover material (e.g., by daily soil cover) that the gas tends to migrate horizontally.

6.1 Landfill Gas Monitoring

As required under Condition 7 of Consent 95008 monitoring of methane (CH_4) levels has been undertaken within, and in the vicinity of, the landfill to better understand the levels of LFG generation and whether any lateral subsurface migration was occurring. The monitoring locations are based on the consent requirements, with the exception of wells MW1 – MW3. These three wells were installed in June 2022 to gain a better understanding of the subsurface LFG conditions on the northern side of the landfill (installed on the northern edge of the landfill, reportedly within the landfill zone). The monitoring locations include (as shown in Figure 2):

- Groundwater wells within the landfill (LGS1, LGS7, LD5 and LS4[10]);
- Leachate interception drain wells (LGS27, LGS29, LS31 and LS32);
- Sentinel LFG monitoring well (G34, G37, G38, MW1, MW2 and MW3)[11]; and
- LFG monitoring feature (G35 'cesspit on Blanc Avenue' and G36 'Basement of 34 Blanc Avenue').

A copy of the LFG monitoring data up to October 2023 is appended (Appendix F).

In addition to CH_4, LFG measurements have included oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO) and hydrogen sulphide (H_2S). LFG flow rates have not been measured in any of the monitoring wells due to the impracticality of undertaking such measurements in these open areas (i.e. manholes and cesspits).

A summary of the results is as follows:

- Of the four wells located within the landfill areas, LS4 showed the highest LFG concentrations with readings consistently around 60% CH_4 and 40% CO_2 (i.e. typical for LFG) with other gases O_2, H_2S, and CO making up a small proportion. This is not unexpected given its location within the Eastern Landfill, which is the most recent landfill to be filled. A LFG collection and destruction system has been installed within this landfill area to manage the LFG being produced. The remaining 3 wells are located in, or near, the Western Landfill area and showed generally low LFG concentrations (CH_4 up to 2.5%, but often recorded at 0.0%). This indicated that there may be low levels of LFG being generated from the older landfill area. This was expected as LFG production decreases over time as organic matter within the landfill diminishes. However, the screened intervals on these wells is unknown, including one being recorded as a 'deep' well, and this may affect the LFG readings being measured.
- LFG was regularly detected within the interception drainage system monitoring locations, with occasional concentrations as high as those recorded within the landfill itself. This was not unexpected given the interception drain was constructed on the outer edge of the landfill and was filled with permeable material. The presence of LFG within this site infrastructure is being managed by WMNZ and signage has been installed to inform workers of the risks associated with working near or within these manholes.

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[10] LS4 was buried as part of the final capping works that commenced in August 2019.

[11] Three new LFG wells (MW1, MW2 and MW3) were installed in June 2022.

- New LFG wells MW1 – MW3 installed on the northern edge of the landfill have shown the presence of LFG at concentrations similar to those within the landfill itself (60% CH_4 and 40% CO_2). This was not unexpected given their location on the edge of the landfill and that waste was observed in the ground when installing these wells. Sentinel LFG well G34 located to the further to the north shows no signs of any obvious subsurface LFG migration beyond the extent of the landfill perimeter with CH_4 concentrations recorded up to 0.3% and CO_2 up to 0.5% (measured quarterly since 2006).
- Low levels of CO_2 (between 1-4%) were consistently being detected in sentinel wells G37 and G38 located between the landfill and Walton Park. CH_4 has been detected up to 0.3% in these wells occasionally. However, given the presence of a surface water body (Christies Creek) located between the landfill and these sentinel wells, where this would provide a barrier to LFG migration, it was unlikely that these low-level detections were related to the landfill.
- LFG monitoring was undertaken within a cesspit (stormwater sump ‘G35’) at the end of Blanc Avenue. This cesspit was connected to the closest stormwater pipe to the landfill and was thought to have been included in the consent conditions to determine whether LFG was entering the stormwater system (refer Figure 2, Appendix A). To date, LFG has not been detected at concentrations that would indicate the presence of LFG entering the stormwater network. Low level detections have occasionally been detected (CH_4 up to 0.2%). There is no evidence to suggest this is from the landfill.
- Sampling location G36 is located within the basement of the dwelling located at 34 Blanc Avenue (refer Figure 2, Appendix A). This is the closest residential property to the landfill and monitoring to date has shown no indicators that LFG has been detected within the basement of the dwelling.

6.2 Landfill Gas Migration Summary

The monitoring data showed that high levels of LFG was being generated within the Eastern Landfill, which was expected. The final cap has recently been placed (August 2022) and a LFG collection and flare system installed to manage the ongoing generation of LFG from this landfill area. LFG migration from this landfill area into the associated underground landfill infrastructure was evident, with LFG being detected within the interception drainage system. Given its proximity to the landfill and permeable nature of the trench system, this was not unexpected and the presence of LFG in these areas is being managed by WMNZ.

Monitoring confirms that there is minimal LFG being produced in the Western Landfill area. This is expected given its age.

Outside of the landfill, there were no indicators to suggest subsurface lateral migration of LFG was occurring. This was helped by the construction of the landfill (dome), presence of perimeter surface water bodies around sections of the landfill areas providing a barrier to LFG migration, and generally low permeability soils underlying the site (former wetland).

7.0 Stormwater Runoff Quality

There are two stormwater retention ponds that capture stormwater from the Eastern Landfill (refer Figure 2, Appendix A). These were originally installed to capture stormwater runoff from the landfill during the period of landfilling to intercept any stormwater runoff in the event it contained any leachate or sediment from the exposed areas of the ground. Condition 6 of Consent 93542 requires surface water samples to be collected from the two stormwater retention ponds (‘North Pond’ and ‘Weighbridge Pond’), as part of each of the quarterly sampling rounds to determine the suitability of the stormwater to be discharged to the nearby surface water bodies.

Prior to 2009, no sampling had been carried out as there was no discharge occurring from the ponds at the time of the inspection. However, since 2009, sampling of the water in the ponds has been undertaken regardless of whether a discharge was occurring or not, to better understand the water quality that would be discharged in any subsequent rainfall event.

The Eastern Landfill is now fully capped (and vegetated) and to manage stormwater on the slopes of the landfill, a drainage channel has been constructed in the cap along the eastern side of the landfill (approx. mid-way down the slope) and directs any runoff towards the ‘North Pond’. Stormwater from the northern slope of the landfill is also directed to the ‘North Pond’. Similarly, a cap drainage channel formed on the southern slope (midway down slope) intercepts runoff and directs this to the ‘Weighbridge Pond’. Both ponds eventually discharge into the wetland, via outlet structures. Stormwater from the western slope of the Eastern Landfill will runoff into Christies Creek.

There is no stormwater control on the Western Landfill area. Any stormwater runoff from this area would runoff to the perimeter surface water bodies (Christies Creek) that discharge into the wetland area.

7.1 Stormwater Sampling

Samples have routinely been collected since 2009 from the two retention ponds, when water was present in accordance with Condition 5 of Consent No. 93542. On each occasion, a discrete ‘grab’ sample was collected in the area of the discharge point and sent for analysis of TAN, BOD_5, total suspended solids and turbidity. Field parameters including conductivity and pH were measured using handheld instruments. The laboratory results have been tabulated and presented in Appendix G.

A summary of the results is detailed below together with comparison with the Australian And New Zealand Guidelines For Fresh And Marine Water Quality (ANZG 2018).

The results for the 'North Pond' show that pH can vary in the pond ranging between pH 6.53 and pH 9.76 between 2009 and 2022. The cause for the variability was unknown. TAN was occasionally detected at low levels with concentrations generally below 0.05 mg/L, but has been recorded up to 0.38 mg/L. BOD_5 has also occasionally been detected (up to 11 mg/L). Apart from the pH, the results are below the Default Guideline Value (DGV) in the ANZG 2018 Guidelines. Since monitoring began, there has been no obvious signs of any landfill leachate in the 'North Pond'. Since the Eastern Landfill has been capped, there has been no obvious changes in the water quality.

Sampling of the 'Weighbridge Pond' since 2009 showed the presence of leachate impacts with TAN recorded up to 67 mg/L and BOD_5 up to 410 mg/L (between 2009 and 2013)). This was when the landfill was still operational and being filled and the pond received runoff from the access road up into the landfill. In order to prevent any leachate-impacted stormwater from entering the wetland, a temporary pumping system was set up to direct any water entering the pond into the leachate interception drainage system (via sump LS26). From 2012, the 'Weighbridge Pond' started to occasionally dry up and became permanently dry in 2013 and sampling ceased. It is plausible to suggest that the reason for the pond drying up was a result of changes to the landfill shape and recontouring, as a result of the landfill development and, more recently, the final cap being placed. A drainage channel was formed in the cap on the southern slope to direct stormwater runoff from the upper section of the landfill towards the 'Weighbridge Pond' but to date no water is entering the pond.

8.0 Kaikorai Wetland – Estuary Complex

8.1 Desktop Review

The existing environment and the Ecological Impact Assessment were undertaken as a desktop review, using data from a range of sources. No site visit was undertaken as part of this assessment as the water level in the estuary was too high at the time.

Historical information on the ecological condition of the wetland – estuary complex was sourced from ORC, Land and Water Aotearoa (LAWA), grey literature and scientific papers, as well as from monitoring data collected as part of Consent 93540 – Discharge leachate to groundwater.

In order to characterise the historical freshwater fish community, the New Zealand Freshwater Fish Database (NZFFD) was accessed on 10 October 2022 and all records for the Kaikorai catchment accessed.

8.2 Existing Environment

The Kaikorai Wetland – Estuary Complex is a moderately-sized coastal lagoon with extensive adjacent swamp/marsh area (Figure 4). The 170-ha catchment is dominated by pasture and urban areas, with the major land use being residential housing and a small amount of light industrial activity. Historically, Kaikorai Valley has included heavy industrial activities including a freezing works and cement factory. Stormwater draining the catchment flows through Kaikorai Stream into the estuary.

The swamp marsh area, named Kaikorai Lagoon Swamp, is regarded as a “Regionally Significant Wetland” under the Regional Plan: Water for Otago and an Area of “Significant Conservation Value” in the DCC 2nd Generation District Plan. The wetland – estuary complex is highly valued by Kai Tahu for cultural and spiritual beliefs, values and uses, including mahika kai and waahi taoka. The northern and western edges of the swamp borders the Fairfield and Green Island Landfill’s.

The lower reach of the complex is comprised of a shallow, intertidal estuary, which undergoes intermittent closure. A range of contaminants enters the lower estuary from multiple sources in the catchment, including urban stormwater, agricultural and industrial run-off, and seepages from Fairfield and Green Island landfills. In addition to contaminant loadings, the estuary is impacted by the accumulation of muddy sediments, as a result of a constricted lagoon mouth, poor flushing, reclamation, and causeways across the lower reaches (Wriggle 2018). During periods when the estuary mouth is closed, the estuary stratifies, resulting in both low dissolved oxygen and algal bloom issues in the lower reaches (Wriggle 2018). The estuary has been described as expressing symptoms of excessive muddiness and a high level of eutrophication with extensive gross eutrophic zones, defined by soft mud, poor sediment oxygenation and high phytoplankton growth (Wriggle 2018).

8.3 Water Quality

In aqueous solutions, TAN is present in both the ammonium ion (NH_4^+), and the unionised free ammonia (NH_3) forms. Of the two forms, NH_3 is considered to be the most toxic due to its lack of charge and its high lipid solubility, meaning that it can readily diffuse through cell membranes (Sutherland 2022). The proportion of each form of TAN is dependent on a number of physico-chemical factors, including pH. As pH of the water increases, ionisation decreases, resulting in an increase in the proportion of NH_3 and subsequently higher toxicity (Emerson et al. 1975). In order to meaningfully compare TAN concentrations between sites and with statutory regulations, all TAN concentration have been adjusted to pH 8, following the methods of ANZECC (2000) and Hickey (2014).

Kaikorai Stream

ORC undertake regular water quality and ecological health monitoring in the Upper Kaikorai Stream (at Brighton Road), north east (upstream) of the Fairfield Landfill. Water quality monitoring records from 2006 to present, show that the stream is a moderately impacted stream, with degrading trends in nutrients (both nitrogen and phosphorus), clarity, turbidity, and *E. coli* concentrations (LAWA 2022).

When compared to the Attribute Bands of the NPS-FM (2020), the annual and 5-yealy 95th percentile nitrate-nitrogen and dissolved reactive phosphorus concentrations of the Upper Kaikorai Stream at Brighton Road were in Attribute Band B (LAWA 2022).

Upper Kaikorai Stream had the lowest annual and 5-year median pH adjusted TAN concentrations compared to all other sites (Table 2, below). Median TAN concentrations increased further downstream, suggesting that some seepage may be occurring from the landfills (Fairfield and Green Island). However, the annual and 5-year 95th percentile concentrations were higher at the Upper Kaikorai Stream at Brighton Road than in the stream where it adjoins the Fairfield Landfill (EW43) (Table 2). This indicates that, on occasion, inputs of TAN occur upstream of the landfills. The 5-year 95th percentile pH adjusted TAN concentration was within Attribute Band C, below the national bottom line (Table 2).

The annual median and 95th percentile pH values exceeded the default guideline value (DGV) pH range (7.2 – 7.8) for lowland rivers in New Zealand (ANZG 2018). However, the 5-yearly median and 95th percentile pH concentrations in Kaikorai Stream were within the DGV range (Table 2).

Table 2: Water quality parameters for 2022 and the preceding five years (2018 – 2022) compared to the attribute bands of the National Policy Statement – Freshwater (2020) and the Australian and New Zealand water quality guidelines (2000).

Parameter	Site	Annual median	Attribute Band	Annual 95th percentile	Attribute Band	5-year median	Attribute Band	5-year 95th percentile	Attribute Band
Total ammoniacal nitrogen (mg/L)	Christies Creek (FH38)	1.8	D	4.1	D	0.3	C	2.8	D
	Coal/Christies Creek (FH39)	0.4	C	0.7	C	0.5	D	2.1	C
	Upper Kaikorai Stream at Brighton Rd	0.01	A	0.3	B	0.01	A	1.7	C
	Kaikorai Stream (EW43)	0.1	B	0.2	B	0.05	B	0.2	B
	Estuary Stream (FH40)	0.2	B	1.2	C	0.1	B	2.9	D
Nitrate – nitrogen (mg/L)	Christies Creek (FH38)	0.02	A	0.04	A	0.1	A	0.6	A
	Coal/Christies Creek (FH39)	0.5	A	0.6	A	0.6	A	1.0	A
	Upper Kaikorai Stream at Brighton Rd	0.3	A	1.5	B	0.4	A	1.6	B
	Kaikorai Stream (EW43)	0.2	A	1.1	A	0.4	A	1.0	A
	Estuary Stream (FH40)	0.2	A	0.6	A	0.2	A	0.8	A
pH (unitless)	Christies Creek (FH38)	6.2		7.2		5.9		6.4	
	Coal/Christies Creek (FH39)	6.7		7.2		6.9		7.4	
	Upper Kaikorai Stream at Brighton Rd	7.9		8.3		7.3		7.8	

Table 2: Water quality parameters for 2022 and the preceding five years (2018 – 2022) compared to the attribute bands of the National Policy Statement – Freshwater (2020) and the Australian and New Zealand water quality guidelines (2000).

Parameter	Site	Annual median	Attribute Band	Annual 95th percentile	Attribute Band	5-year median	Attribute Band	5-year 95th percentile	Attribute Band
	Kaikorai Stream (EW43)	7.2		7.8		7.3		8.2	
	Estuary Stream (FH40)	7.4		7.5		7.9		8.5	

Notes:

1. *TAN concentrations have been adjusted to pH 8*
2. *Red blocks indicate below the national bottom line of the NPS-FM (2020)*
3. ** Only 2021 data available at the time of this assessment.*

Kaikorai Lagoon Swamp 'Wetland' and Tributaries

Regular water quality sampling in the swamp has been carried out in accordance with the monitoring requirements of Consent 93540. Surface water samples were collected from the following locations (as shown in Figure 14) since 2001 (includes both consented and additional locations to further understand conditions):

- FH38 (additional location) – on the north-western boundary of the landfill site (Christies Creek) intended to represent upgradient conditions,
- FH39 (consented location) - western end of the landfill site, just downstream of the convergence of Coal and Christies Creek's,
- EW43 (consented location) - Kaikorai Stream, to the east of the landfill,
- FH40 (consented location) - main estuary stream flowing through the wetland. It is noted that FH40 is within the designated CMA of the estuary, rather than in the designated wetland (see Figure 14 for reference).

The 5-year, and 20-year[12], water quality results are summarised in Table 10, Appendix H. Additional sampling undertaken in permanent waterbodies within the designated wetland in 2012 showed TAN concentrations ranging from 0.3 – 2.5 mg/L, including 0.63 mg/L at FH40 at the time of sampling. This suggests that, in the absence of regular water quality data in the designated wetland area, FH40 may be a suitable proxy for median water quality within the wetland but not indicative of the potential range in concentration of a given water quality variable. It is also unclear on how Site FH40 and the wetland area interact, if at all.

As discussed in Section 3.0, by definition of the NES-F (2020) and NPS-FM (2020), the wetland area is a designated natural inland wetland. The attribute bands for various water quality parameters defined in the NPS-FM (2020) apply to the wetland and its tributaries. While the NPS-FM (2020) compares water quality parameters annually, for this assessment a conservative approach was taken by comparing both the annual values and those measured over the last 5 years. This was to better understand the longer-term water quality in the swamp and its major tributaries.

The 20-year long-term median chloride concentrations in sites FH38, FH39 and EW43 indicate that these were freshwater environments, with the 95th percentile indicating that, on occasion, EW43 and FH39 became brackish. The brackish periods most likely coincided with periods where the estuary mouth had closed,

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[12] The 5 year and 20 year periods have been used to help show recent trends (over the past 5 years) against longer term trends (over the past 20 years).

causing the brackish water levels to rise and flood back towards the wetland. For Site FH40, chloride concentrations indicate this site ranged from freshwater to brackish. This most likely reflected differences in tidal heights and/or lagoon mouth status, during sampling events.

Median and 95th percentile annual and 5-year pH adjusted TAN concentrations were below the national bottom line for both Christies Creek (FH38) and Coal/Christies Creek (FH39) (Table 2). For Site FH40, while median annual and 5-year pH adjusted TAN concentrations were within Attribute Band B, the 95th percentile annual and 5-year concentrations were within Attribute Band C and D, respectively (Table 2). This means that, overall, Site FH40 was below the national bottom line. Below the national bottom line for TAN means that the 20% most sensitive species, would be regularly impacted by TAN toxicity, leading to reduced survival and fecundity in the wetland and its tributaries.

The median annual and 5-year pH adjusted TAN concentrations showed a decreasing trend, from Christies Creek (FH38) to Site FH40 (tip of estuary stream), indicating a degree of dilution. However, the 95th percentile TAN concentration were more variable between sites, decreasing between Christies Creek (FH38) and Coal/Christies Creek (FH39), before increasing again at FH40, indicating a fluctuating environment.

For nitrate-nitrogen all tributaries and the swamp were within Attribute Band A for the median annual and 5-year nitrate-nitrogen concentrations (Table 2). The annual and 5-year 95th percentile concentrations were within Attribute Band A for all sites, except the most upstream site, the Upper Kaikorai Stream at Brighton Road, which was in Attribute Band B. Based on the monitoring results, nitrate was unlikely to negatively affect any sensitive species in the swamp, or tributaries.

While the NPS-FM (2020) specifies attributes for dissolved oxygen (DO), these are based on 7-day mean minimum and 1-day minimum values, while only spot measurements have been undertaken in the swamp and tributaries quarterly, as part of the consent conditions monitoring. Direct comparison of DO against the NPS-FM (2020) cannot be made but the long-term median DO concentrations at the sampling sites have been considered against the NPS-FM (2020) and placed in ecological context. For the tributaries on the western side of the landfill (FH38 and FH39), median DO concentrations were 5.0 and 7.2 mg/L, for Christies Creek and below the Coal-Christies Creek convergence, respectively. DO percentage saturation was 44 and 64%, respectively (Table 10, Appendix H). The long-term 20- year median DO concentrations and percentage saturation were similar to the 5-yearly values for both sites (Table 10, Appendix H). Based on the Attribute Bands of the NPS-FM (2020), aquatic organisms in Christies Creek would experience moderate DO stress, with a risk of sensitive fish and macroinvertebrates being excluded from this waterway. Aquatic organisms below the Coal-Christies Creek convergence would experience minor DO stress.

For Kaikorai Stream and the swamp, median DO concentrations were within the Attribute Band A, meaning that aquatic organisms would not be stressed from available DO (Table 10, Appendix H).

5-yearly median and 20-year median pH values in Christies Creek (FH38) and Coal-Christies Creek convergence (FH39) were below the DGV pH range of 7.2 – 7.8 for lowland rivers in New Zealand (ANZG 2018). pH values in these creeks have been recorded at levels as low as pH 3.8, with FH38 consistently recording pH levels below pH 6.0. This sampling location is located upgradient to the landfills where the low pH levels are thought to be influenced by historical coal mines in the catchment. The pH levels increase further downstream to more typical values. The long-term low pH values in these two tributaries would most likely exclude sensitive aquatic organisms from these habitats. The median pH values in Kaikorai Stream and swamp were within the ANZECC (2000) DGV range, while the 95th percentile exceeded this range. Organisms within these two waterbodies would occasionally experience stress caused by the occasional elevated pH.

Median 5-year and 20-year zinc concentrations in Christies Creek exceeded the ANZG (2018) hardness corrected 95% protection limits, while the 95th percentile exceeded the hardness corrected 80% protection limits (Table 10, Appendix H). For all other sites, the median 5-year and 20-year zinc concentrations were below the hardness corrected 95% protection limits. The 95th percentile concentrations exceeded hardness corrected 95% protection limits for all sites but not the 80% protection limits (Table 10, Appendix H).

As the swamp is considered under the NES-F (2020) regulations to be a natural inland wetland, and its tributaries were typically freshwater, boron was assessed against the freshwater ANZG (2018) default guideline values. However, it should be noted that, as FH40 ranges from freshwater to brackish water, estuarine water flooding back to the swamp, as a result of tidal influence or back flooding during estuary closure, some boron may have also been sourced from seawater, where it occurs naturally.

The median 5-year and 20-year dissolved boron concentrations exceeded the 95% protection limits in all sites, except Kaikorai Stream, but were all below the 80% protection limits (Table 10, Appendix H).

Elevated TAN concentrations in deep wells seaward of the interception drain, indicate the presence of leachate from the Fairfield landfill. However, as discussed above (Section 5.3), based on the current data available, it is unclear where the groundwater and surface water interact in this area. Surface water TAN concentrations indicate that the aquatic ecosystem of the swamp and tributaries are likely impacted, which may translate to negative effects on sensitive organisms. However, there are no known records of aquatic habitat and ecological assessments to confirm the extent of impact, if any.

The close proximity of Green Island Landfill as well as other land use activities in the wider catchment (both current and historical) make it difficult to ascribe the effects the leachate from Fairfield alone is having on the Kaikorai Wetland/Estuary Complex.

8.4 Surface Water Levels

There is no continuous water level monitoring in the wetland area but discrete water level measurements are recorded on a staging post installed in the wetland during the quarterly monitoring rounds required under Condition C of Consent No. 93540. Water levels in the wetland (SP5, Figure 2 Appendix A) showed that the water level fluctuated between 1.62 mRL and 0.80 mRL (i.e. 0.82 m change). Based on visual observations during the monitoring rounds, the low water levels corresponded to times when the wetland was dry and only small pockets of water were present. The high-water level readings reflected periods when the wetland area was inundated with water. Information provided by WMNZ also indicated that water levels have been sufficiently high to overtop the perimeter access track which has an RL of between 1.8 and 2.0 mRL. This suggested that water levels in the wetland had reached at least 2.0 mRL, on occasion.

Previous investigations have shown that the wetland area is not tidally influenced. The water levels changes are related to the backwater effect associated with the estuary mouth and whether it is open to the ocean or not. This can be further affected during rainfall events with increased inflows to the area. The mouth regularly closes and if it does not naturally open during flood events or through coastal storms, is opened by mechanical means by ORC. There is no formal process for when the mouth is mechanically opened, but it appears to be opened when levels get too high and cause localised flooding. Without a level that triggers mechanical opening of the mouth, it can be assumed that the wetland water levels will vary according to the status of the estuary ocean outlet and that occasionally the water levels in the wetland will overtop the perimeter access road, as has already been observed.

8.5 Sediment Quality

Sediment quality is routinely monitored in the estuary for percentage mud, contaminants (total nutrients, metals and metalloids) and estuary macrofauna, as part of ORC’s state of the environment monitoring programme. The three sentinel monitoring sites are located in unvegetated regions of the estuary. Site D is located at the top of the estuary, alongside the mouth of Kaikorai Stream, Site B is located mid-way down the estuary (just north of the causeway) and Site A is located in the lower reaches of the estuary, near the mouth (Figure 14).

The percentage of mud content is used as an indicator of estuarine health, with declining health associated with increasing mud percentages. Since the start of monitoring in 2007, Site B has had consistently higher percentage mud than the other two sites. During ORC's 2020 state of the environment monitoring survey, percentage mud at Site B was 78%, compared to 8% at Site A and 37% at Site D (LAWA 2022). When compared against national guidelines for estuary health, Site B would be regarded as being heavily impacted by the mud and macrofauna communities degraded. For Site D, the percentage mud would result in an unbalanced macrofaunal community and dominated by several pollution tolerant species, while for Site A, the macrofaunal community would potentially be only slightly negatively impacted by the presence of mud.

As with percentage mud, sediment total nitrogen (TN) content varies across the estuary, with the highest concentrations in the middle of the estuary, at Site B (2134 ± 248 mg/kg), indicating poor condition (Salt Ecology 2020). TN concentrations at the top of the estuary (Site D) were rated fair (1305 ± 315 mg/kg), while TN concentrations near the mouth of the estuary (Site A) were rated good (533 ± 67 mg/kg) (Salt Ecology 2020).

Long-term zinc concentrations at Site B (240 ± 19 mg/kg) were consistently above the ANZG (2018) DGV but below the GV-high, indicating that ecological impacts from zinc contamination was possible (LAWA 2022). Zinc at sites A and D, along with copper, lead, arsenic, mercury, cadmium, chromium and nickel concentrations at all sites were consistently below the ANZG (2018) DGV for sediment health (LAWA 2022).

Overall, sediment quality in the upper and lower reaches of the estuary indicate low stress and good estuarine health, while sediment quality in the middle of the estuary indicates moderate to poor health.

8.6 Macroinvertebrates and Macrofauna

The freshwater macroinvertebrate community index (MCI) and the quantitative macroinvertebrate community index (QMCI) scores are indicators of stream health. High scores indicate a macroinvertebrate community that is diverse and represented by sensitive species, while low scores indicate a community comprised of a few pollution, or disturbance, tolerant species.

In the Upper Kaikorai Stream at Brighton Road, both the MCI and the QMCI were within Attribute Band D, below the national bottom line (NPS-FM 2020). MCI and QMCI scores within Attribute Band D are indicative of severe organic pollution or nutrient enrichment and the community comprised of taxa that are pollution tolerant. This is reflective of lowland streams that are impacted by a range of pollutant inputs.

Macroinvertebrate community data has not been collected in Kaikorai Stream downstream of the Brighton Road monitoring site, Christies Creek, Coal/Christies Creek, or the wetland.

Estuarine macrofauna health is assessed using the Estuary Macrofauna Score (EMS), which assesses how relatively impacted the macrofauna community is by the presence of mud, a major stressor in estuaries.

The EMS assessed at the three sentinel sites, indicated that the community was moderately (Site B), to highly, impacted (Sites A and D) in the estuary (LAWA 2022). This means that the macrofauna community has reduced diversity and abundance due to the presence of mud.

8.7 Vegetation

The swamp region is classified by ORC as a saltmarsh, meaning that it is dominated by vegetation able to tolerate saline conditions. A broadscale survey conducted by Wriggle (2018) mapped a total of 33.8 ha of saltmarsh across the intertidal estuary region. Of this, a herbfield extended over 28.6 ha, dominated by shore leptinella (*Leptinella diocia*), comprising over 85% of the plant cover (Wriggle 2018). Other dominant vegetation types included rushland (2.4 ha), and sedgeland (1.4 ha), with dominant vegetation including jointed wirerush (*Apodasmia similis*), primrose (*Samolus repens*) and ribbonwood (*Plagianthis divaricatus*) (Wriggle 2018).

Introduced weeds were present along modified drainage channels at the northern end of the swamp but were generally excluded from the herbfields (Wiggle 2018). The extensive saltmarshes are recognised as a significant feature of the swamp (Wriggle 2018).

In the lower estuary, opportunistic growths of marine macroalgae, in particular ulva, dominate the estuary, on occasions (Salt Ecology 2022). When the mouth of the estuary is closed during the summer period, phytoplankton blooms occur (Wriggle 2018).

8.8 Fish

The New Zealand Freshwater Fish Database (NZFFD) showed a total of nine fish species were recorded in Kaikorai Stream and a total of four in the swamp area. Upland bullies, common bullies, and longfin eels were the most frequently recorded native species in the stream, while unidentified eels were the most common in the swamp (Table 3). The nationally vulnerable lamprey was recorded in the stream on one occasion (Table 3).

Both freshwater and marine species have been recorded in the lower estuary, with black flounder and yellow-eye mullet the most frequently recorded marine species in the estuary (Table 3). Freshwater species were of low abundance in the estuary, with the exception of banded kokopu, where 7 individuals were recorded on one sampling occasion (Table 3).

Table 3: New Zealand Freshwater Fish Database records for the Kaikorai Wetland – Estuary Complex

Water body	Species common name	Species Scientific name	Number of records	Abundance range	Status
Kaikorai Stream	Black flounder	*Rhombosolea retiaria*	2	1	Not threatened
	Brown trout	*Salmo trutta*	5	1-37	Introduced
	Common bully	*Gobiomorphus cotidianus*	6	1 - 24	Not threatened
	Inanga	*Galaxias maculatus*	3	1 - 5	Declining
	Banded kokopu	*Galaxias fasciatus*	1	1	Not threatened
	Lamprey	*Geotria australis*	1	1	Nationally vulnerable
	Longfin eel	*Anguilla dieffenbachii*	4	1 - 21	Declining
	Shortfin eel	*Anguilla australis*	1	1	Not threatened
	Redfin bully	*Gobiomorphus huttoni*	1	1	Not threatened
	Upland bully	*Gobiomorphus breviceps*	2	10 - 134	Not threatened
	Unidentified bully	*Gobiomorphus* sp.	1	1	
	Koura	*Paranephrops*	1	1	
Kaikorai Lagoon Swamp 'Wetland'	Common bully	*Gobiomorphus cotidianus*	1	2	Not threatened
	Inanga	*Galaxias maculatus*	6	1 - 3	Declining
	Unidentified eel	*Anguilla* sp.	1	50	
	Banded kokopu	*Galaxias fasciatus*	1	7	Not threatened
	Black flounder	*Rhombosolea retiaria*	1	10	Not threatened

Table 3: New Zealand Freshwater Fish Database records for the Kaikorai Wetland – Estuary Complex

Water body	Species common name	Species Scientific name	Number of records	Abundance range	Status
Kaikorai Estuary 'Estuary'	Common bully	*Gobiomorphus cotidianus*	2	1	Not threatened
	Common smelt	*Retropinna retropinna*	1	1	Not threatened
	Estuarine triplefin	*Grahamina* sp.	1	1	Not threatened
	Inanga	*Galaxias maculatus*	1	1	Declining
	Shortfin eel	*Anguilla australis*	1	1	Not threatened
	Unidentified flounder	*Rhombosolea* sp.	1	1	
	Yelloweye mullet	*Aldrichetta forsteri*	2	12 – 21	Not threatened
	Banded kokopu	*Galaxias fasciatus*	1	7	Not threatened
	Unidentified marine species		2	1 - 4	

8.9 Birds

The ORC website for the descriptions of wetland and estuaries states that the Kaikorai wetland-estuary complex is utilised by over 15 bird species and is recognised as an important habitat for the nationally threatened species Australasian Bittern and Banded Dotterel (Table 4). The area is also regarded as a critical habitat for the life cycle of a number of indigenous birds, as well as a habitat utilised by a range of birds, including white-faced heron, oystercatchers and paradise shelducks (Table 4).

Table 4: Native bird records for the Kaikorai Wetland – Estuary Complex

Wetland value	Species Common Name	Species Scientific Name
Habitat for nationally or internationally rare or threatened species or communities	Australasian Bittern	*Botaurus poiciloptilus*
	Banded Dotterel	*Charadrius bicinctus bicinctus*
Critical habitat for the life cycles of indigenous fauna which are dependent on wetlands	Mallard	*Anas platyrhynchos*
	Shoveller	
	Black Swan	*Cygnus atratus*
	Pukeko	*Porphyrio porphyrio melanotus*
	Pied Stilt	*Himantopus himantopus*
	Black-backed Gull	*Larus dominicanus*
Wetland habitat used by birds	Shags	*Phalacrocoracidae*
	Gulls	*Laridae*
	Royal Spoonbill	*Platalea regia*
	Terns	
	White-faced Heron	Ardea *novaehollandiae novaehollandiae*
	Oystercatchers	*Haematopodidae*
	Paradise Shelduck	*Tadorna variegata*
	Marsh Crake	*Porzana pusilla affinis*

8.10 Estuary Trophic Condition Assessment and Susceptibility

A New Zealand Estuary Trophic Index (ETI) toolbox was developed to assist with the determination of the susceptibility of an estuary to eutrophication by determining current trophic state and assessing how changes to nutrient loads may alter its state (Robertson et al. 2016a). The physical and nutrient susceptibility tool (ETI Tool 1) is a desktop approach that uses an estuary's physical characteristics, nutrient input load and estuary response relationships to determine its susceptibility (Robertson et al. 2016a). The NZ ETI toolbox database (https://shiny.niwa.co.nz/Estuaries-Screening-Tool-1/) has complied data on 446 estuaries around New Zealand, from a range of data sources, to enable susceptibility and trophic condition to be calculated from existing data.

ETI Tool 1 ranked Kaikorai Estuary in Susceptibility Band D, Macroalgae Band D and Phytoplankton Band D. Band D rating for susceptibility means that there is significant, persistent stress on a range of aquatic biota caused by indicators exceeding tolerance levels (Robertson et al. 2016). Band D ranking indicates a likelihood of local extinctions of some species and loss of ecological integrity (Robertson et al. 2016). In Kaikorai Estuary, susceptibility is indicated by both the high nitrogen loading susceptibility and nuisance growths of both macroalgae and phytoplankton in the estuary.

9.0 Effects on Groundwater Quality

9.1 Conceptual Model of Leachate Migration

As previously discussed (Section 5), the presence of TAN both within the landfill and leachate interception drain, as well as downgradient of the landfill, is considered to be a key indicator of landfill leachate presence. Based on the background information available on groundwater levels and water quality at the site, it is apparent that the leachate interception drain is capturing a significant portion of leachate leaving the site. However, given the presence of much lower, but still elevated, leachate indicators in the downstream wells, it is apparent that some leachate is entering the groundwater system and migrating beyond the interception drain.

Based on the available information, it appears as though the shallow sediments below the landfill and Kaikorai Wetland-Estuary consist of interbedded layers of marine sediments, predominantly sands and silts. These sediments form a reasonably thin water bearing layer that overlies the underlying Abbotsford Mudstone. The hydraulic conductivity testing also suggests that the hydraulic properties of the sediments are highly variable. The water quality information from wells outside of the landfill also indicates that the leachate concentrations in groundwater leaving the landfill area are also highly variable but appear to be higher within the deep wells.

Conceptually, leachate forms via decomposition of putrescible and organic fractions of landfill material which are transported by water percolating through the waste profile or will form when waste is placed in saturated conditions. Both the Eastern and Western landfills appear to have been formed with little preparation works so the base of the waste is likely saturated. Groundwater mounding within the landfill areas has been identified as a driver for lateral leachate migration towards the perimeter water bodies and also vertical migration into the deeper water bearing zones. Based on the groundwater flow direction and groundwater sampling results, leachate appears to be migrating to the east and south from the landfill. There does not appear to be any evidence of any leachate migration from the landfill northwards into the land that is zoned for future residential development.

The Western Landfill has cover material in place diverting rainfall, however, some infiltration of rainfall and percolation through waste will be occurring. The final capping works were completed on the Eastern Landfill in 2022 so the majority of rainfall will be expected to runoff with less infiltration to generate leachate. It is expected that leachate level in the landfill will reduce over time, reducing the mounding effect and gradient. It is clear that the leachate interception drain is effective in drawing down water levels within the shallow strata both within the landfill and downstream of the landfill, albeit in close proximity to the landfill.

This depression in groundwater levels also appears to be effective in capturing the majority of leachate within the shallower marine sediments migrating from the landfill. However, the leachate interception drain does not appear to be as effective in drawing in groundwater from the deeper strata or intercepting leachate migration at depth, as evident by the elevated concentrations of TAN in deep wells LD11 and LD17. Interestingly water level data from when the leachate pump has been non-operational indicates that natural water levels within the deeper and shallow strata could be similar, but the pumping from the leachate interception drain has a lower connection with the deeper strata. The overall conceptual setting suggests that leachate is likely to be migrating downwards beneath the landfill and entering both the shallow and deeper strata, and while the majority of leachate is being captured by the interception drain, a smaller component is migrating beyond the landfill site predominantly via the deeper strata that is less influenced by pumping effects of the interception drain. The conceptual model has been presented on Figure 15.

It is noted that it is currently unknown where groundwater emerges to surface water in the Kaikorai Wetland-Estuary Complex given the absence of groundwater level information below the wetland-estuary. However, based on the groundwater quality sampling undertaken within the wetland in 2012, it has been identified that leachate was impacting groundwater beneath the wetland at least to a distance of around 300 m south of the site. It is also expected that some discharge could be occurring towards the east of the landfill towards Kaikorai Stream. An isotopic study undertaken in 2004 confirmed the presence of leachate in Kaikorai Stream and in plant matter (semi-aquatic grass) collected below the high-water mark in the estuary (North et al. 2004). However, as Kaikorai Stream and the downstream receiving environment will also be impacted by Green Island Landfill on the opposite side of the stream-estuary, it means that defining the individual impacts from the Fairfield site would be difficult to determine.

Based on the presence of the Abbotsford Mudstone outcropping around 1.2 km downgradient of the site, groundwater within the shallow wetland-estuary sediments would be expected to upwell at this point if this has not already occurred further upstream.

9.2 Mass Discharge of Contaminant Migration

In order to quantify the magnitude of potential contaminant concentrations leaving the landfill, high level estimates of mass flux and mass discharge have been estimated based on the available information. Calculating mass discharge is primarily based on Darcy's law of groundwater flow through a particular cross-sectional area. The contaminant mass discharge can then be calculated based on a known contaminant concentration within groundwater. As such, the following equation applies to calculate the mass discharge of a contaminant leaving the landfill:

Mass discharge = cross sectional area x hydraulic conductivity x hydraulic gradient x contaminant concentration

As the leachate migration from the landfill is likely to be discharging both south to wetland-estuary, and east to Kaikorai Stream, mass discharge along each boundary has been assessed separately. As the historical sampling has identified TAN as a key concern, this parameter has been assessed. The four input parameters are discussed below.

Cross Sectional Area

The assumption has been made that groundwater is discharging along the entire southern and eastern boundaries, with each boundary shown on Figure 16. The southern boundary is approximately 680 m long, while the eastern boundary is approximately 320 m in length. As discussed in Section 4.1.1, available logs in the area suggest that the shallow marine sediments could be as thin as 5 m in places and have also been recorded as thick as 16 m. Considering the available well log information and the termination depth of the deeper monitoring wells (which could have been terminated at the boundary with the underlying mudstone) an average thickness estimate of 10 m has been adopted. It is considered that this could be a reasonable estimate of the average thickness of the shallow strata below the landfill and wetland. This gives a cross sectional area of 6,800 m^2 for the southern boundary and 3,200 m^2 for the eastern boundary.

Hydraulic Conductivity

As discussed in Section 4.1.3, hydraulic conductivity testing on two deep and two shallow wells has shown that the hydraulic conductivity is highly variable, with results in the range of 0.01 to 6.6 m/day. The conceptual setting indicates that the strata below the site consists of interbedded layers of sands and silts of various grain sizes, as reflected by the large range of hydraulic conductivity results. LS13 has a distinctly higher hydraulic conductivity value than the remaining three wells, indicating that the well is likely to be screened within a more permeable lens. As discussed in Section 5.3, a greater hydraulic connection between the interception drainage system and LS13 is apparent in the water quality data. The average hydraulic conductivity value derived from the deep wells of 0.38 m/day has been adopted for the mass discharge calculations on the assumption that the majority of the shallower groundwater flow is being captured by the leachate interception drain.

Hydraulic Gradient

The hydraulic gradient beneath the site and downstream wetland (towards the south) is the most uncertain piece of information given the absence of groundwater level information from the wetland. The groundwater gradient beyond the east of the site can be somewhat more constrained as conceptually it is expected that groundwater migrating eastwards is likely to be hydraulically linked to, and discharge to, Kaikorai Stream. Hydraulic gradient estimates are discussed separately for the southern and eastern boundaries.

- Southern Boundary

High level estimates of potential hydraulic gradients beyond the southern boundary have been made based on water level information from LD8 and LD11 (Figure 9) given that these deeper wells appear to be uninfluenced by pumping from the leachate interception drain. It is noted that the temporary sampling ports installed within the wetland did not show artesian groundwater levels which could suggest that the point of groundwater discharge to the estuary is further downstream beyond the area of these investigations.

As shown on Figure 9, groundwater levels in wells LD8 and LD11 have been reasonably consistent over time. The mean groundwater level in LD8 is 1.16 m RL, compared to 1.59 m RL in LD11. The maximum groundwater levels in both wells are reasonably consistent with a maximum of 1.65 m RL in LD8 and a maximum of 1.69 m RL in LD11. For the purposes of conservatism for calculating the mass contaminant discharge from the site, high groundwater levels will provide the most conservative assessment. However, a range of 1.69 m RL (i.e., the maximum of the highest levels) to 1.16 m RL (the lowest of the average levels) has been adopted to provide a range of potential groundwater levels at the southern boundary of the landfill.

The investigation in 2012, as discussed in Section 5 of this report, was undertaken during a period when water levels in the wetland were low, and survey elevations within the wetland indicated that this area had a very flat gradient with an elevation drop of 49 mm between surface water sites SW7 and

SW12 (i.e., over a distance of around 500 m; see Appendix A, Figure 12). Assuming that groundwater could discharge to the wetland in the general vicinity of SW12 approximately 500 m downstream of the site where the wetland area on the southern side of the landfill meets Kaikorai Stream (elevation of 0.809 m RL in 2012), this would result in a hydraulic gradient range of around 0.0007 to 0.0018. It is noted that these estimates are reasonably uncertain, and it is possible that groundwater could discharge above or below this point. In order to add conservativism to the assessment, consideration has been given for groundwater discharge to occur in the vicinity of SW11 (2012 elevation of 0.822 m RL) around 250 m downstream of the site. This would give a hydraulic gradient range of 0.0014 to 0.0035. The lowest and highest range of 0.0007 to 0.0035 have been adopted for the assessment.

- Eastern Boundary

Deep monitoring well LD17 on the eastern boundary has shown reasonably consistent groundwater levels over time with a minimum level of 0.97 m RL, a maximum level of 2.11 m RL and an average of 1.86 m RL. Unfortunately, the water level measurements taken in Kaikorai Stream (SP3; Appendix A, Figure 2) have not been surveyed in terms of the site datum. As such, the next closest surface water elevation measurements are from SP5 within the wetland. However, in general water levels at SP3 would be expected to be higher than the wetland and therefore to provide a conservative assessment it is assumed that the wetland levels are the same as the level within Kaikorai Stream near the eastern boundary of the site. Based on the available data, the elevation difference between LD17 and SP5 during each of the sampling rounds has ranged from 0.25 to 1.18 m (excluding two negative values from the dataset). Based on the distance of around 65 m between LD17 and Kaikorai Stream, this gives a potential hydraulic gradient range of 0.0038 to 0.018.

Contaminant Concentration

As previously discussed, wells LD11 and LD17 generally show the highest TAN concentrations downstream of the landfill and have also displayed reasonably steady concentrations since 2002 with no obvious trends. As LD11 is situated centrally on the southern boundary of the landfill, the data from this well has been adopted for the assessment of contaminant mass discharge for the southern boundary. The minimum concentration from this well is 20 mg/L, with a maximum concentration of 41.1 mg/L.

Likewise, well LD17 is situated centrally on the eastern boundary of the landfill, and the data from this well has been adopted for the assessment of contaminant mass discharge for the eastern boundary. The minimum concentration from this well is 18.3 mg/L, with a maximum concentration of 29 mg/L.

Assumptions

This assessment has applied a number of assumptions as follows:

1. It has been assumed that the TAN concentrations in the deep wells outside of the landfill are representative of the entire saturated thickness of strata below the wetland-estuary (and above the mudstone). In reality this is conservative given the lower concentrations observed in shallower wells due to the attenuation effect from the leachate interception drain.
2. It has been assumed that the underlying mudstone is impermeable.
3. It has been assumed that the strata below the wetland has a constant uniform thickness of 10 m.
4. It has been assumed that TAN concentrations within the deep wells outside the landfill are solely derived from landfill leachate from the site. Additional sources such as upstream land uses, other landfilling including the nearby Green Island Landfill have not been considered.

Results

The relevant input parameters for each boundary are summarised in the following table.

Table 5: Mass Discharge Calculation Input Parameters

Boundary	Cross Sectional Area (m²)	Hydraulic Conductivity (m/day)	Hydraulic Gradient (m/m)	Contaminant Concentration (mg/L)
Southern	6,800	0.38	0.0007 to 0.0035	20 to 41.1
Eastern	3,200	0.38	0.0038 to 0.018	18.3 to 29

Based on the above parameters, the mass discharge of TAN in groundwater from the site could be in the order of 121 to 1,007 g/day. The results for each boundary based on the different range of potential hydraulic gradients and contaminant concentrations are summarised in the following table. For comparison, using the annual total discharge volumes of leachate pumped to the DCC wastewater treatment plant and average TAN concentrations at EPS42, the average mass discharge of TAN in the pumped leachate was calculated at 21,102 g/day. On this basis, somewhere between 95.4% and 99.4% of the leachate being generated is being intercepted and removed by the interception drainage system. This is very rough calculation using a number of conservative assumptions and average values over the period of monitoring but provides a high-level indication of the mass loading in groundwater movement away from the landfill. The landfill ceased receiving waste from 2017 and capping completed in 2022, and monitoring rounds since have started to show a decline in TAN concentrations and a reduction in the pumped leachate volumes. Over time the mass loading in groundwater would be expected to decline.

Table 6: Mass Discharge Results

Southern Boundary Mass Discharge (grams/day)		
Hydraulic Gradient	**TAN Concentration**	
	20	**41.1**
0.0007	36	74
0.0035	181	372
Eastern Boundary Mass Discharge (grams/day)		
Hydraulic Gradient	**TAN Concentration**	
	18.3	**29**
0.0038	85	134
0.018	401	635

The above estimates provide a quantification of the potential volume of TAN migrating in groundwater beyond the landfill and interception drainage system. While the exact location of where groundwater is likely to emerge as surface water within the wetland-estuary is unknown, based on the presence of the Abbotsford Mudstone converging around 1.2 km downstream of the landfill which would likely force groundwater to discharge at the surface, this is considered to be the most likely downstream extent of groundwater discharge. The 2012 investigations undertaken in the wetland area immediately downstream of the landfill did not indicate the presence of above ground artesian water levels at that time (of low water levels) which could indicate that groundwater discharges further south of the investigation area.

Overall, it is clear that there is a small component of leachate entering the groundwater system downgradient of the site, and the potential effects on Kaikorai Wetland-Estuary are further discussed in Section 10 of this report. In order to monitor the effects of potential leachate migration into the Kaikorai Wetland-Estuary, a tentative groundwater monitoring programme has been proposed which is included in Appendix I, which is largely based on the previous monitoring regime with some additional recommendations to better reflect the complexity of this system. The sampling locations are preliminary at this stage and will be confirmed following a site inspection and assessment to better understand where groundwater may be upwelling into the estuary complex. It is the intention that this monitoring programme will be incorporated into the wider aftercare management plan being prepared by WMNZ and also the new resource consents to be sought by WMNZ.

10.0 Effects on Groundwater and Surface Water Quantity

The leachate interception drain at the site is expected to be abstracting both a component of landfill leachate as well as a component of groundwater. Consent 93541 authorises the take of underground water containing leachate and other groundwater. As such, the abstraction of leachate and groundwater from the interception drain requires an assessment of the potential effects on groundwater quantity.

Based on the historical leachate pumping volumes, total annual discharge volumes fluctuated between approximately 22,000 m^3 and 37,500 m^3 between 2004 - 2017 and have been generally declining since 2017. The reduction in leachate volume is likely related to the closing and progressive capping of the landfill, which is reducing the rainfall entering the landfill generating leachate. Based on the average monthly discharge rates presented on Figure 9, typical average rates of around 2 to 5 m^3/hour have been recorded since 2018, with the exception of the flooding of the wetland area (and pump chamber) which required higher than normal pumping rates to draw water levels back down to normal pumping levels. Rates of around 2 to 5 m^3/hour result in daily volumes of around 48 to 120 m^3/day which are considered to be low. However, the effects of the drawdown from the leachate interception drain on neighbouring wells, surface water and saltwater intrusion are assessed below.

Currently the leachate pumping volumes are recorded as average monthly rates in cubic metres per hour. Under the Resource Management (Measurement and Reporting of Water Takes) Amendment Regulations (2020), water permit holders are required to record measurements of the water taken under a water permit in each 15-minute period (instead of each day). The requirements state that the daily records must be electronically provided to ORC by the end of the following day. Typically, this is achieved using a telemetry system. The regulations come into force a certain number of years after the commencement of the regulations (2020) as follows:

- 2 years after if the rate is greater than or equal to 20 L/s
- 4 years after if the rate is greater than or equal to 10 L/s but less than 20 L/s
- 6 years after if the rate is greater than or equal to 5 L/s but less than 10 L/s

The instantaneous pumping rate is not currently recorded, however, it has been calculated to typically be between 4.7 and 6.1 L/s, with rates calculated as high as 9.2 L/s. This suggests that the regulations will come into force for the site in 2026.

It is recommended that the consent includes a condition to monitor and record the instantaneous rate of abstraction (average of 15 minutes). We expect ORC would apply this condition to the groundwater permit. Upgrading the flow monitoring equipment to record an instantaneous rate will also allow for a better understanding of the abstraction rates from the leachate interception drain.

10.1 Effects on Neighbouring Groundwater Users

The closest well recorded as in use for water supply purposes is located more than 1 km to the south-east of the landfill site on the opposite side of Kaikorai Stream. Additionally, the DCC water services maps[13] indicate that the nearby settlements of Fairfield, Abbotsford, Green Island and Waldronville all have a reticulated water supply and are therefore not expected to have private water supply wells. The groundwater level monitoring data obtained from the site both from wells within and outside of the landfill, as well as within the leachate interception drain shows that the pumping of leachate contaminated groundwater is causing a drawdown depression in the local vicinity around the drain within shallow wells (as required by Consent 93541). The drawdown effects do not appear to propagate far into the adjacent strata likely as a result of the low permeability marine sediments, and minimal drawdown effects have been observed within the deeper downstream monitoring wells.

Any drawdown effects are expected to occur locally and remain constrained to the estuarine sediments within the local vicinity of the wetland, with the estuarine deposits shown previously on the geological map (Figure 5). The closest well used for water supply purposes is situated outside of the wetland area and at a significant distance from the site and as such, no drawdown effects on neighbouring wells from groundwater abstraction within the leachate interception drain are anticipated.

10.2 Effects on Surface Water Flows

As previously discussed, a significant portion of the abstracted water from the leachate interception drain is likely to comprise groundwater. As such, the abstraction of this groundwater is likely to result in a reduction of surface flows within the wetland due to a lower quantity of groundwater discharging to the wetland-estuary than would otherwise occur. In recent years, typical daily volumes of pumped water have been around 48 to 120 m^3/day, or equivalent to 0.6 to 1.4 L/s which is a low rate of take. As mentioned previously, it is currently

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[13] https://www.dunedin.govt.nz/do-it-online/maps-and-photos/water-services-map-and-wws-work-in-progress

unknown exactly where groundwater emerges into the wetland-estuary, but it is expected to occur between the site and the point at which the mudstone deposits flanking the estuary converge around 1.2 km downstream of the site. The potential loss of groundwater discharge to the wetland-estuary is likely to occur diffusely over a reasonably large area, and it can be inferred that the full effect should be evident within a distance of around 1.2 km downstream.

The interception drain has been designed to create a hydraulic depression over a length of approximately 1 km around the southern and eastern sides of the landfill to prevent the outward flow of leachate impacted groundwater towards the wetland-estuary system. Monitoring data indicates that the interception drainage system is successfully capturing the majority of the leachate migrating towards the wetland-estuary. The majority of the take would comprise groundwater/leachate, but at times when the wetland area is under water, it is possible that a proportion of the take may be sourced from the surface water body. The degree of direct connectivity between the trench and the surface water in the wetland is unknown, but when the wetland water level rises to a level above the perimeter access road around the landfill, water directly enters the top of the permeable trench and has also been observed to overtop the leachate pumping chamber. In this situation the leachate interception drainage system gets overwhelmed and the pump will switch off, notifying WMNZ.

Under the Regional Plan: Water for Otago, groundwater takes situated within 100 m of surface water are allocated as surface water under Policy 6.4.1A and given the proximity of the interception drain to the wetland, the abstraction is considered be allocated as a surface water take under the relevant planning framework. The groundwater take is over the entire 1 km length of the interception drain as opposed to a single point take so its surface water depletion effect would be highly dispersed. Given that the purpose of the interception drain is to remove leachate impacted groundwater that would otherwise flow into the estuary, applying a minimum flow restriction (noting there is no current minimum flow site on the estuary or Kaikorai Stream) to the take would be detrimental to the receiving environment. It should also be noted that the average rate of the take (around 0.6 to 1.4 L/s) at the sump is small, considering that the allowable stream depletion effect for groundwater abstractions situated more than 100 m from a waterbody is up to 5 L/s under Policy 6.4.1A of the Regional Plan: Water for Otago.

The groundwater sourced surface water recharge losses due to pumping from the interception drain are also likely to be minimal in comparison to the wider water level fluctuations within the wetland caused by the periodic closing and opening of the estuary mouth. As such, it is considered appropriate to grant the consent without the addition of minimum flow restrictions.

10.3 Effects on Saline Intrusion

The landfill interception drain is situated approximately 2.4 km inland of the coast. Any drawdown effects will be limited to the extent of the shallow estuarine sediments beneath the landfill and downstream estuary (Figure 5). Given the very low rate of take, and presence of bedrock outcrop between the site and the coast which is likely to act as a barrier to saltwater intrusion, pumping from the leachate interception drain is not expected to cause any saline intrusion effects. However, it is noted that the estuary can be brackish at times and therefore it is possible that some of this water may be drawn into the drain. Although this is not expected to change the saline/freshwater interface near the coast.

11.0 Effects on Surface Water Quality and Ecology

Monitoring data shows that some leachate is entering the groundwater system and migrating beyond the interception drain and potentially entering the Kaikorai Stream and wetland/estuary. The results suggest concentrations beyond the interception drain are relatively stable in downgradient wells (in particular the deeper wells) since 2002 when sampling began. Overtime some improvement in groundwater quality is anticipated as the Eastern Landfill has been capped limiting any further rainfall infiltration reducing the leachate generation potential. Furthermore, the landfill cap reduces the likelihood of any stormwater runoff containing leachate impacts. The only potential for leachate effects on surface water is via breakouts on the sides of the landfill. However, given the shape of the landfill (dome) and reduced rainfall infiltration, the potential for breakouts is reduced and are unlikely.

The Western Landfill is covered, however, some rainfall infiltration is apparent based on the mounded water levels so leachate generation and migration will continue in the short to medium term. The interception drain extends along the southern edge of this landfill area intercepting leachate migration. This landfill area is much older and quarterly sampling of the leachate being collected from this area (interception drain wells LS24 and LS26, Appendix D2) show the lowest TAN concentrations of any of the interception drain wells and an obvious decreasing trend is apparent.

The passive discharge of leachate impacts in groundwater is expected to continue from the Eastern and Western Landfill areas in the immediate future and is expected to be emerging to the surface in the wetland-estuary complex at some point. The site no longer receives waste and the capping works have been completed so the volume of leachate generation will be expected to reduce with time and concentration levels will also be expected to reduce. This will start to have a reduced impact on groundwater quality and ultimately improve the surface water quality in the wider area. The following is an assessment of effects on surface water as a result of the ongoing passive discharge.

11.1 Aquatic Ecological Values

The known physical and ecological characteristics of the tributaries, Kaikorai Swamp wetland and the Kaikorai estuary were assessed against the matters and attributes outlined in the Environment Institute of Australia and New Zealand Guidelines (Roper-Lindsey 2018). A summary of these values is provided in Tables 7 – 9, below.

Table 7: Kaikorai Stream and Tributaries Aquatic Ecological Valuation Summary based on EIANZ Criteria

Matter	Attributes	Value
Representativeness	- The Kaikorai catchment is highly modified and dominated by pasture (48%) and urban (21%), with low levels of native forest catchment surrounding upper tributary streams only. The lower tributaries (Christies and Coal Creeks) are heavily modified and channelised, with low quality instream habitat conditions. - Surface water quality in the lower tributaries did not represent 'reference' water quality conditions for TAN, zinc, and boron. - Macroinvertebrate communities in the Upper Kaikorai Stream/Abbotts Creek were indicative of pollution tolerant species, with MCI and QMCI scores below the national bottom line. - Kaikorai Stream/Abbotts Creek has a diverse freshwater fish community (10 taxa), including the nationally vulnerable lamprey. Ecological values of Christies and Coal Creeks are unknown.	Moderate
Rarity/ distinctiveness	'Threatened- Nationally vulnerable' lamprey and the 'At Risk-Declining' longfin eel, and declining inanga utilise Abbotts Creek/Kaikorai Stream for habitat, passage, lifecycle and feeding.	High
Diversity and Pattern	There is a high taxonomic richness of native freshwater fish in the Kaikorai Stream but the low diversity of macroinvertebrates. Ecological values of Christies and Coal Creeks are unknown.	Moderate
Ecological Context	All tributaries have been heavily modified, with poor water quality and loss of naturalness. Abbotts Creek/ Kaikorai Stream is a habitat for national rare or threatened species of freshwater fish.	Moderate
	Overall Value	**High**

Table 8: Kaikorai Swamp Wetland Ecological Valuation Summary based on EIANZ Criteria

Matter	Attributes	Value
Representativeness	- The Kaikorai swamp/wetland has undergone substantial habitat modification, with an estimated 100 ha of saltmarsh modified or lost. Extensive herbfields remain in the wetland, forming a distinctive swamp. Low levels of native forest remain in the catchment, with urbanisation and pasture impacting on tributaries. - Surface water quality in the swamp did not represent 'reference' water quality conditions for TAN, zinc, and boron. - New Zealand Freshwater Fish Database (NZFFD) records indicate that native fish communities in the Kaikorai Swamp have low diversity, with only four reported.	Moderate
Rarity/ distinctiveness	The swamp/wetland is recognised as a wetland of regional significance, as well as significant conservation values, with only 15% of swamps remaining in Otago. The wetland is a habitat for the threatened Australasian Bittern and the Banded Dotterel.	Very High
Diversity and Pattern	There is a high taxonomic richness of birdlife that utilise the Swamp – Estuary complex and well as herbfields.	High
Ecological Context	The swamp/wetland is classified as a "Regionally Significant Wetland" under the Regional Plan: Water for Otago and an Area of "Significant Conservation Value" in the DCC 2nd Generation District Plan. It provides habitat for national rare or threatened species of birds and fish, and critical habitat for the life cycle of a wide range of birds that are dependent on wetlands.	Very High
	Overall Value	**Very High**

Table 9: Kaikorai Estuary Ecological Valuation Summary based on EIANZ Criteria

Matter	Attributes	Value
Representativeness	- The Kaikorai Estuary has undergone major habitat modification, with loss of habitat, reduction in terrestrial buffer zones, and causeway construction, resulting in substrate modification. - Water quality arising from the tributaries fails to meet 'reference' conditions for TAN, zinc, and boron. Sediment quality in the estuary did not represent 'reference conditions' for total nitrogen, zinc, and percentage mud. Macrofauna communities in the estuary were moderately to heavily impacted by the percentage mud. - New Zealand Freshwater Fish Database (NZFFD) records indicate that Kaikorai Estuary supports a diverse fresh and marine fish population, with a total of five freshwater and five marine species recorded.	Moderate
Rarity/ distinctiveness	The estuary provides habitat and food for the 'Threatened' Australasian Bittern and the Banded Dotterel. The estuary is also utilised for habitat, passage, lifecycle and feeding of a number of native fish including the 'At Risk-Declining' longfin eel and 'Declining' inanga.	Very High
Diversity and Pattern	There is a high taxonomic richness of native fish and birds that utilise the estuary.	High
Ecological Context	The ecological context score of **high** has been assigned based on the following criteria: - The estuary plays a significant role in ecological connection and function of the wetland (swamp) of significant regional importance. The estuary provides habitat and food sources for national rare or threatened species of birds. - The estuary is ranked in the Susceptibility Band D, in the Estuary Trophic Index, meaning that the estuary is vulnerable to nutrient loading, macroalgal growth and phytoplankton blooms.	High
	Overall Value	**Very High**

With limited comparable upstream and downstream water quality and ecological data, a more fulsome Ecological Impact Assessment could not be undertaken. However, commentary has been provided on the potential effects of the discharge on the downstream aquatic community. The discharge of leachate to the wetland-estuary is likely contributing to the total contaminant loadings, particularly TAN, zinc and boron, while the reduction in groundwater recharge may result in a reduction in the dilution effects of contaminants. Some level of leachate discharge to groundwater/surface water is likely to have been occurring since the landfilling at Fairfield commenced (circa 1967) and the reducing in groundwater recharge since the operation of the interception drainage system (1997). The operation of the interception drain is critical for the ongoing management of the leachate, however, now that the landfill is no longer receiving waste the volume of leachate generation will be expected to reduce with time and concentration levels will also be expected to reduce.

11.2 Aquatic Effects

The following effects to the values of the Kaikorai Swamp Wetland, its tributaries, and the estuary as a result of the Fairfield leachate diffuse discharge were identified and assessed as:

Water quality effects

- Elevated TAN concentrations
- Elevated concentrations of boron and zinc
- Disturbed physicochemical conditions (e.g., reduced dissolved oxygen and pH)

Sediment effects

- Elevated total nitrogen concentrations
- Elevated zinc concentrations

Potential aquatic ecological effects

- Chronic and non-lethal toxicity effects to aquatic organisms and community compositional shifts
- Behavioural avoidance of degraded water (e.g., causing a behavioural barrier to migratory fish passage)
- Reduced food sources for birds using the wetland-complex

Magnitude and Level of Effects

The tributaries, the swamp and, ultimately, the estuary, receive discharges from a number of sources, including stormwater runoff, industrial discharge, as well as potentially from Fairfield and Green Island Landfills. The combined discharges negatively affects water and sediment quality, which, in turn, impacts ecosystem health.

One of the challenges in assessing the magnitude and level of effects is the lack of comparable sites upstream of the potential influence from any of the landfills for both water quality and ecological values, nor any distinction between contributions from the different landfills. Long-term monitoring data indicates degradation in several water quality parameters as water flows from Christies Creek into Coal Creek before entering the swamp. Similarly, degradation in water quality is indicated between Upper Kaikorai Stream at Brighton Road and the stream before it enters the estuary, where both Fairfield and Green Island Landfills may potentially be contributing to the water quality degradation.

In addition to this, the volume and fate of leachate contaminated groundwater is unknown. As mentioned earlier, the shallow groundwater is expected to upwell between the interception drain and the Abbotsford Mudstone outcropping around 1.2 km downgradient. Upwelling in the small channels within the wetland would result in higher surface water concentrations and therefore higher ecological impacts at those points, than in the open body of the estuary further downstream.

While there are no ecological monitoring data to confirm our assumptions, it is plausible to suggest that the poor water quality, particularly TAN concentrations, measured in the wetland and its tributaries, would negatively affect sensitive species, as well as reduce available food sources to higher organisms. However, this would depend on the presence of sensitive species upstream of the landfill and the degree of impact caused by the landfill (and other activities in the catchment and around the wetland-estuary). MCI and QMCI scores from the Kaikorai Stream at Brighton Road indicate that the upstream community was degraded and comprised of pollution tolerant species. Further degradation of the MCI and QMCI scores may be expected downstream of the Brighton Road monitoring location and in the wetland, but this has not been assessed. Similarly, the ecological values of Christies and Coal Creeks are unknown but given the long-term TAN concentrations, pH and DO, aquatic communities are anticipated to be comprised of only a few of the most pollution tolerant species, if any.

Comparisons between the 5-yearly and the 20-yearly median and 95th percentile concentrations, showed that the water quality in the wetland and its tributaries, while degraded, was relatively stable. Ecological values within the wetland and tributaries would be integrated with the long-term degraded but stable water quality.

The presence of nationally vulnerable fish and bird species indicate that, at least, parts of the swamp and its tributaries, support high ecological values and high rarity/distinctiveness. Due to the Very High Ecological Value of the wetland, the magnitude of any effects of leachate seepage would be considered to be higher than in the estuary, or the tributaries. However, with uncertainty on the location of groundwater discharge to the wetland-estuary complex and the lack of monitoring data, the effects on aquatic life cannot be determined. A monitoring plan has been proposed to address this which is summarised below.

Several of the recorded fish species taxa have a migratory life stage, including lamprey, eels and banded kokopu, and require passage between the sea and freshwater to successfully reproduce. Elevated TAN concentrations (≥2 mg/L) can present a barrier to migratory movements due to behavioural avoidance of the elevated TAN (Richardson, Williams & Hickey 2001). Long-term water quality data indicate that, on occasions, elevated TAN in the tributaries and wetland could act as a migratory barrier and prevent some fish from successfully completing their life cycle. The magnitude of this effect would depend on the frequency and duration of TAN exceedances of 2 mg/L during migration periods.

In summary, degraded water quality in the tributaries and wetland are likely to negatively affect the aquatic community, including reduced biodiversity and available food sources. On occasions, elevated TAN concentrations may act as a barrier to fish migration. It should also be noted that elevated DRP concentrations in the groundwater could negatively affect surface water quality in regions where groundwater recharges. However, surface water DRP monitoring is not part of the existing consent monitoring therefore concentrations in the surface water are unknown.

A tentative groundwater, surface water and ecology monitoring plan has been proposed in Appendix I to determine the level and magnitude of effects of the leachate and any on-going monitoring requirements. It is proposed that this monitoring plan will be included in the consent conditions for the new resource consents to be sought by WMNZ.

12.0 Effects on Human Health from Subsurface LFG Migration

The Western Landfill area is at the end of the LFG production cycle, which is supported by the low levels of LFG in the wells being monitored. Whilst there would still be some LFG being produced, the volume would not be sufficient to generate sufficient pressure to force lateral migration where the any LFG being produced would passively discharge through the ground surface.

The Eastern Landfill area is currently in its peak production phase and a LFG collection and flare system has been installed to manage the LFG being generated. Some lateral migration into the interception drainage system is occurring, however given its proximity to the landfill this is not unexpected. Sentinel wells installed outside of the landfill and monitoring of key locations at nearby receptors have shown no evidence to suggest lateral subsurface migration is occurring.

Based on the information available, the risk to nearby residents, and to any future residents of the land zoned for residential development to the immediate north of the landfill but as yet undeveloped, from subsurface LFG migration from the landfill is acceptably low. Monitoring of the existing LFG wells in the landfill areas and sentinel wells between the landfill and receptors is recommended to continue as a prudent approach and has been included in the proposed monitoring programme. It is recommended that a review of the monitoring conditions be undertaken every 5 years to ensure the controls and monitoring programme remain suitable for the level of risk identified.

13.0 Leachate Management – Interception Drain

Leachate will continue to be generated from both landfill areas and without any controls may result in high TAN concentration leachate/groundwater entering the Kaikorai wetland-swamp-estuary complex. This has the potential to result in acute toxic exposure to aquatic life, resulting in reduced fecundity and survival, while nutrients may accumulate in the sediments of the wetland and estuary, causing further eutrophication. Therefore, maintaining a hydraulic depression within the interception drainage system to intercept the leachate impacted groundwater migrating towards the wetland-estuary system is critical (as has been occurring since 1997).

Situations when the hydraulic depression may not be maintained include pump failure through lack of maintenance, or inundation of the system during periods of estuary mouth closure and/or floods, or the reduced effectiveness of the interception drain through biofouling of the lateral pipe sections.

To reduce the risk of operational failure, a robust maintenance schedule is being carried out by WMNZ and an alarm system to alert of any pump failure installed.

To improve the monitoring of the effectiveness of the depression created by the interception drainage system and when remedial works of the lateral sections may be required, it is being recommended that pressure transducers be installed in the leachate pump chamber and within lateral sections to record water levels every 15 minutes and downloaded every 3 months. This will be reported in the annual report submitted to Council.

Occasionally water levels in the wetland-estuary have risen above the perimeter access track and overtopped the pump chamber and flooded the interception drainage system, causing the high-high alarm to trigger shutting down the leachate pump system. To mitigate this occurring in the future, the access track and pump chamber will need to be elevated permanently. A condition has been included to address this.

Overtime, leachate levels, gradient and toxicity will decrease, and this will be observed in the leachate interception drainage system discharge. It is recommended that a review of the monitoring conditions be undertaken every 5 years to ensure the controls and monitoring programme remain suitable for the level of risk identified.

14.0 Monitoring Measures

The mitigation measures proposed in this report in conjunction with the implementation of the AMP will continue to minimise the impact from the landfill to the surrounding environment, including minimising the risk for high TAN concentrations entering the wetland and impacting aquatic life. The monitoring plan proposed will continue to support and assess the effectiveness of the mitigation measures with a review of the monitoring conditions undertaken every 5 years to ensure the mitigation controls and monitoring programme remain suitable for the level of risk identified.

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Appendix A: Figures

pdp

FIGURE 1: SITE LOCATION

RECONSENSTING FOR FAIRFIELD LANDFILL

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., DEPRECATED BASEMAP - EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

SCALE : 1:12,500 (A3)

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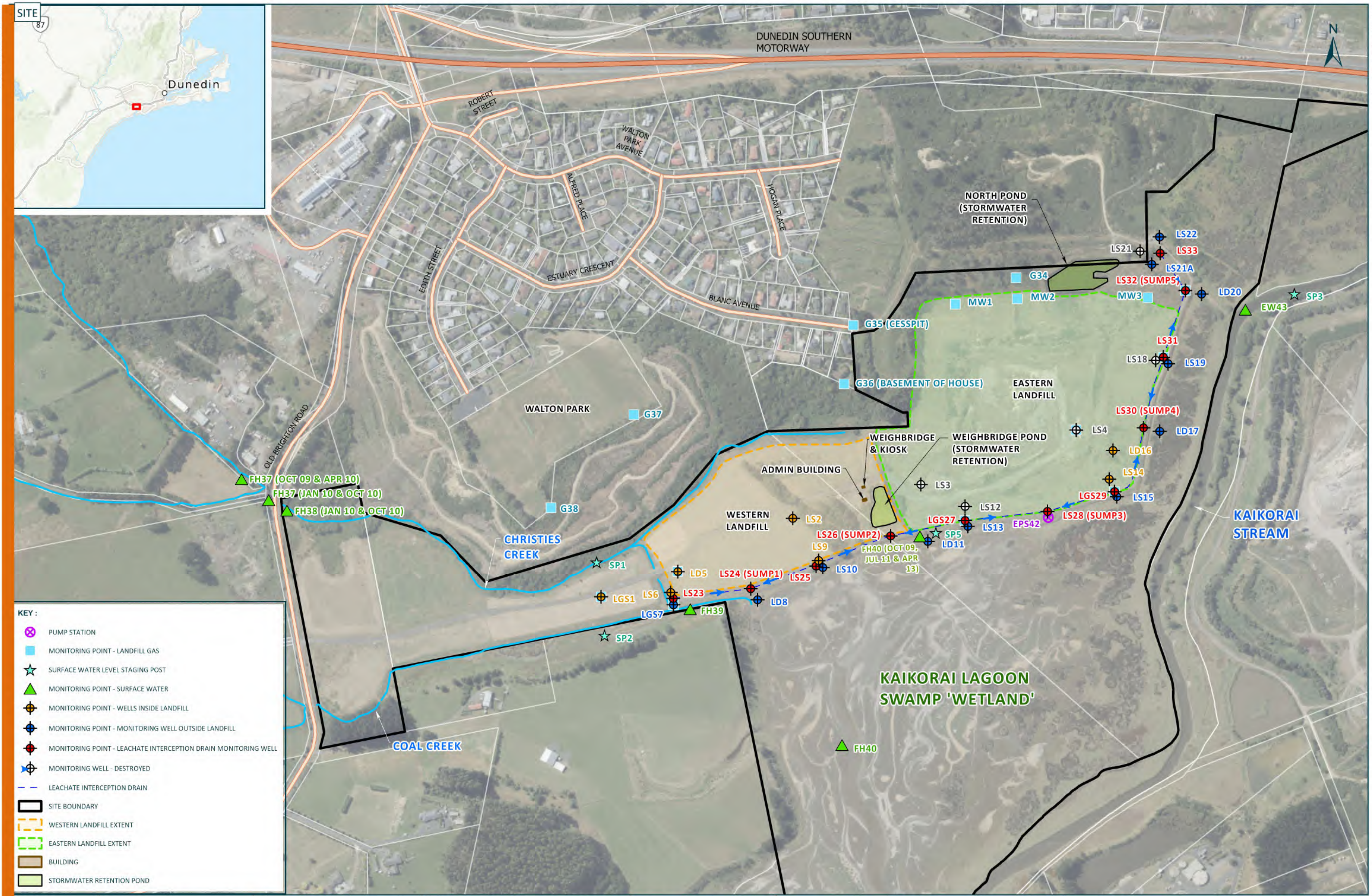

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NO.	REVISION	DATE	BY
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C	UPDATED	AUG 23	JR
B	UPDATED	MAY 23	BR
A	ISSUED	AUG 22	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. ALL DATA DERIVED FROM CADASTRAL DRAWINGS (MAY NOT BE SPATIALLY ACCURATE).

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FIGURE
FIGURE 2: SITE LAYOUT AND CURRENT MONITORING LOCATIONS

PROJECT
FAIRFIELD LANDFILL RECONSENTING

pdp

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NO.	REVISION	DATE	BY
D	UPDATED	FEB 24	JR
C	UPDATED	AUG 23	JR
B	UPDATED	MAY 23	BR
A	ISSUED	AUG 22	BR

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1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
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3. ALL DATA DERIVED FROM CADASTRAL DRAWINGS (MAY NOT BE SPATIALLY ACCURATE)

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FIGURE
FIGURE 3: LEACHATE INTERCEPTION DRAIN AND DRAINAGE LAYOUT

PROJECT
FAIRFIELD LANDFILL RECONSENTING

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NO.	REVISION	DATE	BY
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D	UPDATED	AUG 23	JR
C	UPDATED	MAY 23	BR
B	REVISED	FEB 23	BR
A	ISSUED	NOV 22	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE WWW.LINZ.GOVT.NZ/ABOUT-LINZ/LINZ-DATA-SERVICE/HELP/USING-LINZ-DATA/ATTRIBUTING-AERIAL-IMAGERY-DATA AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. WETLAND DATA DERIVED FROM HTTPS://MAPS.ORC.GOVT.NZ/ARCGIS/REST/SERVICES/WATERPLAN/MAPSERVER/5

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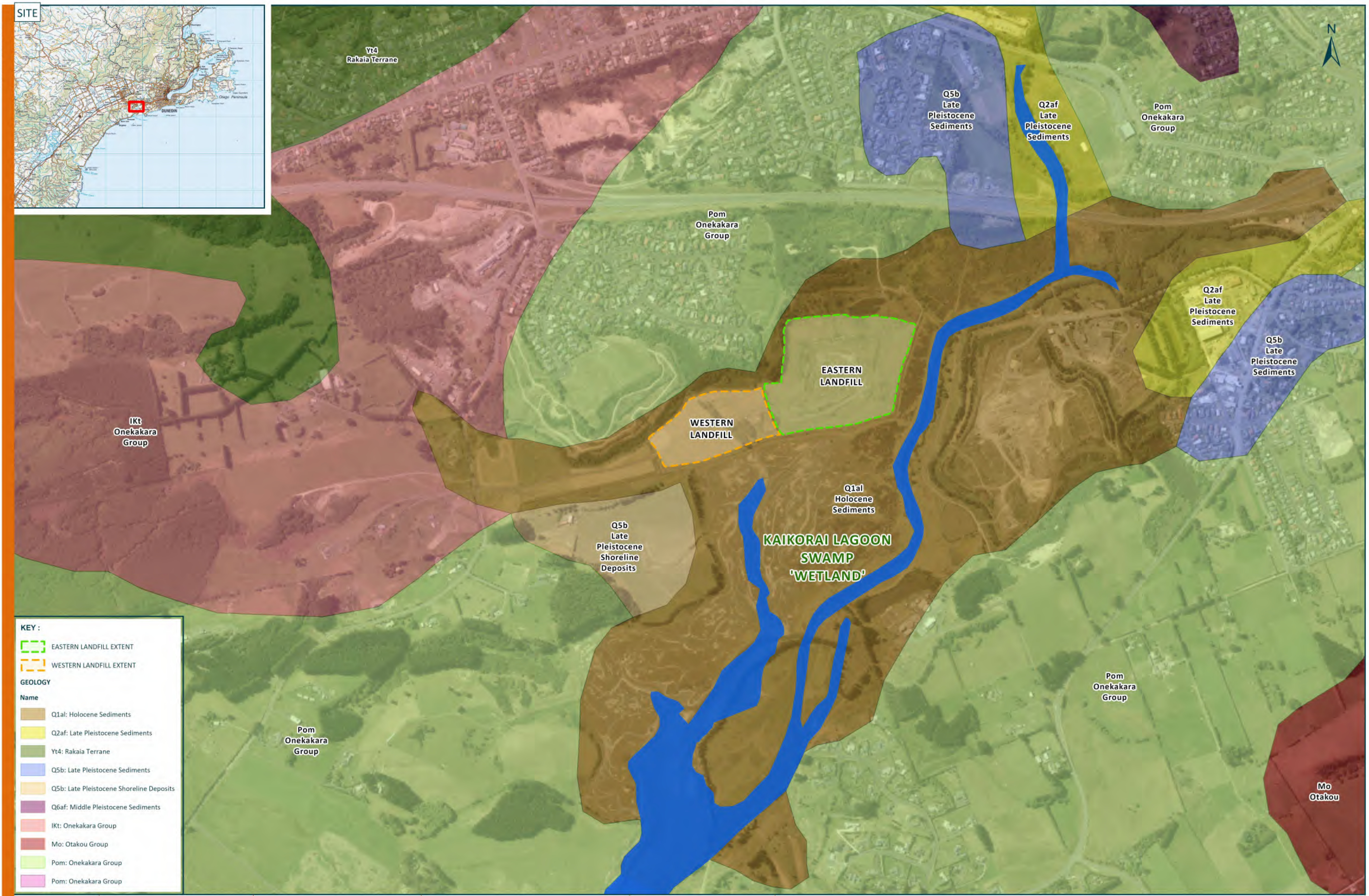
FIGURE
FIGURE 4: KAIKORAI LAGOON SWAMP WETLAND AND KAIKORAI LAGOON ESTUARY EXTENT

PROJECT
FAIRFIELD LANDFILL RECONSENTING



0 200 400
METRES
SCALE : 1:10,000 (A3)

NO.	REVISION	DATE	BY
D	UPDATED	FEB 24	JR
C	UPDATED	AUG 23	JR
B	UPDATED	MAY 23	BR
A	ISSUED	NOV 22	BR

SOURCE:
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2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. GEOLOGICAL DATA RETRIEVED FROM WEB MAP SERVICE: http://maps.gns.cri.nz/geology/wms?version=1.1.0&layers=NZL_GNS_250K_seamless_qmap_geological_map_current_view&styles=

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NZ LTD

FIGURE
FIGURE 5: SITE GEOLOGY

PROJECT
FAIRFIELD LANDFILL RECONSENTING

C021187802_Landfill_Figures.aprx - C021187800_GIS003_GEOLOGY

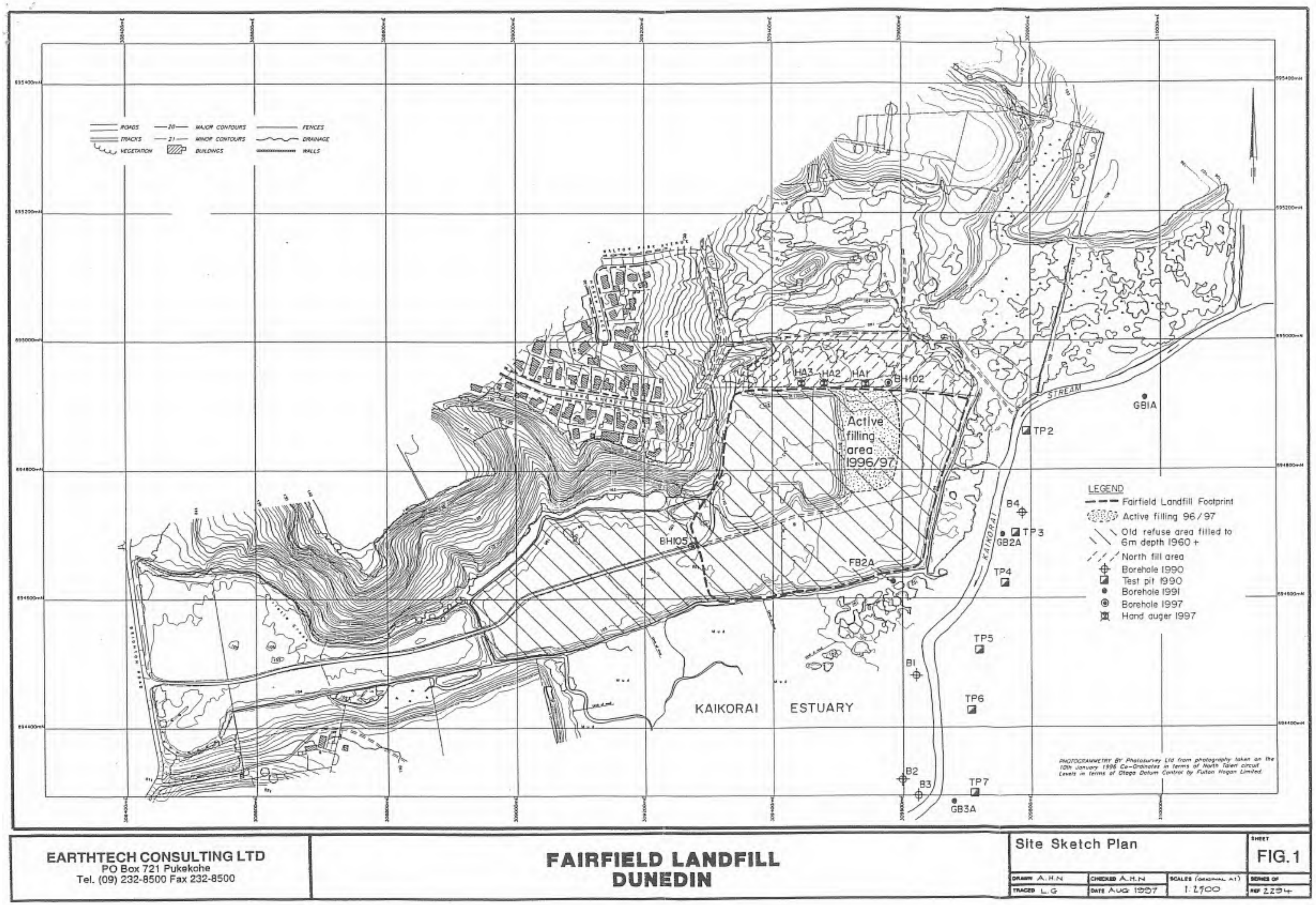

FIGURE 6: MAP BY EARTHTECH CONSULTING LTD SHOWING LOCATIONS OF SUBSURFACE INVESTIGATIONS UNDERTAKEN NEAR FAIRFIELD LANDFILL

pdp

0 75 150
METRES
SCALE : 1:4,000 (A3)

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2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. SITE DATA DERIVED FROM CADASTRAL DRAWINGS.

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FIGURE
FIGURE 7: LOCATION OF TEMPORARY GROUNDWATER SAMPLING SITES (2012 INVESTIGATION)

PROJECT
FAIRFIELD LANDFILL RECONSENTING

C02187802_Landfill_Figures.aprx - C02187800_GIS006

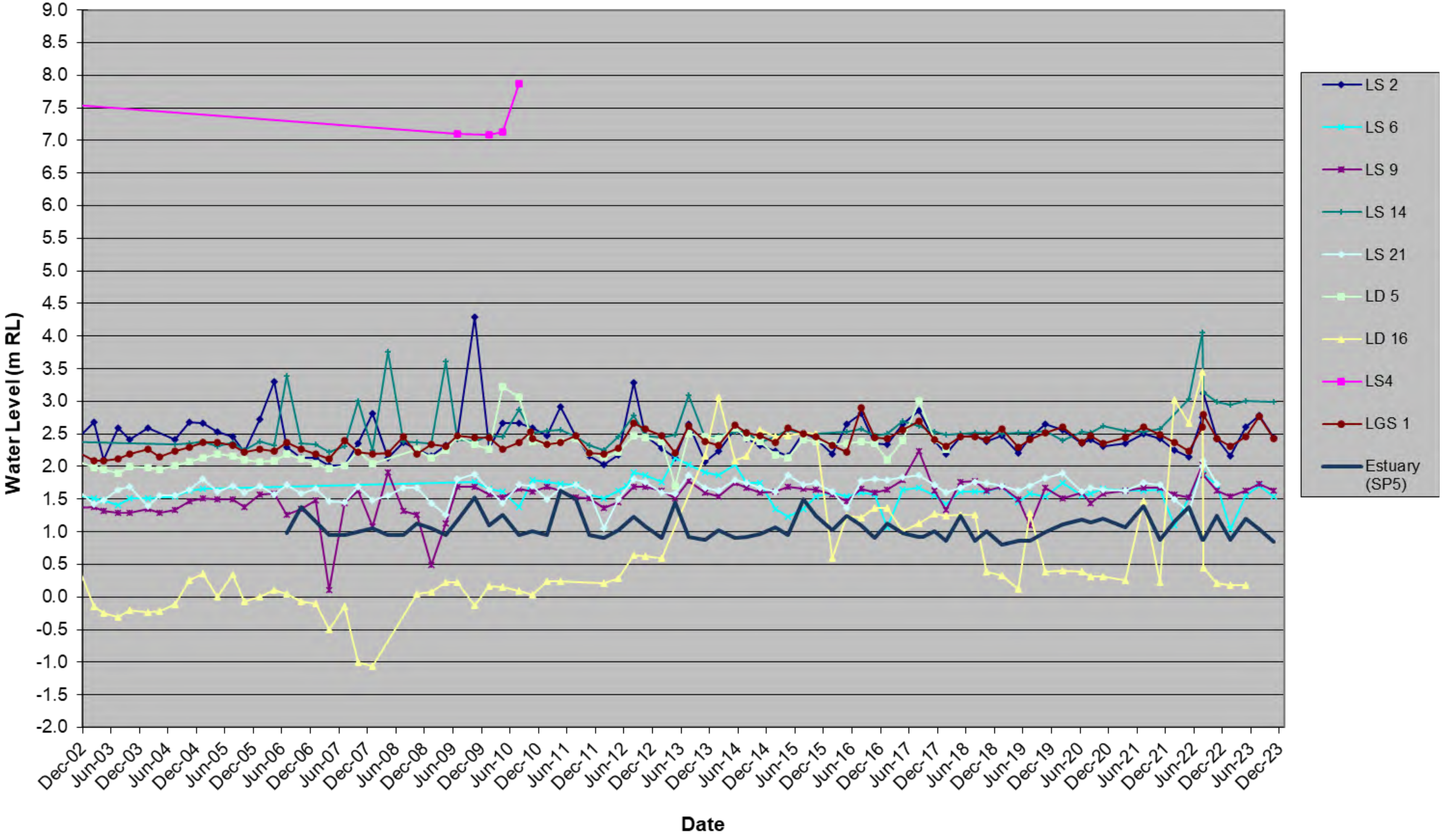

FIGURE 8: GROUNDWATER LEVELS FROM WELLS WITHIN THE LANDFILL

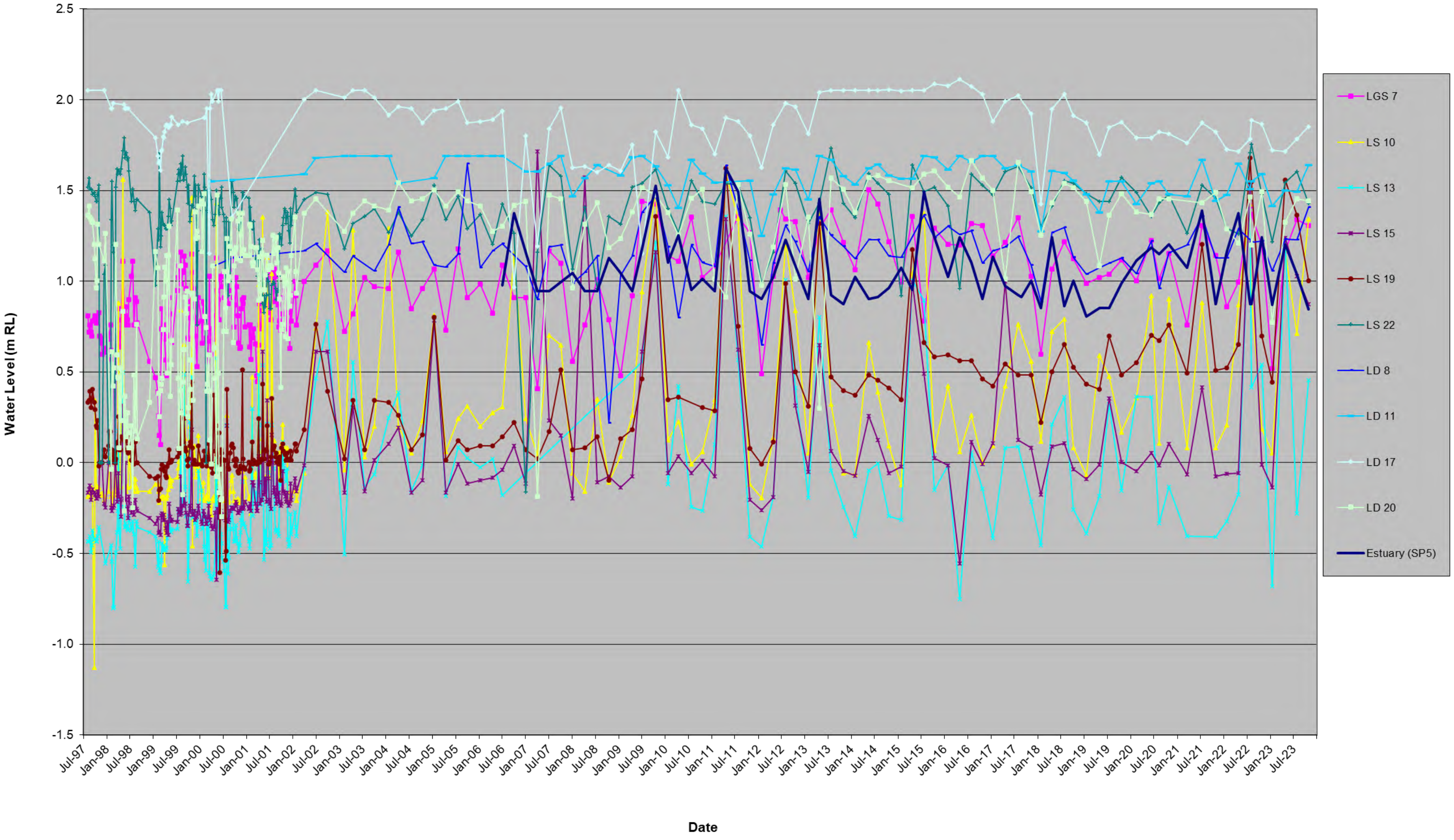

FIGURE 9: GROUNDWATER LEVELS FROM WELLS OUTSIDE THE LANDFILL

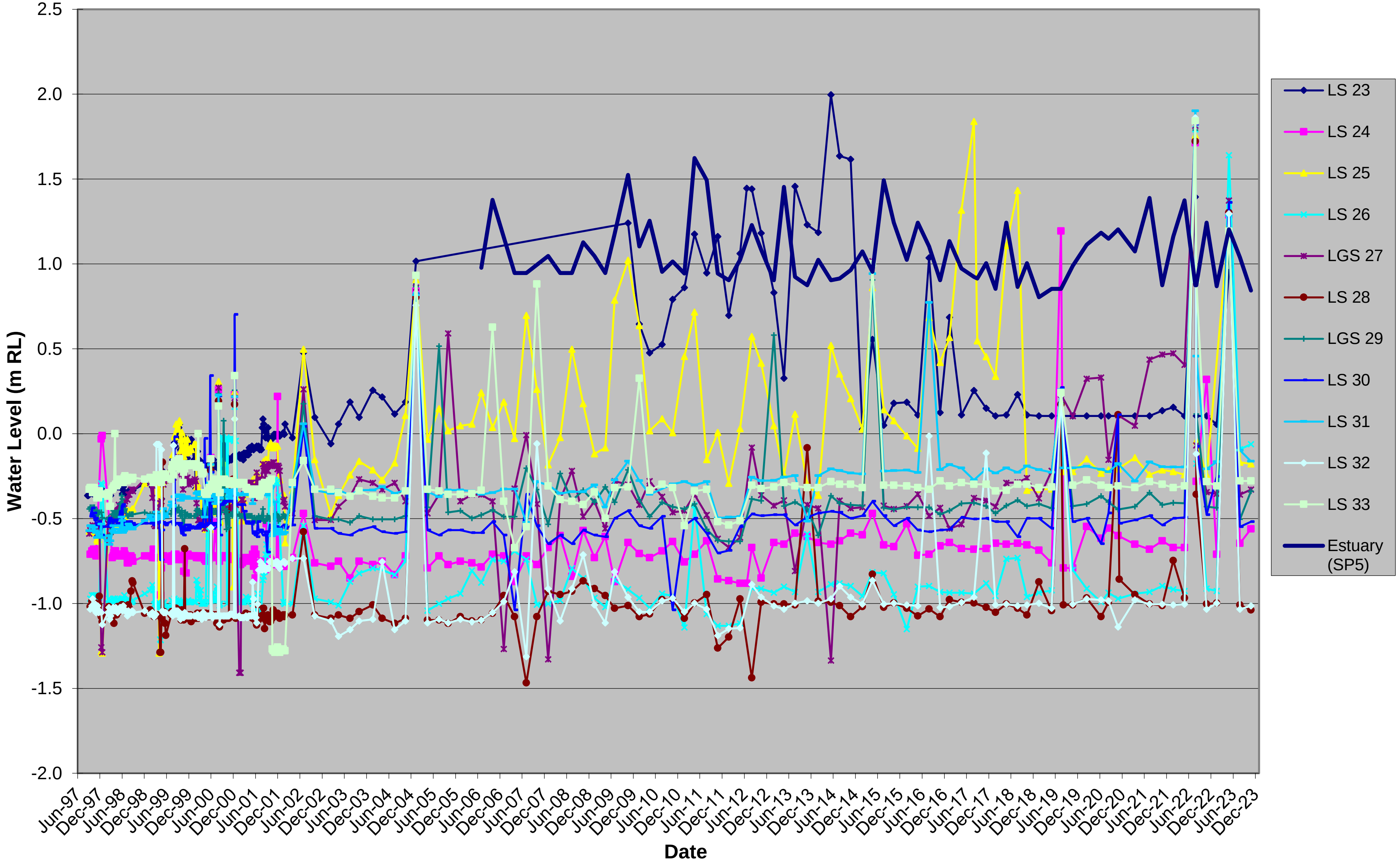

FIGURE 10: GROUNDWATER LEVELS FROM LEACHATE INTERCEPTION DRAIN WELLS

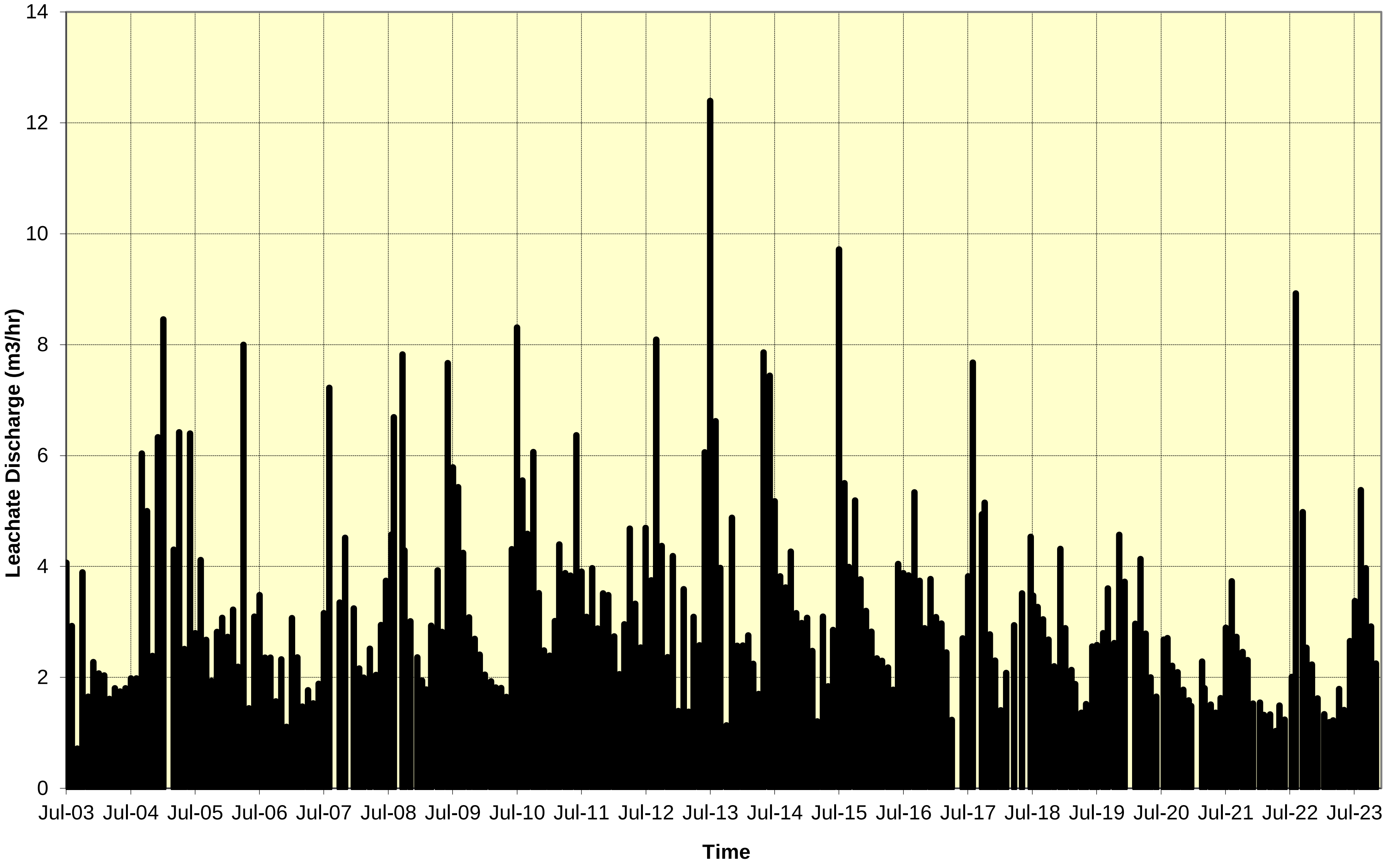

FIGURE 11: AVERAGE MONTHLY LEACHATE PUMPING VOLUMES (M³/HOUR)

C021878.02_Landfill_Figures.aprx - C021878.00_GIS007

pdp

0 75 150

METRES

SCALE : 1:4,500 (A3)

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B	UPDATED	MAY 23	BR
A	ISSUED	NOV 22	BR

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2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. SITE DATA DERIVED FROM CADASTRAL DRAWINGS.

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FIGURE
FIGURE 12: RELATIVE WATER LEVELS (m RL) (2012 INVESTIGATION)

PROJECT
FAIRFIELD LANDFILL RECONSENTING

pdp

0 75 150
METRES
SCALE : 1:4,500 (A3)

NO.	REVISION	DATE	BY
D	UPDATED	FEB 24	JR
C	UPDATED	AUG 23	JR
B	UPDATED	MAY 23	BR
A	ISSUED	NOV 22	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. SITE DATA DERIVED FROM CADASTRAL DRAWINGS.

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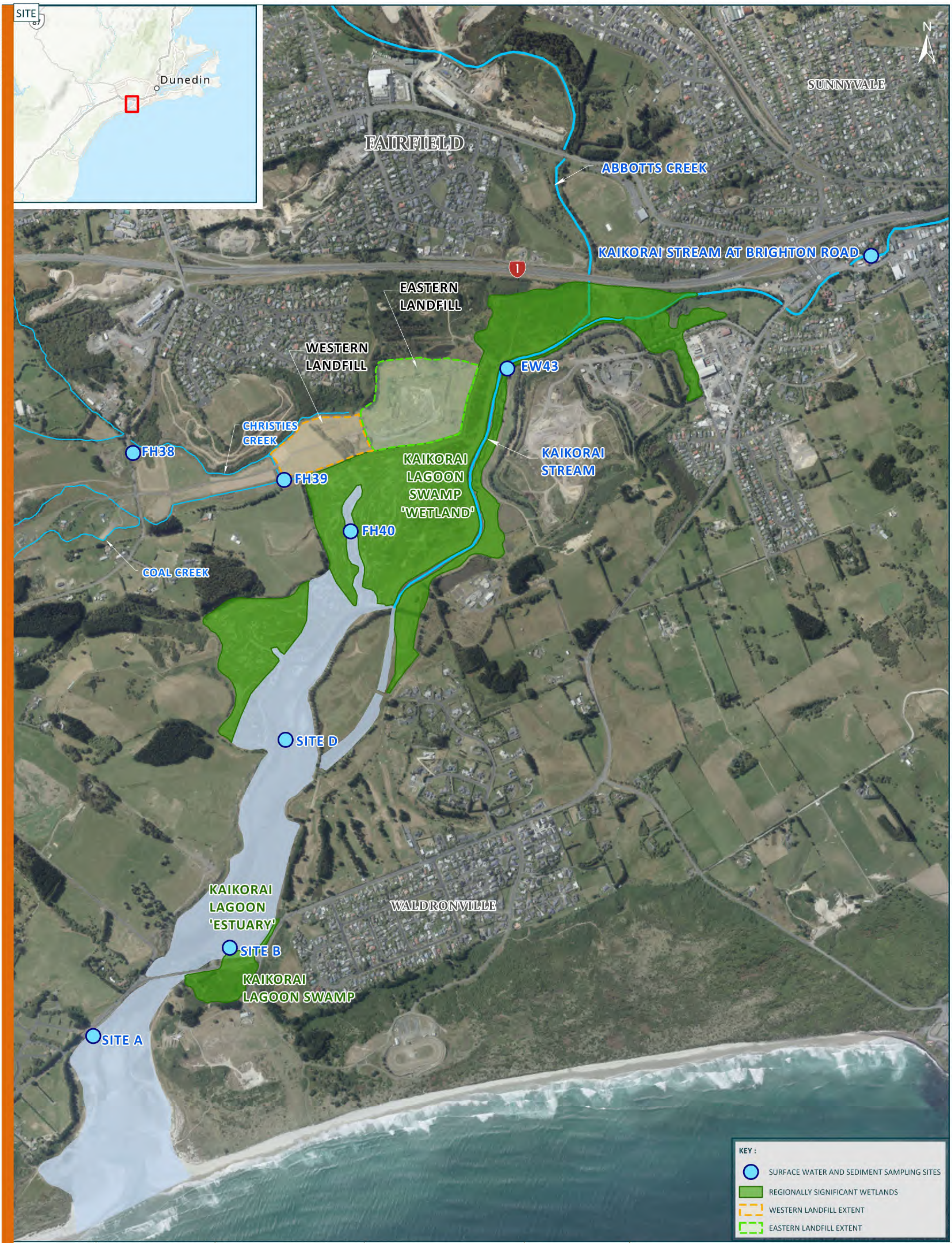
FIGURE
FIGURE 13: TEMPORARY GROUNDWATER SAMPLING LOCATIONS (2012 INVESTIGATION) – TOTAL AMMONIACAL-N CONCENTRATIONS (mg/L)

PROJECT
FAIRFIELD LANDFILL RECONSENTING



pdp

0 150 300
METRES
SCALE : 1:12,500 (A3)

E	UPDATED	FEB 24	JR
D	UPDATED	AUG 23	JR
C	UPDATED	MAY 23	BR
B	REVISED	FEB 23	BR
A	ISSUED	NOV 22	BR
NO.	REVISION	DATE	BY

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE WWW.LINZ.GOVT.NZ/ABOUT-LINZ/LINZ-DATA-SERVICE/HELP/USING-LINZ-DATA/ATTRIBUTING-AERIAL-IMAGERY-DATA AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
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3. WETLAND DATA DERIVED FROM HTTPS://MAPS.ORC.GOVT.NZ/ARCGIS/REST/SERVICES/WATERPLAN/MAPSERVER/5

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FIGURE
FIGURE 14: SURFACE WATER AND SEDIMENT SAMPLING SITES

PROJECT
FAIRFIELD LANDFILL RECONSENTING

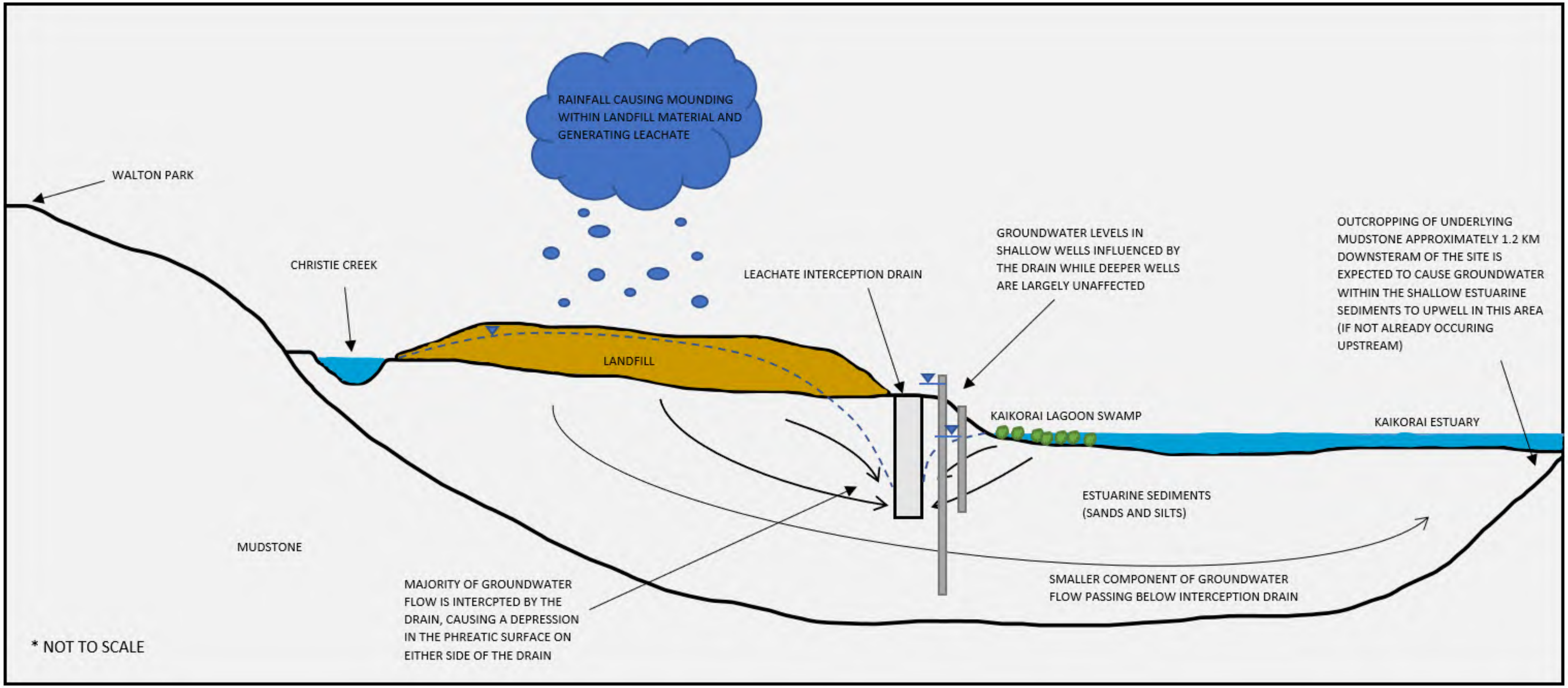

FIGURE 15: CONCEPTUAL SCHEMATIC OF GROUNDWATER MOVEMENT

0 50 100
METRES
SCALE : 1:3,000 (A3)

NO.	REVISION	DATE	BY
C	UPDATED	FEB 24	JR
C	UPDATED	AUG 23	JR
B	UPDATED	MAY 23	BR
A	ISSUED	NOV 22	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. SITE DATA DERIVED FROM CADASTRAL DRAWINGS.

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FIGURE
FIGURE 16: SITE BOUNDARIES USED FOR MASS DISCHARGE CALCULATIONS

PROJECT
FAIRFIELD LANDFILL RECONSENTING

Appendix B: Logs

Copy of this
sent to Waste management

APPENDIX B

SITE INVESTIGATION DATA

1990, Boreholes BH1, BH2, BH3 and BH4 – Royds Garden

1990, Test Pits TP1 – TP7 – Soils and Foundations

1991, Boreholes GB1, GB2, GB3 and FB2 – B.J. Douglas

1997, Boreholes BH102 and BH105 – Opus Consultants

1997, Auger Holes HA1, HA2 and HA3 – Opus Consultants

RoydsGarden
LIMITED
Consulting Engineers & Planners

FEATURE. GREEN ISLAND LANDFILL
LOCATION. DUNEDIN
ATTITUDE/DIRECTION; VERTICAL

7483/ BH 1
R.L. GROUND(m). 105.03
MACHINE;

GEOLOGICAL UNIT DESCRIPTION	CORE LOSS/ LIFT %	DEPTH (m) below GL	USC SYMBOL	DESCRIPTION OF MATERIAL RECOVERED.	DRILL METHOD	DATE/DEPTH m	SAMPLES AND TESTS	DATE	WATER LEVEL	CASING (mm)	PENETRATION (SPT) (uncorrected for overburden)	MOISTUF CONTENT (%)
FILL		0		BRICKS & RUBBLE								
									▽			
		5		CAR BODY with some silt	Rotary Wash							
ALLUVIUM		6	CH	Yellow brown firm CLAY								
			ML	Grey SILT with minor to some clay & trace of sand			II					
		7	ML	Grey brown SILT with minor clay								
			ML	Grey brown mottled orange SILT with minor clay & medium gravel								
ABBOTSFORD MUDSTONE		8	ML	Blue grey SILT with minor clay & trace of fine sand - Mudstone			II					
		9	ML	Grey brown SILT with minor clay - Mudstone								

COMMENTS SHEILBY TUBES II

LOGGED CDM
DATE 15/1/91
LENGTH 9.0m

DRILLER McNEILL
STARTED 5/12/90
FINISHED 5/12/90

Borehole Logs 199

Figure A4

RoydsGarden
LIMITED
Consulting Engineers & Planners

FEATURE. GREEN ISLAND LANDFILL
LOCATION. DUNEDIN
ATTITUDE/DIRECTION; VERTICAL

7483 / BH 2

R.L. GROUND(m). 109.52
MACHINE;

GEOLOGICAL UNIT DESCRIPTION	CORE LOSS/ LIFT %	DEPTH (m) below GL	GRAPHIC LOG	USC SYMBOL	DESCRIPTION OF MATERIAL RECOVERED.	DRILL METHOD	DATE/DEPTH m	SAMPLES AND TESTS	DATE	WATER LEVEL	CASING (mm)	PENETRATION (SPT) (uncorrected for overburden)	MOISTURE CONTENT (%)
FILL		0			RUBBISH								
		6			RUBBLE & BRICKS					▽			
		7			RUBBISH								
		8			TIMBER RUBBISH								
ALLUVIUM		9		OL	Blue grey SILT with minor fine sand & organics - soft	Rotary Wash		II					
		10		OL	Grey SILT with minor fine sand & clay & trace of organics - soft			II					
		11		ML	Grey brown SILT with some clay - soft			II					
		12		ML	Blue grey mottled orange green SILT with minor to some clay & trace organics			II					
		14		SM	Blue grey SAND with minor fine gravel & silt - Sand; fine to coarse			II					
		15		CL	Grey green SILT with minor to some sand & clay. & minor gravel fine-med								
		15		ML	Grey green SILT with some fine to medium sand & trace of gravel -fine			II					
ABBOTSFORD MUDSTONE		16		ML	Grey brown SILT with minor to some fine to medium subangular gravel & minor fine sand - Mudstone			II					

COMMENTS SHELBY TUBES II

LOGGED CDH
DATE 15/1/91
LENGTH 17.5m

DRILLER McNEILL
STARTED 6/12/90
FINISHED 6/12/90

Figure A4d

RoydsGarden
LIMITED
Consulting Engineers & Planners

FEATURE. GREEN ISLAND LANDFILL

LOCATION. DUNEDIN

ATTITUDE/DIRECTION: VERTICAL

7483/ BH 3

R.L. GROUND(m). 107.34

MACHINE:

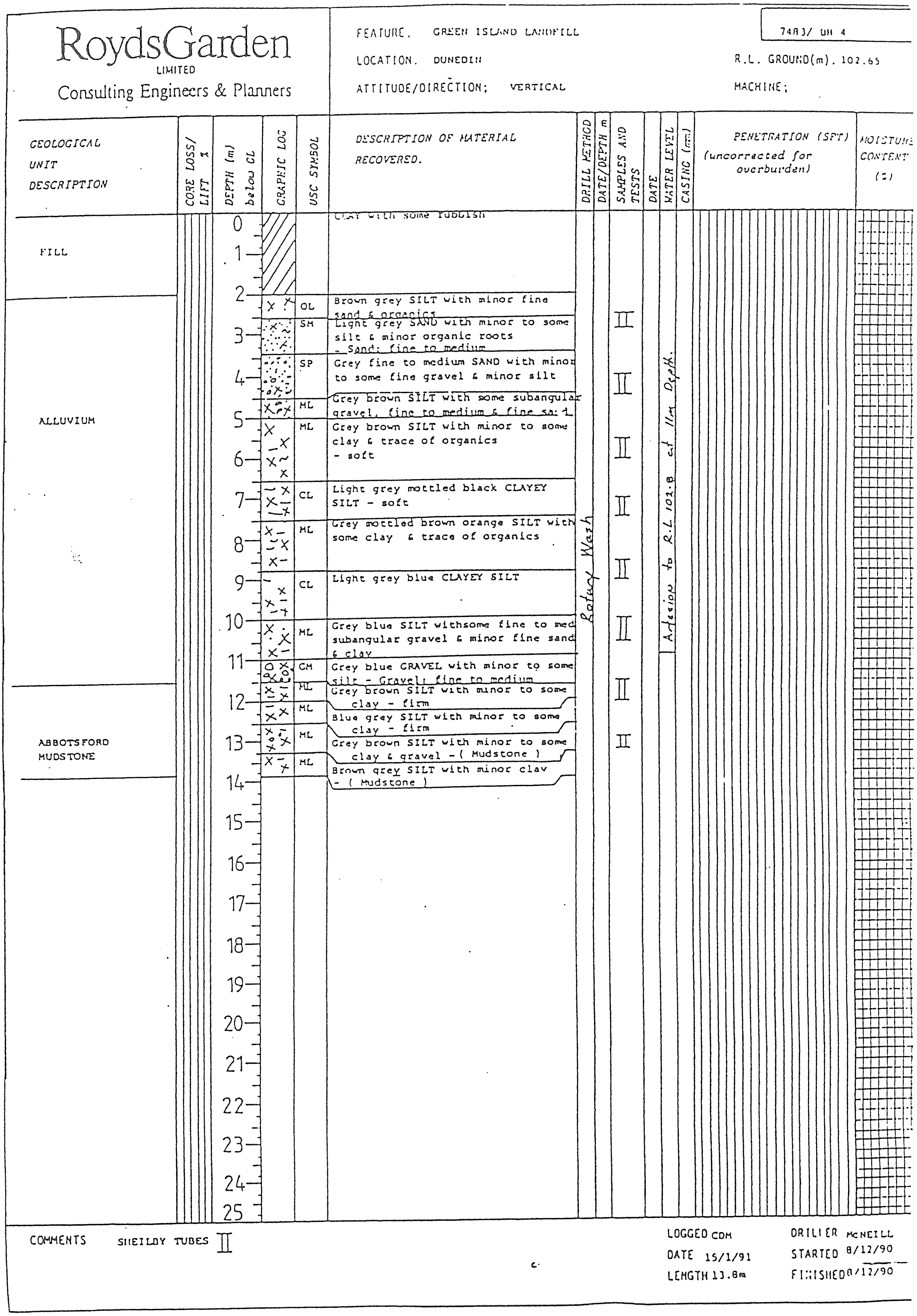
GEOLOGICAL UNIT DESCRIPTION	CORE LOSS/ LIFT %	DEPTH (m) below GL	USC SYMBOL	DESCRIPTION OF MATERIAL RECOVERED.	DRILL METHOD	DATE/DEPTH m	SAMPLES AND TESTS	DATE	WATER LEVEL	CASING (mm)	PENETRATION (SPT) (uncorrected for overburden)	MOISTURE CONTENT (%)
FILL		0–7		RUBBISH					▽ (4)			
ALLUVIUM		7	CH	White yellow CLAY								
			CI	Red yellow CLAY								
		8	ML	Dark grey SILT - Soft			II					
		9	ML	Grey brown SILT with minor wood & clay - soft			II					
		10	ML	Grey brown SILT with minor to some clay & minor fine to medium sand - soft	Rotary Wash							
		11	ML/ CL	Light grey blue mottled black SILT with come clay / CLAYEY SILT & minor organics			II					
		12–15	ML	Light grey blue SILT with minor to some clay & trace to minor fine sand			II II					
		15	GM	Grey brown SILTY GRAVEL with minor fine sand - Gravel; subangular to angular, fine to medium			II					
ABBOTSFORD MUDSTONE		16–17	ML	Dark grey brown SILT with minor gravel; fine to medium, subangular & minor clay - Mudstone			II					

COMMENTS SHELBY TUBES II

LOGGED CDH
DATE 15/1/91
LENGTH 17.2m

DRILLER MCNEILL
STARTED 7/12/90
FINISHED 7/12/90

Figure A4e



RoydsGarden
LIMITED
Consulting Engineers & Planners

FEATURE. GREEN ISLAND LANDFILL
LOCATION. DUNEDIN
ATTITUDE/DIRECTION; VERTICAL

7483/ UH 4
R.L. GROUND(m). 102.65
MACHINE;

GEOLOGICAL UNIT DESCRIPTION	USC SYMBOL	DESCRIPTION OF MATERIAL RECOVERED.	SAMPLES AND TESTS
FILL		CLAY with some rubbish	
ALLUVIUM	OL	Brown grey SILT with minor fine sand & organics	
	SM	Light grey SAND with minor to some silt & minor organic roots - Sand: fine to medium	II
	SP	Grey fine to medium SAND with minor to some fine gravel & minor silt	II
	ML	Grey brown SILT with some subangular gravel, fine to medium & fine sand	
	ML	Grey brown SILT with minor to some clay & trace of organics - soft	II
	CL	Light grey mottled black CLAYEY SILT - soft	II
	ML	Grey mottled brown orange SILT with some clay & trace of organics	
	CL	Light grey blue CLAYEY SILT	II
	ML	Grey blue SILT withsome fine to med subangular gravel & minor fine sand & clay	II
	GM	Grey blue GRAVEL with minor to some silt - Gravel: fine to medium	
ABBOTSFORD MUDSTONE	ML	Grey brown SILT with minor to some clay - firm	II
	ML	Blue grey SILT with minor to some clay - firm	
	ML	Grey brown SILT with minor to some clay & gravel - (Mudstone)	II
	ML	Brown grey SILT with minor clay - (Mudstone)	

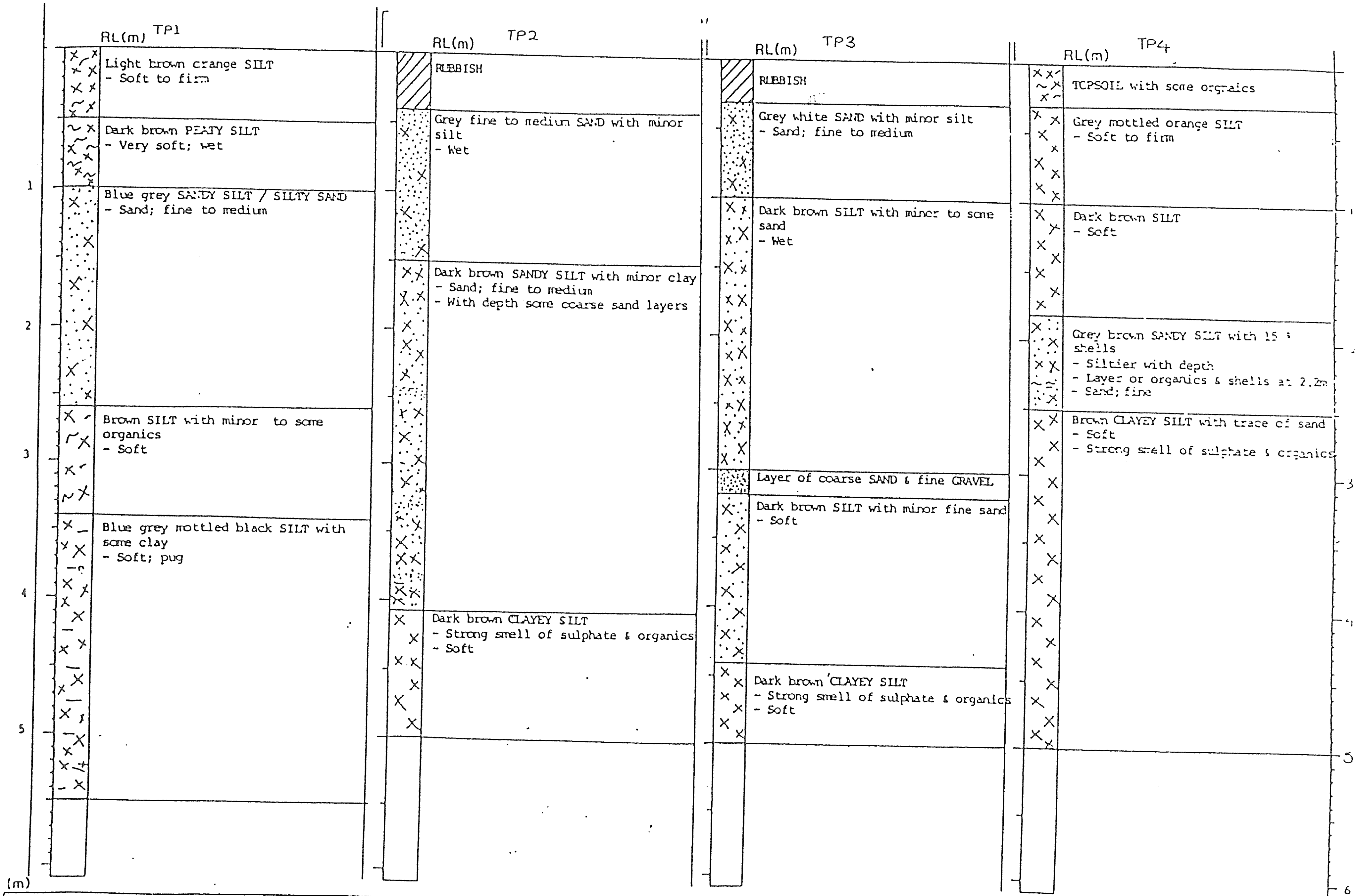
CORE LOSS/LIFT %
DEPTH (m) below CL
GRAPHIC LOG
DRILL METHOD: Rotary Wash
DATE/DEPTH m
DATE
WATER LEVEL: Artesion to R.L 102.8 at 11m Depth.
CASING (mm)
PENETRATION (SPT) (uncorrected for overburden)
MOISTURE CONTENT (%)

COMMENTS SHEILDY TUBES II

LOGGED CDM
DATE 15/1/91
LENGTH 13.8m

DRILLER McNEILL
STARTED 8/12/90
FINISHED 8/12/90

Figure A4



TP1

Light brown orange SILT
- Soft to firm

Dark brown PEATY SILT
- Very soft; wet

Blue grey SANDY SILT / SILTY SAND
- Sand; fine to medium

Brown SILT with minor to some organics
- Soft

Blue grey mottled black SILT with some clay
- Soft; pug

TP2

RUBBISH

Grey fine to medium SAND with minor silt
- Wet

Dark brown SANDY SILT with minor clay
- Sand; fine to medium
- With depth some coarse sand layers

Dark brown CLAYEY SILT
- Strong smell of sulphate & organics
- Soft

TP3

RUBBISH

Grey white SAND with minor silt
- Sand; fine to medium

Dark brown SILT with minor to some sand
- Wet

Layer of coarse SAND & fine GRAVEL

Dark brown SILT with minor fine sand
- Soft

Dark brown CLAYEY SILT
- Strong smell of sulphate & organics
- Soft

TP4

TOPSOIL with some organics

Grey mottled orange SILT
- Soft to firm

Dark brown SILT
- Soft

Grey brown SANDY SILT with 15 % shells
- Siltier with depth
- Layer or organics & shells at 2.2m
- Sand; fine

Brown CLAYEY SILT with trace of sand
- Soft
- Strong smell of sulphate & organics

SOILS & FOUNDATIONS
Geotechnical Consulting Engineers

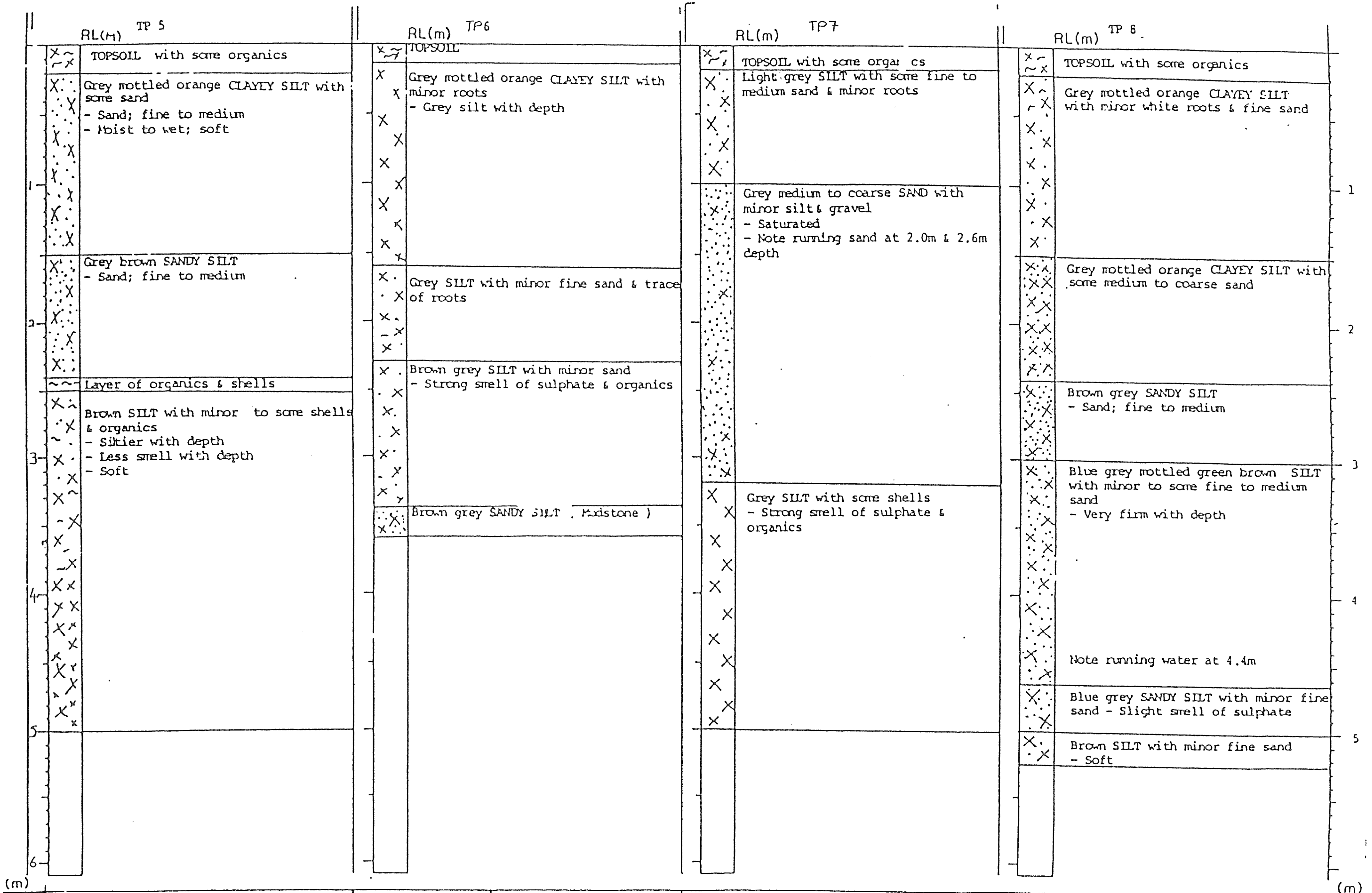
Drawn CDM
Date 1/11/90
Checked

Driller CDM
Date 27/10/90
Logged by CDM

Site location Green Island
Bore location Waste Management Centre
Drilling type Excavator

Project:
LEACHATE CONTROL

Test Pit Logs 1990



SOILS & FOUNDATIONS	Drawn CDM Date 1/11/90	Driller CDM Date 27/10/90	Site location Green Island Bore location Waste management centre	Project LEACHATE CONTROL

Figure A4

Name of company: Barry J Douglas Consulting Geologist

Borehole No. G81A
Sheet 1 of 1

Equipment & methods: Works Drilling
Truck mounted Mobile Top Drive rig
Driller : Evan Woodrow
HW casing
3 7/8" tricone used for wash boring after SPT/Finger Tube sampling

Location No: Green Island Refuse Landfill

Carried out for: Dunedin City Council
c/- Becc. Steven

Ground level:

Coordinates:

Date: 10/12/91

Main description	Detail
Man-made (9/12/91)	temporary dry platform for drilling rig (above soft, saturated, ground surface)
very dark grayish brown; organic rich; clayey silt, topsoil; interlaminated with brown v.f. sand	firm; very dark grayish brown (10YR3/2) organic rich; clayey silt; abundant fine rootlets (.04-.07m thick) interlaminated with loosely packed; uniformly graded, brown; v.f. sand
very dark grayish brown; silt - v.f. sandy silt	soft; 2.5Y3/2; uniformly graded silt-v.f. sandy silt; mottled black with leachate
black, organic rich clayey silt	organic rich; clayey silt; plant debris abundant; leachate sludge
black; leachate sludge impregnated v.f.-f. sand & v.f. sandy silt	loosely packed; uniformly graded; quartzose v.f.-f. sand, black 5Y2.5/1 - locally interlaminated with black, organic rich, v.f. sandy silt. black, leachate sludge impregnated
Black, leachate impregnated sand to 2.65m, thereafter grayish brown; upward fining cycles of thin sandy beds with scoured bases.	loosely packed; black to very dark brown silty v.f.-f. sand; upward grading [illegible] well graded v.f.-f.-m. [illegible] that [illegible] overlying basal [illegible] loosely packed; grayish brown; [illegible] v.c. sand [illegible] v.f.-f. [illegible] grayish brown; uniformly graded silty v.f.-f. sand; abundant plant debris loosely packed; v. dark grayish brown; gap graded v.-v.c. & f.-v.f. sand; with plant debris + clay clasts
organic rich, very dark grayish brown (2.5Y3/2) silty v.f. sand	soft; v. dark grayish brown; silty v.f. sand comminuted plant debris, fine rootlets
organic rich, very dark grayish brown (2.5Y3/2); thinly interbedded clayey silt, sandy silt or silty v.f. sand (1.05m)	soft; v. dark grayish brown; clayey silt; highly plastic; [illegible] rootlets common v. dark grayish brown; v.f. sandy silt muddy sandy gravel; [illegible] clay clasts v. dark grayish brown; v.f. sandy silt soft; v. dark grayish brown; clayey silt fine rootlets [illegible] highly plastic; [illegible] v. dark grayish brown; silty v.f. sand; uniformly graded soft; olive gray; clayey silt homogeneous; minor comminuted plant detritus
olive gray (5Y5/2) or greenish gray (5GY5/1); thinly interbedded clayey silt, v.f. sandy silt or silty v.f. sand; minor comminuted organic detritus (2.75m)+	soft; olive gray; clayey v.f. sandy silt minor comminuted plant detritus soft; olive gray; clayey silt; [illegible] v.f. sand; [illegible]; highly plastic soft; olive gray - greenish gray; clayey silt thinly interbedded ([illegible]) with clayey v.f. sandy silt; highly plastic; homogeneous soft; greenish gray; slightly clayey silt; homogeneous greenish gray; silty v.f. sand loosely packed; greenish gray - dark greenish gray silty v.f. sand (uppermost) grading down to v.f. sand (lowermost); uniformly graded greenish gray; silty v.f. sand loosely packed; greenish gray; v.f. sandy silt; uniformly graded, homogenous greenish gray; silty v.f. sand

USC SYMBOL

Reduced level

Depth & thickness: (1m), 1, 1.5, (.3), 1.8, 1.9, 2.5, 2.65, 2.73, 3, 3.2, 3.65 (.05), 3.7, 3.8, 4.1 (.15), 4.25, 4.6, 4.85, 5, (0.5), 5.5, 6.05, 6.5, 6.6, 6.9, 7

Samples/tests Depth	Sample Type	Sample No.	SPT RESULT
1 - 1.5 .5/.5 = 100%	Finger Tube	1	
1.5 - 2 .45/.5 = 90%	Finger Tube	2	
2 - 2.5 .2/.5 = 40%	Finger Tube	3	
2.5 - 3m .45/.45 = 100%	SPT	1	N=0
3 - 3.5m .45/.45 = 100%	SPT	2	N=0
3.5 - 4m .45/.45 = 100%	SPT	3	N=0
4 - 4.5m .45/.5 = 90%	Finger Tube	4	
4.5 - 5m .45/.5 = 90%	Finger Tube	5	
5 - 5.5m .43/.45 = 95%	SPT	4	N=0
5.5 - 6m .5/.5 = 100%	Finger Tube	6	
6 - 6.5m .5/.5 = 100%	Finger Tube	7	
6.5 - 7m .5/.5 = 100%	SPT	5	N=0

Drilling & casing progress

Water recovery: ▽ .7m 11/12/91

STARTED: 8.30 am 10/12/91

FINISHED: 1.45 pm 10/12/91

Depths: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Water: Water level observations during boring are given on last sheet of log.

Sample/test key
D Disturbed sample
B Bulk sample
W Water sample

ROCK HARDNESS
VH - Very hard
H - Hard
MH - Moderately hard
MS - Moderately soft
S - Soft
VS - Very soft

Remarks: Borehole depth 7m
Borehole cased to 7m (HW casing)

ROCK WEATHERING
UW - Unweathered
SW - Slightly weathered
MW - Moderately weathered
HW - Highly weathered
CW - Completely weathered

Logged by: B. J. DOUGLAS

Scale:

Borehole Logs 1991

Figure A5a

Name of company: Barry J Douglas Consulting Geologist		Borehole No. G82A (c) Sheet 1 of 1
Equipment & methods: Works Drilling Truck mounted Mobile Top Drive rig. Driller : Evan Woodrow H W. casing 3⅞" tricone - wash boring after SPT/Sinyor Tube sampling	Location No: Green Island Refuse Landfill	
Carried out for: Dunedin City Council C/- Beca Steven	Ground level:	Coordinates:	Date: 29/11/1991

Main description	Detail	USC SYMBOL	Reduced level	Legend	Depth & thickness	Samples/tests : SPT RESULT Depth	Sample Type	Sample No.	Drilling & casing progress	Water recovery
dark grayish brown; humic topsoil	humic rich silt, abundant rootlets	OL								
olive gray; silt	very soft; micaceous silt	ML			.3					▽ .13m 10.30am
light olive gray: silty v.f. sand - v.f. - f. sand	soft; uniformly graded	SM			.55(.015)	.3 - .8 .23/.45 = 51%	SPT	1 N=3		.45m 12.30pm O.H. 2.95m
light olive gray. v.f. sandy silt	soft; uniformly graded sandy silt	ML								
light gray quartose fine sand	loosely packed; uniformly graded fine sand				.8					
pale olive quartose v.f.-f. sand	loosely packed; uniformly graded v.f. - f. sand (from wash sample)	SP			1.14	1.1 - 1.84 .5/.74 = 67%	SPT	2. N=<1		1.18m 4.30pm O.H. @ 4.4m
Olive gray - very dark grayish brown m-f-v.f. sand	loosely packed; uniformly graded sand, fining upward from f.-m.-c. sand (lowermost) to f.-v.f. sand (uppermost) fibrous rootlets & organic (plant) detritus abundant				1.84					
Dark grayish brown non coherent granular sand	loosely packed; well graded granular quartz rods, lignite clasts, shelly mollusca clasts, abundant plant detritus from c. sand matrix	SW			2.1	1.84 - 2.35 .45/.45 = 100%	SPT	3 N=0		
Dark grayish brown & dark olive gray v.f.-f sand or f. sand	loosely packed, uniformly graded v.f.-f sand or fine sand	SP			2.35 2.45	2.35 - 2.95 .5/.6 = 83%	SPT	4 N=0		
"	loosely packed; uniformly graded or well graded; silty v.f. sand or v.f. sandy silt				2.95 3.01 3.4 3.5	2.95 - 3.4 .33/.45 = 73%	SPT	5 N=0	2.95m 1pm Tricone casing advance started. Casing pulled back to 2.95m	
very dark grayish brown silt	soft; well graded silt; abundant comminuted plant detritus	OL			3.8	3.4 - 3.9 .4/.45 = 89%	SPT	6 N=0		
organic rich; very dark grayish brown; clayey silt; homogeneous; abundant comminuted plant detritus; minor fibrous rootlets.	soft; highly plastic; clayey silt with abundant comminuted plant detritus; homogeneous	OH				3.9 - 4.4 .5/.5 = 100%	SPT	7 N=0		
					4.9	4.4 - 4.9 .43/.45 = 95%	SPT	8 N=0		
					5.1	4.9 - 5.4 .3/.45 = 67%	SPT	9 N=0		
"	soft; well graded v.f. sandy silt; abundant comminuted plant detritus, small well preserved gastropod				5.33 5.4	5.4 - 5.75 .23/.35	SPT	10a		
	soft; highly plastic, clayey silt; abundant comminuted plant detritus; benthic foraminifera common					5.75 - 6.25 .5/.5 = 100%	SPT	10b N=0		
very dark grayish brown, organic rich clayey silt					6.25					

STARTED: 9am 29/11/91 FINISHED: 6.15pm 29/11/91 Depths: All depths and reduced levels in metres. Thicknesses given in brackets in depth column. Water: Water level observations during boring are given on last sheet of log.	Sample/test key D Disturbed sample B Bulk sample W Water sample ROCK HARDNESS VH - Very hard H - Hard MH - Moderately hard MS - Moderately soft S - Soft VS - Very soft	Remarks: Borehole depth 6.25m Borehole cased to 6m ROCK WEATHERING UW - Unweathered SW - Slightly weathered MW - Moderately weathered HW - Highly weathered CW - Completely weathered	Logged by: B.J Douglas Scale:

Figure A5b

Name of company: **Barry J Douglas Consulting Geologist**

Borehole No. GB3A
Sheet 1 of 1

Equipment & methods: Works Drilling
Truck mounted Mobile Top Drive rig.
Driller : Evan Woodrow
H.W. casing
3⅞" tricone - wash boring after SPT / Finger Tube.

Location No: Green Island Refuse Landfill

Carried out for: Dunedin City Council
C/- Beca Steven

Ground level:

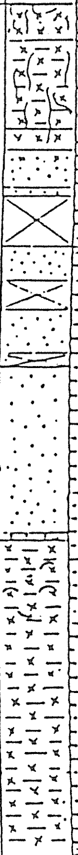
Coordinates:

Date: 6/12/91

Main description	Detail	USC SYMBOL
very dark grayish brown humic topsoil	humic rich, silty with abundant matted roots	Pt
grayish brown - light brownish gray clayey silt	soft; clayey silt with rootlets	OH
greenish gray - gray silty clay	soft; greenish gray - gray, silty clay fine within rootlets, highly plastic; homogeneous; massive.	CH
greenish gray silt	soft; silt; well graded, in situ rootlets	MH
greenish gray silty v.f. sand gray v.f - f. sand	loosely packed; well graded, silty v.f. sand loosely packed, [illegible] silty v.f. sand [illegible] organic rich; loosely packed v.f.-f. sand	SM
dark gray (5Y4/1), locally gray (5Y 5/1); organic rich; v.f. - f. - m. sand	loosely packed (uniformly graded) fine sand and v.f. - medium sand; comminuted plant detritus abundant loosely packed; well graded v.f.-f.-m. sand; abundant comminuted plant detritus loosely packed, uniformly graded, f-m. quartz sand; abundant comminuted plant detritus, dark gray gray '' dark gray ''	SP
	well graded; f. - c. sand	SW
abundant molluscan (principally broken bivalve) shells & benthic foraminifera olive gray (5Y4/2), locally dark gray, clayey silt; locally with molluscan fragments foraminifera	soft; olive gray (5Y4/2); clayey silt; homogeneous; highly plastic; benthic foraminifera [illegible] dark gray; clayey v.f. sandy MH (4-4.45) dark gray; clayey silt; very soft (4.4-4.5) soft; olive gray (5Y4/1); clayey silt; homogeneous; highly plastic (4.5-6.14m)	MH

Reduced level

Legend



Depth & thickness

.13 (.13)
.25 (.12)
(.65)
.9 (.15)
1.05
(.35)
1.4
1.76
(.24)
2
2.2
(.3)
2.5
2.6
(1.2)
3.8
3.86 (.06)
(2.28)
6
6.14

Samples/tests: Depth	Sample Type	Sample No.	SPT RESULT
0 - .5	Finger Tube	1	
.5 - 1	Finger Tube	2.	
1 - 1.5 $\frac{.4}{.45}$ = 89%	SPT	1	N = 0
1.5 - 2 $\frac{.24}{.45}$ = 53%	SPT	2	N = 0
2 - 2.5 $\frac{.3}{.45}$ = 67%	SPT	3	N = 3
2.5 - 3 $\frac{.4}{.45}$ = 89%	SPT	4	N = 16
3 - 3.5 $\frac{.44}{.45}$ = 98%	SPT	5	N = 13
3.5 - 4 $\frac{.45}{.45}$ = 100%	SPT	6	N = <1
4 - 4.5 ($\frac{.13}{.45}$ = 29%) .5 rec.	Finger Tube (SPT)	(7) 3	N = 0
4.5 - 5 $\frac{.5}{.5}$ = 100%	Finger Tube	4	
5 - 5.5 $\frac{.5}{.5}$ = 100%	Finger Tube	5	
5.5 - 6.14 .5	Finger Tube	6	

Drilling & casing progress

Water recovery: ▽ .3m

STARTED: 12.20pm 6/12/91

FINISHED: 5.30pm 6/12/91

Depths: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Water: Water level observations during boring are given on last sheet of log.

Sample/test key
D Disturbed sample
B Bulk sample
W Water sample

ROCK HARDNESS
VH - Very hard
H - Hard
MH - Moderately hard
MS - Moderately soft
S - Soft
VS - Very soft

Remarks: Borehole depth 6.14m
Borehole cased to 6m

ROCK WEATHERING
UW - Unweathered
SW - Slightly weathered
MW - Moderately weathered
HW - Highly weathered
CW - Completely weathered

Logged by: B.J. Douglas

Scale:

Figure A5c

Name of company: Barry J Douglas Consulting Geologist

Borehole No. FB2A
Sheet 1 of 1

Equipment & methods: Works Drilling
Truck mounted Mobile Top Drive rig
Driller: Evan Woodrow
H.W. casing
3 7/8" tricone used for wash boring after SPT/Finger Tube Sampling

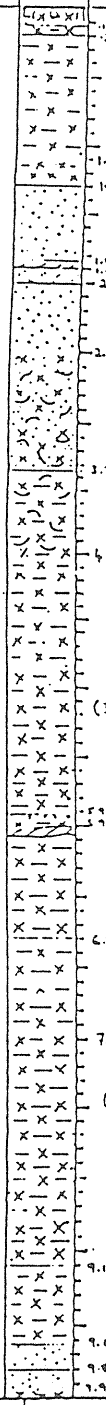
Location No: FAIRFIELD (MAXWELL BROTHERS) REFUSE LANDFILL

Carried out for: Dunedin City Council/Fulton Hogan Group c/- Beca Steven

Ground level:

Coordinates:

Date: 16/12/1991



Main description	Detail	USC SYMBOL	Depth & thickness
dark brown humic topsoil	clayey silt; mottled with fine rootlets.		.14 (.14)
greyish gravel	Clayey silt; organic rich; wet; firm	—	.2 (.06)
olive gray - light olive gray; silty clay - clayey silt; homogenous	firm: light olive gray - olive gray silty clay - clayey silt; homogenous; highly plastic; abundant fine rootlets; more silty (coarser) in lower .2m. Locally mottled yellowish brown soft below .7m	' ıı	(1.1) 1.1
greenish gray (5GY5/1) olive gray (5Y4/2) dark olive gray (5Y3/2) silty v.f. sand	soft - loosely packed; uniformly graded; silty v.f. sand, homogenous, rootlets common; plant detritus common.		1.3 (.56)
wood fragments silty v.f. - f. sand	concentrated wood fragments v. dark grayish brown, silty v.f. - f. sand		1.86 1.9 2 (.1)
olive gray (5Y4/2) silty v.f. sand + slightly silty v.f. - f. sand	soft - loosely packed; uniformly graded; silty v.f. sand; comminuted plant detritus (2 - 2.25m) slightly silty v.f. - f. sand (2.25 - 2.5m)	·ı·	(.5) 2.5
olive gray (5Y 4/2) v.f. sandy silt; minor silty v.f. sand; bivalves abundant	soft - loosely packed; uniformly graded silty v.f. sand - v.f. sandy silt; olive gray: bivalves abundant; minor comminuted plant detritus. silty v.f. sand (2.9 - 3.0m)		(.85) 3.35
organic rich; very dark grayish brown (2.5Y 3/2); clayey silt; homogenous	soft; highly plastic; clayey silt; homogenous; comminuted plant detritus abundant, rootlets common; benthic foraminifera + bivalves abundant between 3.35 - 4.2m loosely packed; uniformly graded; fine sand; olive gray (5.91 - 5.95m) well preserved wood, hard (6 - 6.01m) detail as above	OH	4 (3.45) 5.91 5.95 (.04) 6.8
abrupt colour change greenish gray (5GY 5/1): clayey silt, homogenous	soft, moderately - highly plastic; clayey silt; (slightly coarser than unit above); comminuted plant detritus + rootlets abundant between 6.8 - 7.5m firm; moderately - highly plastic; micaceous; clayey silt; rare or minor comminuted plant detritus + rootlets; homogenous massive. stiff; micaceous; clayey silt: similar to above unit, but stained by limonite - colour mottled greenish gray (5GY5/1) - light olive brown (2.5Y 5/6)	ı:lı	7.5 (2.3) 9.10 (.53)
olive gray; silty v.f. sand	firm - loosely packed; olive gray; limonite stained; non plastic; silty v.f. sand		9.63 (.17)
olive gray; v.f. sand	loosely packed; uniformly graded; v.f. sand		9.8 (.17)
greenish gray; clayey silt	firm; micaceous; clayey silt		9.97

Samples/tests Depth	Sample Type	Sample No. / SPT Result	Drilling & casing progress	Water recovery
0 - .5 .47/.50 = 94%	Finger Tube	1		▽ .52m 17
.5 - 1 .50/.50 = 100%	Finger Tube	2		
1 - 1.5 .50/.50 = 100%	Finger Tube	3		
1.5 - 2 .45/.45 = 100%	SPT	1 N=0		
2 - 2.5 .50/.50 = 100%	Finger Tube	4		
2.5 - 3 .50/.50 = 100%	Finger Tube	5		
3 - 3.5 /.50 =	Finger Tube	6		
3.5 - 4 .45/.45 = 100%	SPT	2 N=0		
4 - 4.5 .50/.50 = 100%	Finger Tube	7		
4.5 - 5 .50/.50 = 100%	Finger Tube	8		
5 - 5.5 .50/.50 = 100%	Finger Tube	9		
5.5 - 6 .45/.45 = 100%	SPT	3 N=0		
6 - 6.5 .50/.50 = 100%	Finger Tube	10		6m; artes flow 6.15p on 6m rose 54 above gr in 10m
6.5 - 7 .50/.50 = 100%	Finger Tube	11		
7 - 7.5 .15/.50 = highly disturbed	Finger Tube	12 driller reset finger catcher in reverse position!		
7.5 - 8 .45/.45 = 100%	SPT	4 N=0		
8 - 8.5 .4/.50 = 80%	Finger Tube	13		
8.5 - 9 .45/.45 = 100%	SPT	Result not valid - stem machine pushed by driller!		8.5m; artesian flow (possibly from fractured clayey silt?)
9 - 9.5 .44/.45 = 98%	SPT	5 N=7		
9.5 - 10 .45/.45 = 100%	SPT	6 N=3		

STARTED: 11.30am 16/12/91

FINISHED: 1.30pm 17/12/91

Depths: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Water: Water level observations during boring are given on last sheet of log.

Sample/test key
D Disturbed sample
B Bulk sample
W Water sample

ROCK HARDNESS
VH - Very hard
H - Hard
MH - Moderately hard
MS - Moderately soft
S - Soft
VS - Very soft

Remarks: Borehole depth 10m
Borehole cased to 9.5m

ROCK WEATHERING
UW - Unweathered
SW - Slightly weathered
MW - Moderately weathered
HW - Highly weathered
CW - Completely weathered

Logged by: B. J. Douglas

Scale:

Figure A5d

RECEIVED
17 JUL 1997

OPUS
INTERNATIONAL CONSULTANTS

14 July 1997

Peter McAulay
EnviroWaste Services Limited
Private Bag 92 810
Penrose
AUCKLAND

CWM01.41

Dear Peter

FAIRFIELD LANDFILL SITE INVESTIGATION RESULTS

A borehole and hand auger testing programme was carried out at Fairfield Landfill from 1 to 4 July 1997. Two boreholes and three handaugers were put down around the periphery of the Fairfield landfill at locations shown on the attached plan.

The drillholes were wash drilled to 5 m, and the undrained shear strength measured by shear vane at 1.5 m centres. Holes were completed when basement materials were encountered (11 to 15 m depth). A summary of shear vane results is presented in Table 1 below:

Hole ID	Depth below ground level (m)	Material	Undrained Shear Strength (kPa)	
			Peak	Residual
102	0-6.3	Yellowish brown silty Clay [FILL]		
	5.70	Greenish grey marine SILT		
	6.85	Greenish grey marine SILT	48	11
	8.05	Greenish grey marine SILT	Refusal	-
	9.60	Greenish grey marine SILT	36	7
	11.10	Greenish grey marine SILT	>100	-
	11.25	End of Hole		
105	0-6.35	Concrete/rubbish		
	8.15	Bluish grey marine silt	39	6
	9.70	Bluish grey marine silt	36	7
	11.45	Bluish grey marine silt	33	8
	12.65	Bluish grey marine silt	39	4.7
	14.55	Bluish grey marine silt	32	1
	15.35	Bluish grey marine silt	38	3
	15.45	End of Hole	$\bar{x}$ = 36kPa.	

Hand auger results and drillers logs are attached.

Opus International Consultants Limited
Dunedin Office
Quality Management Systems Certified to ISO 9001

144 Rattray Street
Private Bag 1913
Dunedin, New Zealand

Telephone: (03) 474 8899
Facsimile: (03) 474 8995
Web site: www.opus.co.nz

Formerly Works Consultancy Services Limited

A health and safety plan was obtained from the drilling contractor prior to commencement of work, and gas concentrations (hydrogen sulphide and methane) were continuously monitored during the drilling operation.

Please contact me should you have any queries with the test results.

Yours faithfully

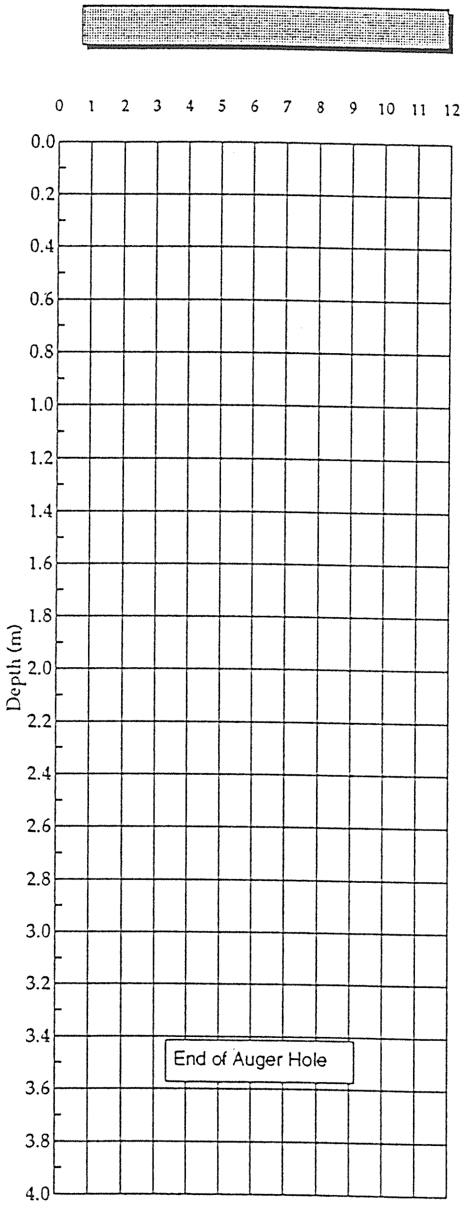
Tim Browne

encl.

AUGER / SHEAR VANE TEST REPORT

Project : Envirowaste Landfill
Location : Fairfield
Test number : Hand Auger Hole No HA1
Client : Opus International Consultants, Dunedin
Comment:
Shear vane No : Dn Lab LCSS04.02
Shear vane correction : NA
Water level (m) : NA
Reduced level (m) : top of hole at ground level
Test methods : Shear Strength using the Pilcon Shear Vane
to the methods of BS1377 : Part 9 : 1990 Test 4.4

Project No:	CWM00.47
Lab Ref No:	L970141



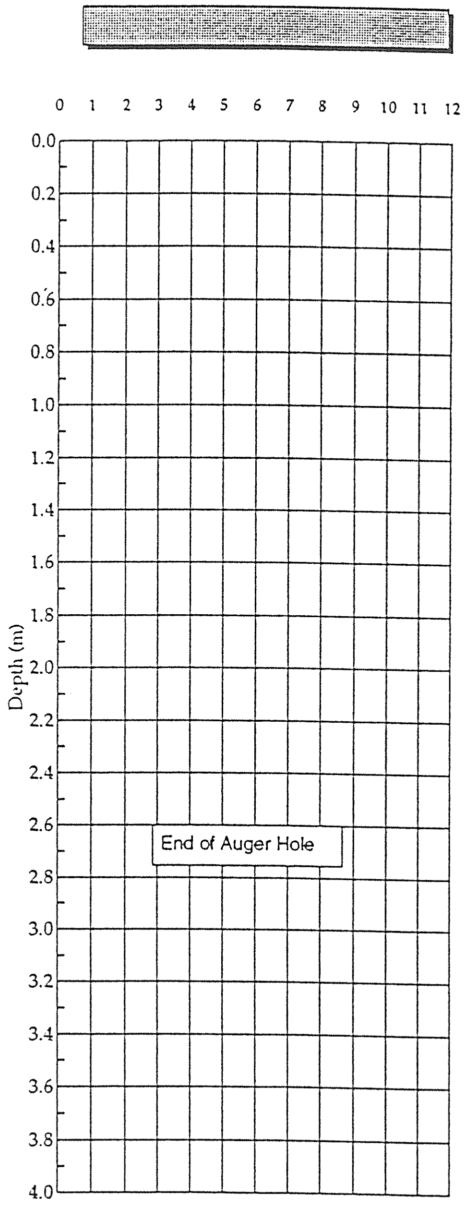
Depth (m)	Max & [Residual] Strength Shear (kPa)	MATERIAL DESCRIPTION
0.1		Grass and Topsoil
0.5		Light yellowish brown silty CLAY (loess) moist, very stiff, plastic, trace of light grey Silt
1.0	150 [110]	same as above but with additional trace of red silty CLAY and green silty CLAY becoming siltier with depth
1.5	138 [60]	light reddish brown silty CLAY (loess) with trace of light grey silt moist, very stiff, plastic
2.0	195 [70]	dark grey silty sandy rounded gravel sized decomposed ASH landfill material, moist, very stiff, non plastic
2.5 3.0 3.2	200 [50] 150 [60] 213 [108]	light reddish brown gravelly silty CLAY (loess) with trace of light grey clayey Silt; moist, firm, mod. plastic also has pockets of moist, plastic red silty clay
3.5		light grey clayey SILT with trace of light brown silty CLAY (loess) moist, hard, mod plasticity. (Bedding planes horizontal)
		End of Hole (too hard to auger further)

Tested by : D Stevenson Date : 16/06/97
Checked by : R Corlett (Laboratory Manager) Date : 14/7/97

AUGER / SHEAR VANE TEST REPORT

Project : Envirowaste Landfill
Location : Fairfield
Test number : Hand Auger Hole No HA2
Client : Opus International Consultants, Dunedin
Comment:
Shear vane No : Dn Lab LCSS04.02
Shear vane correction : NA
Water level (m) : NA
Reduced level (m) : top 200mm of soil previously bulldozed. Hole depths taken from new surface level
Test methods : Shear Strength using the Pilcon Shear Vane
to the methods of BS1377 : Part 9 : 1990 Test 4.4

Project No: CWM00.47
Lab Ref No: L970141



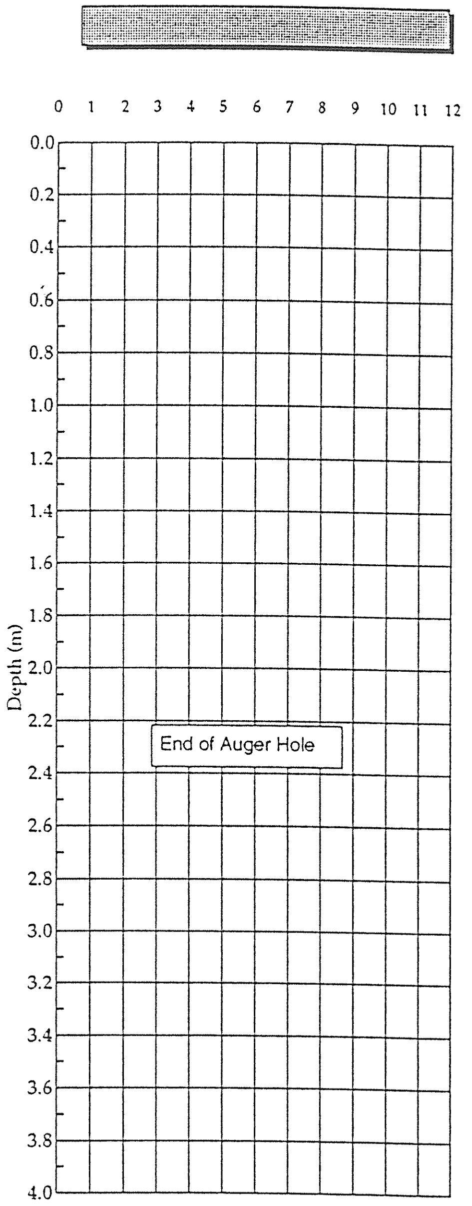
Depth (m)	Max & [Residual] Strength Shear (kPa)	MATERIAL DESCRIPTION
0.5 0.9	95 [60]	Light brown mottled silty CLAY (loess) moist, firm, plastic *increasingly harder with depth*
1.0 1.5 1.8	230+ [60] 210 [60]	light yellowish brown silty CLAY with trace of light grey silty clay hard, moist, plastic *increasingly greener with depth*
2.0 2.5 2.7	155 [15] 210 [35]	dark greenish brown mottled silty CLAY moist, very stiff, plastic with decomposed ash with iron deposits: moist, firm, non plastic *increasingly harder with depth*
		End of Hole (hit small rocks - too hard to auger further)

Tested by : D Stevenson Date : 16/06/97
Checked by : R Corlett (Laboratory Manager) Date : 14/07/97

AUGER / SHEAR VANE TEST REPORT

Project : Envirowaste Landfill
Location : Fairfield
Test number : Hand Auger Hole No HA3
Client : Opus International Consultants, Dunedin
Comment:
Shear vane No : Dn Lab LCSS04.02
Shear vane correction : NA
Water level (m) : NA
Reduced level (m) : top of hole at ground level
Test methods : Shear Strength using the Pilcon Shear Vane
to the methods of BS1377 : Part 9 : 1990 Test 4.4

Project No:	CWM00.47
Lab Ref No:	L970141



Depth (m)	Max & [Residual] Strength Shear (kPa)	MATERIAL DESCRIPTION
0.2		Grass and Topsoil
0.5 0.8	230+[85]	Light yellowish brown silty CLAY (loess) moist, hard, plastic, mottled
1.0 1.5 1.8	230+ 230+ [110]	dark greenish black clayey SILT (possibly decomposed ash and iron deposits) moist, very hard, mod plastic
2.3		as above but with trace of wool and rubbish, wet, methane odour (water heard to be percolating into hole)
		End of Hole (hit rubbish - too hard to auger further)

Tested by : D Stevenson Date : 16/06/97
Checked by : R Corlett (Laboratory Manager) Date : 14/07/97

Appendix C: Leachate Charts

Table 1: Summary of Leachate Discharge from Site for 2023 (m^3/hr)

Date	Corresponding Month of data	Time	Total Hours Since Last Reading (hr)	Pump Hours Since Last Reading (hr)	Discharge Total Reading (m^3)	Average Discharge Flow Rate (m^3/hr)	Discharge Since Last Reading (m^3)	Average Discharge from the Interception Drain to the Pumping Chamber for that period (m^3/hr)	Estuary Level
05 Dec 2022	Nov-22	15:40	793	75	134737	17	1287	1.6	Low
12 Jan 2023	Dec-22	10:30	907	70	135951	17	1214	1.3	Low
10 Feb 2023	Jan-23	15:00	701	48	136789	17	838	1.2	Medium-High
03 Mar 2023	Feb-23	14:30	503	39	137406	16	617	1.2	Very Low
05 Apr 2023	Mar-23	08:30	786	84	138814	17	1408	1.8	High
04 May 2023	Apr-23	13:00	701	93	139803	11	989	1.4	Medium-High
06 Jun 2023	May-23	12:00	791	100	141904	21	2101	2.7	Low
04 Jul 2023	Jun-23	08:30	668	165	144162	14	2258	3.4	Very High
07 Aug 2023	Jul-23	12:40	820	364	148573	12	4411	5.4	Very Low
04 Sep 2023	Aug-23	08:15	668	278	151224	10	2651	4.0	Medium-High
04 Oct 2023	Sep-23	14:10	726	263	153344	8	2120	2.9	Very low
01 Nov 2023	Oct-23	12:30	670	171	154853	9	1509	2.3	High
			Total	**1750**			**21403**	**2.4**	**-**

Data provided by Otago Waste Services

Table 2: Summary of Monthly Average Discharge from the Interception Drain since 2003 (m^3/hr)

Month	Monthly Average for all years	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
January	2.7		2.1	8.5	2.7	3.1	2.2	1.9	1.9	3.0	2.1	3.6	2.8	2.5	2.3	3.0	2.3	2.1	3.0	2.3	1.3	1.2
February	2.2		2.0		3.2	2.4	2.0	2.9	1.8	4.4	3.0	1.4	2.2	1.2	2.3	2.4	1.2	1.9	4.1	1.8	1.3	1.2
March	2.4		1.6	4.3	2.2	1.5	2.5	-	1.8	3.9	4.7	3.1	1.7	3.1	2.2	2.0	2.6	1.4	2.8	1.5	1.0	1.8
April	3.0		1.8	6.4	8.0	1.8	2.0	3.9	1.7	3.8	3.3	2.6	7.9	1.8	1.8	3.1	2.6	1.5	2.0	1.4	1.5	1.4
May	3.2		1.7	2.5	1.4	1.5	2.9	2.8	4.3	6.4	2.5	6.1	7.4	2.9	4.0	2.7	4.1	2.6	1.7	1.6	1.2	2.7
June	4.7		1.8	6.4	3.1	1.9	3.7	7.7	8.3	3.9	4.7	12.4	5.2	9.7	3.9	3.8	4.5	2.6	2.7	2.9	2.0	3.4
July	4.4	4.1	2.0	2.8	3.5	3.2	4.6	5.6	5.6	3.1	3.8	6.6	3.8	5.5	3.8	7.7	3.5	2.8	2.7	3.7	8.9	5.4
August	4.3	2.9	2.0	4.1	2.4	7.2	6.7	4.2	4.6	4.0	8.1	4.0	3.6	4.0	5.3	4.9	3.3	3.6	2.2	2.7	5.0	4.0
September	3.7	0.7	6.0	2.7	2.4	3.4	7.8	3.1	6.1	2.9	4.4	1.1	4.3	5.2	3.7	5.2	3.0	2.7	2.1	2.5	2.5	2.9
October	3.1	3.9	5.0	1.9	1.6	4.5	4.3	2.7	3.5	3.5	2.4	4.9	3.2	3.8	2.9	2.8	2.2	4.5	1.8	2.3	2.2	2.3
November	2.8	1.7	2.4	2.8	2.3	-	3.0	2.4	2.5	3.5	4.2	2.6	3.0	3.2	3.8	2.3	4.3	3.7	1.6	1.5	1.6	
December	2.5	2.3	6.3	3.1	1.1	3.2	2.4	2.0	2.4	2.7	1.4	2.6	3.1	2.8	3.1	1.2	2.9	3.0	1.5	1.5	1.3	

Table 3: Summary of Annual Discharge from the Interception Drain since 2003 (m^3)

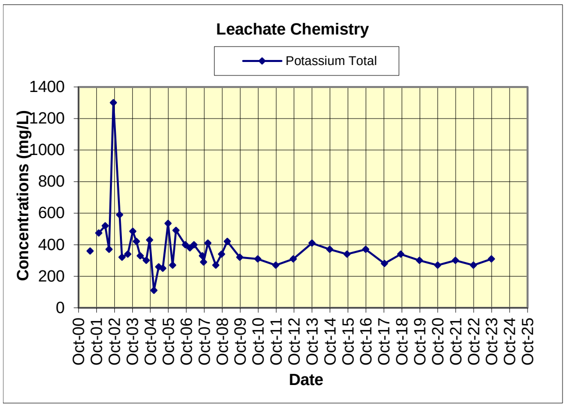
Annual Discharge (November - October)	**2003***	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Average**
	8,618	21,915	35,550	26,426	23,525	33,441	32,927	32,175	31,982	32,632	37,433	34,605	34,064	27,874	32,799	25,603	24,470	22,924	19,415	21,258	21,403	28,621

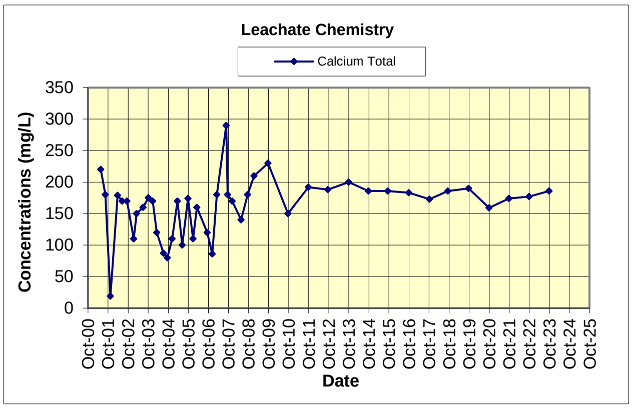
* Only a part year

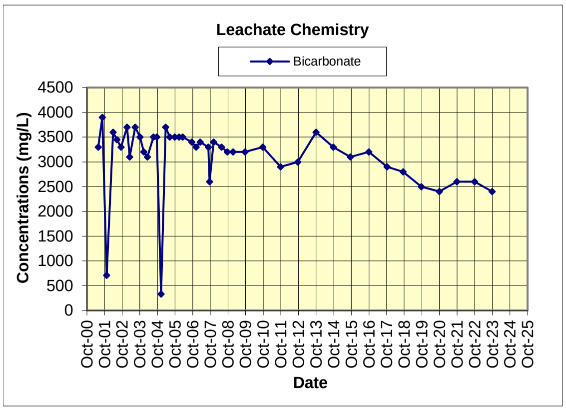
Data provided by Otago Waste Services

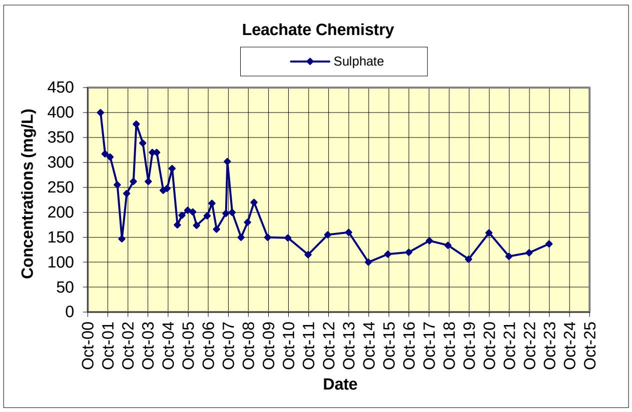
Leachate Chemistry Charts

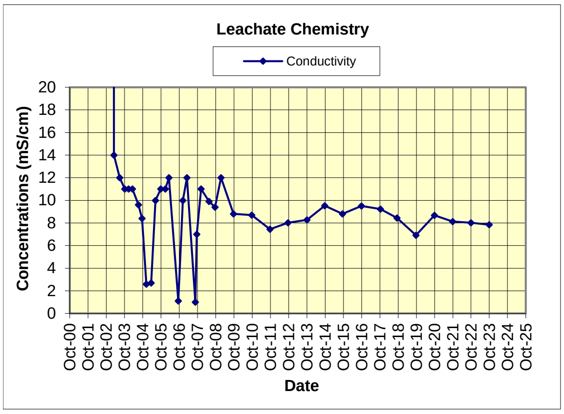
(Fairfield Landfill)

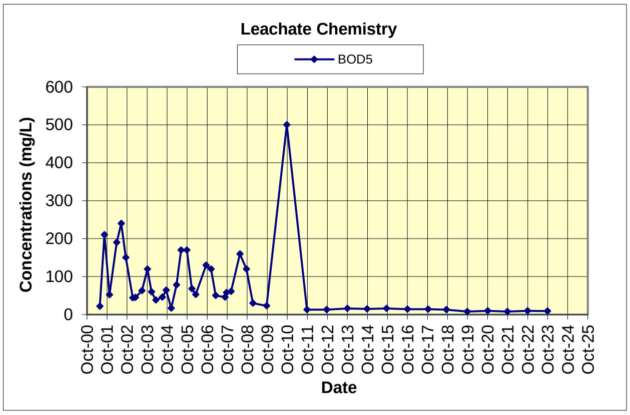


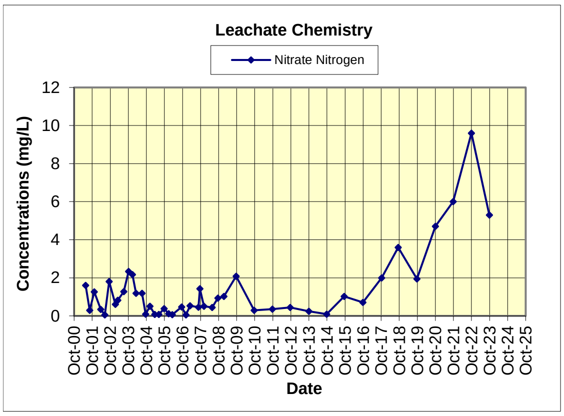


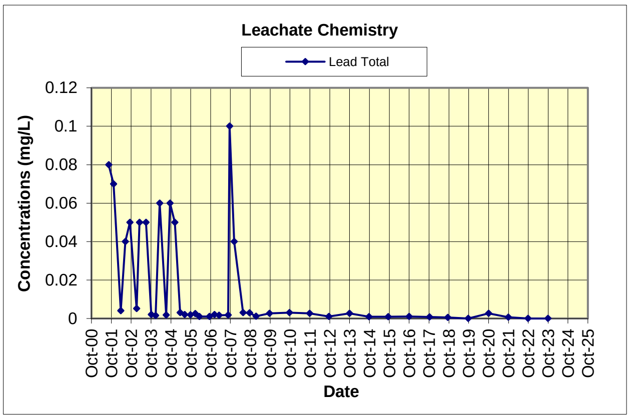






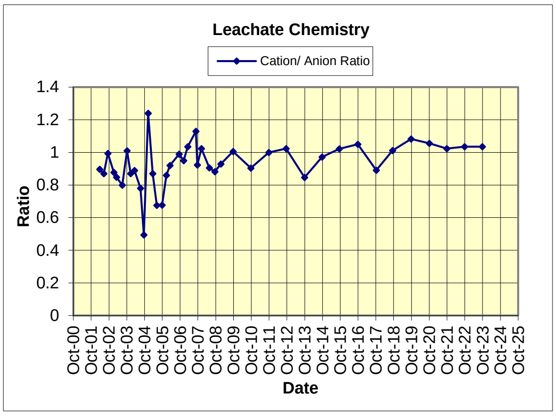


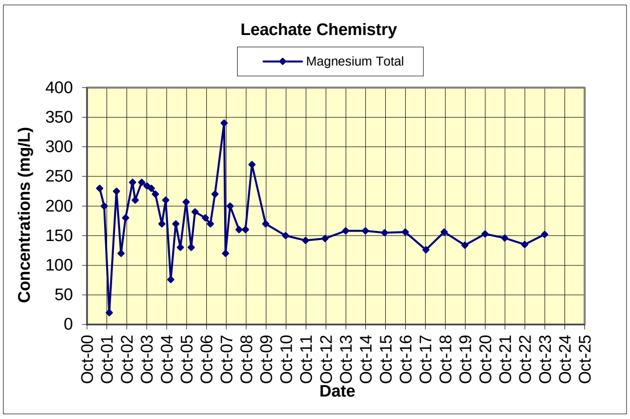


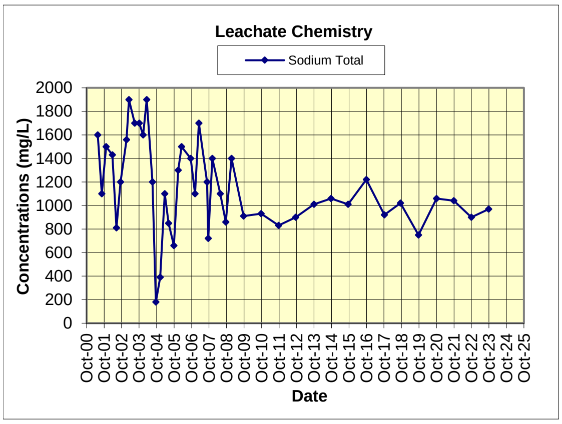


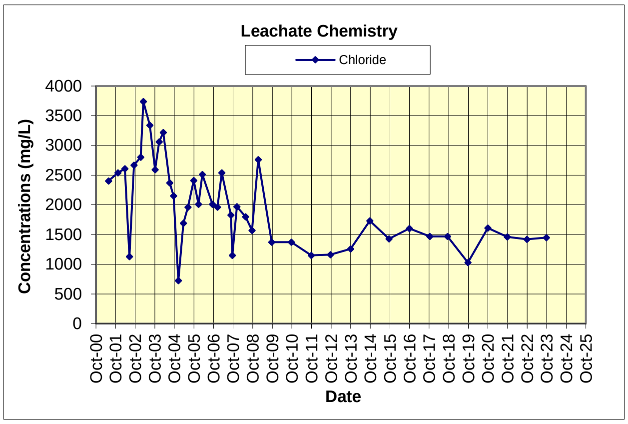
Leachate Chemistry Charts

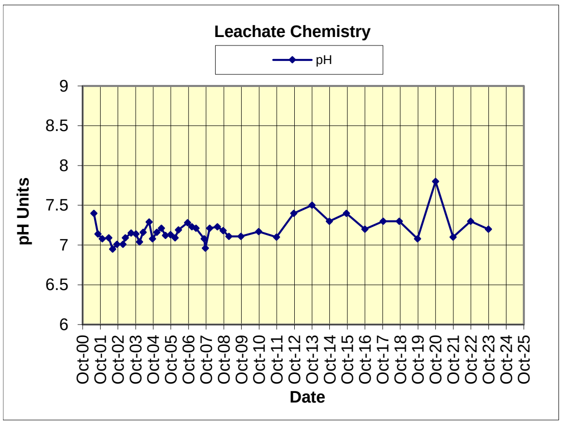
(Fairfield Landfill)

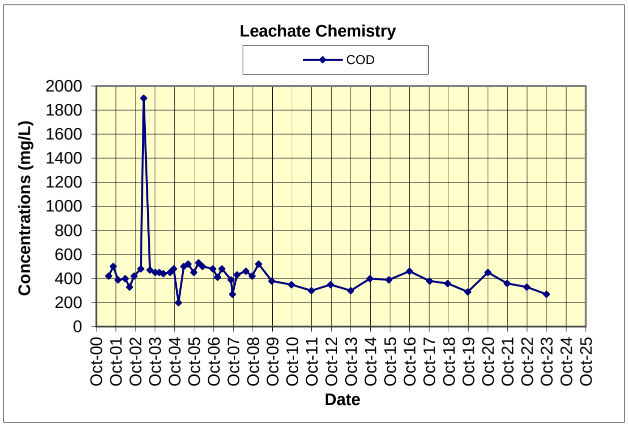


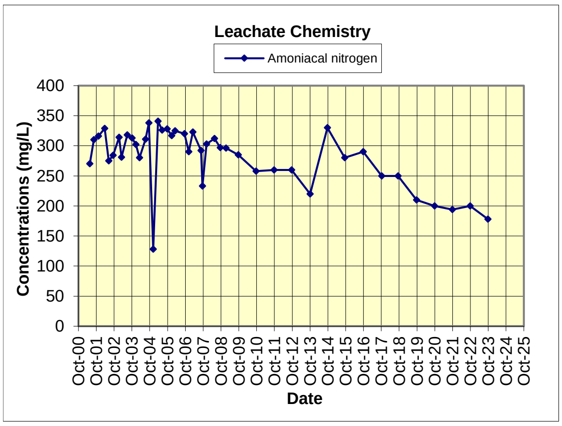


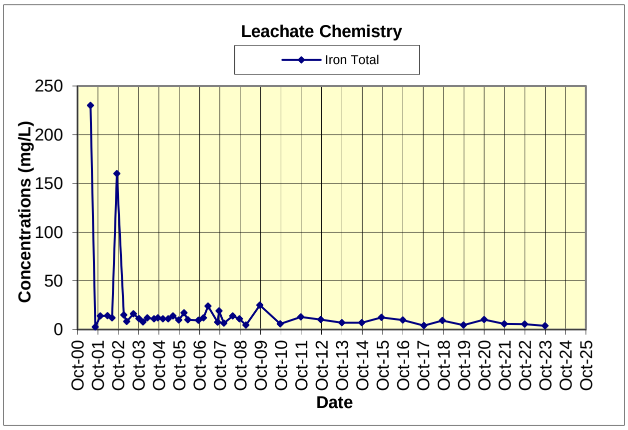






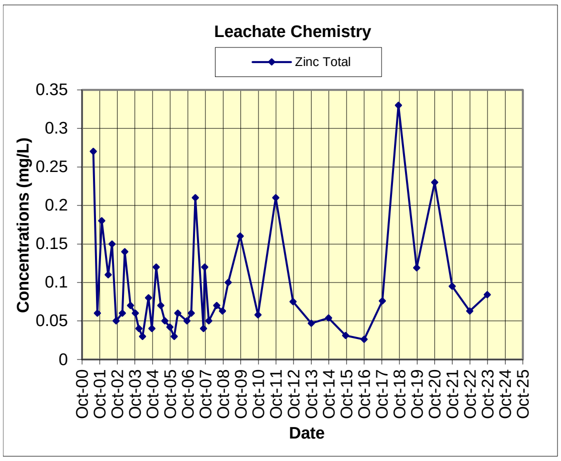






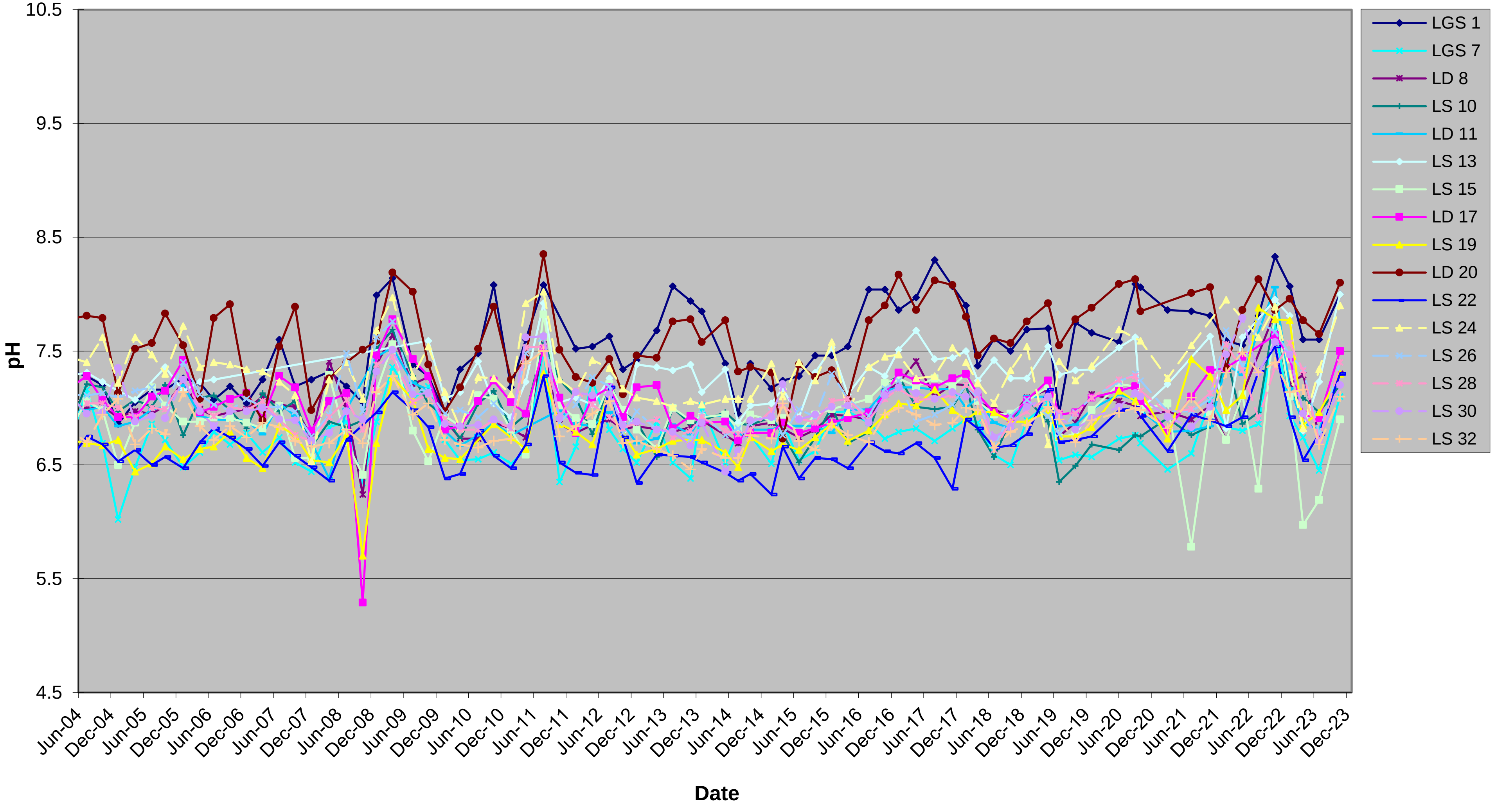
Leachate Chemistry Charts

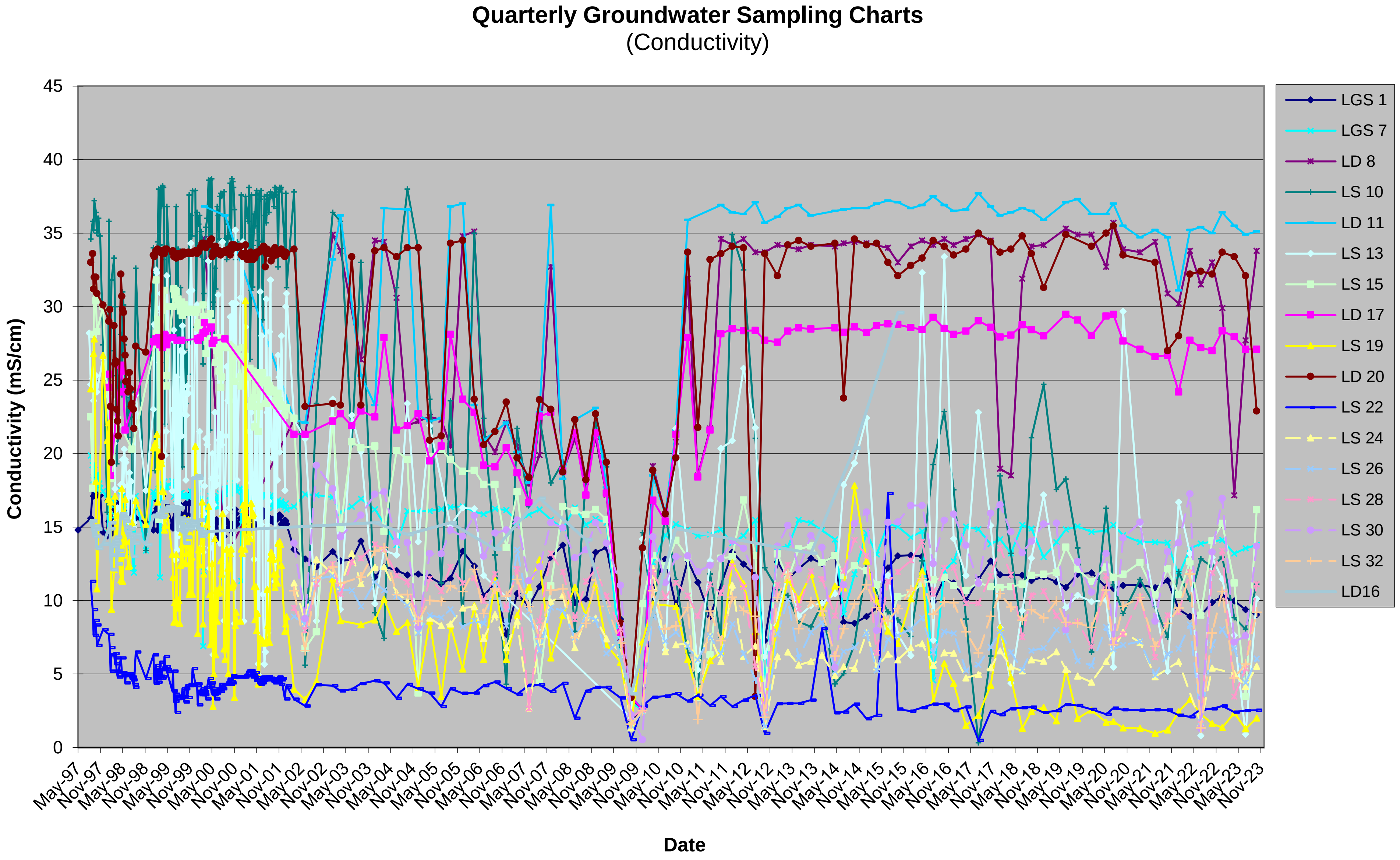
(Fairfield Landfill)

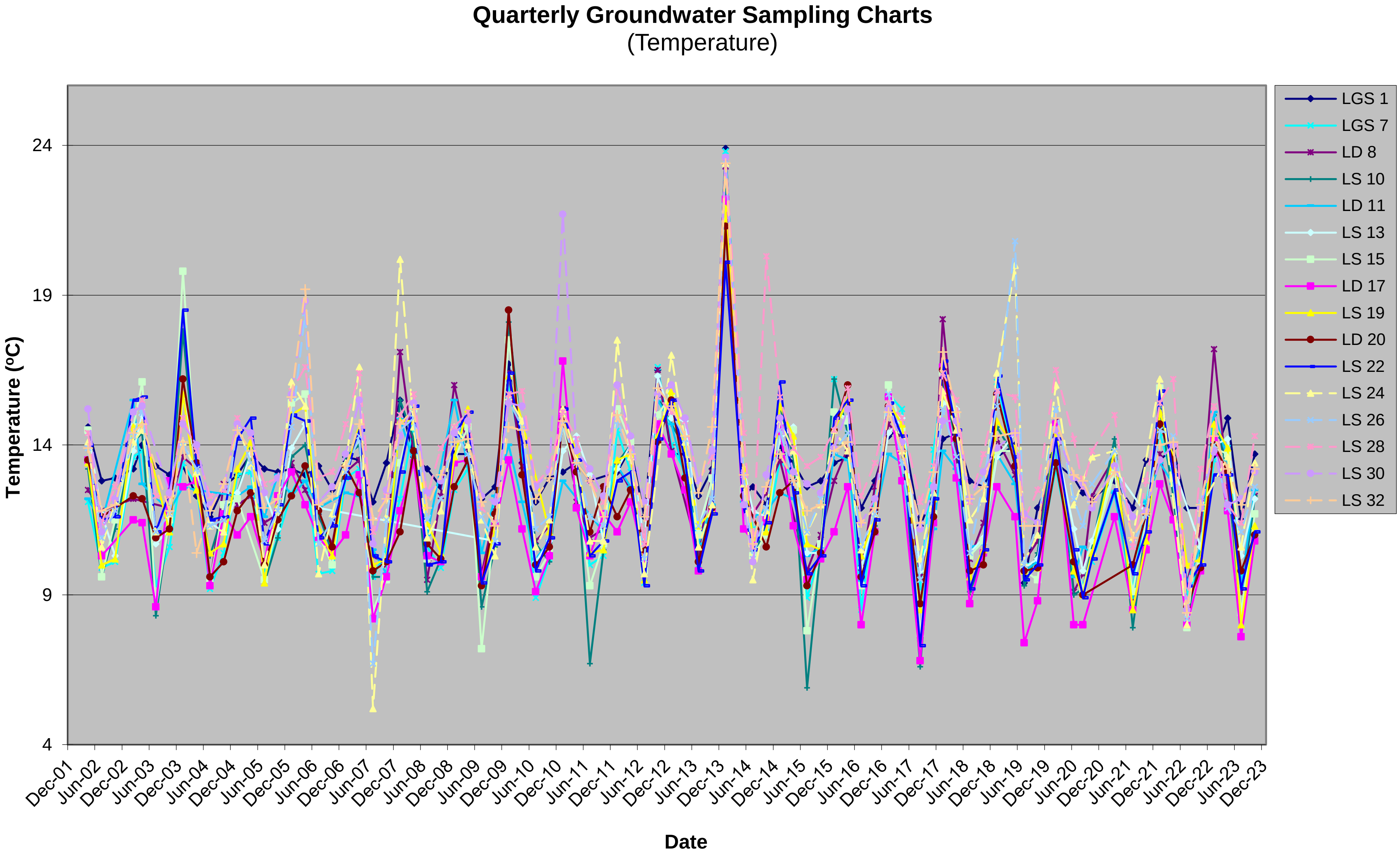


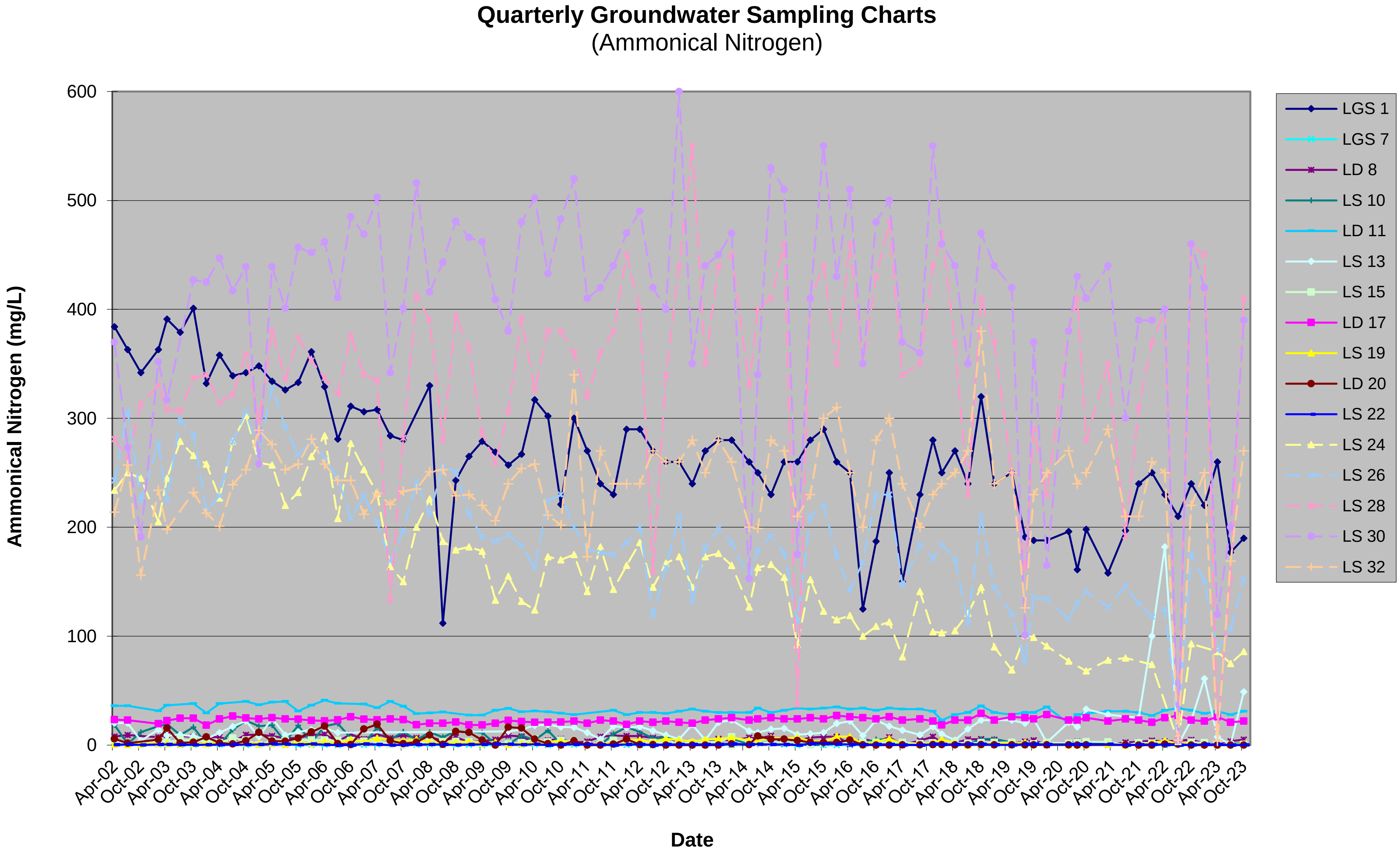
Appendix D: Groundwater Quality

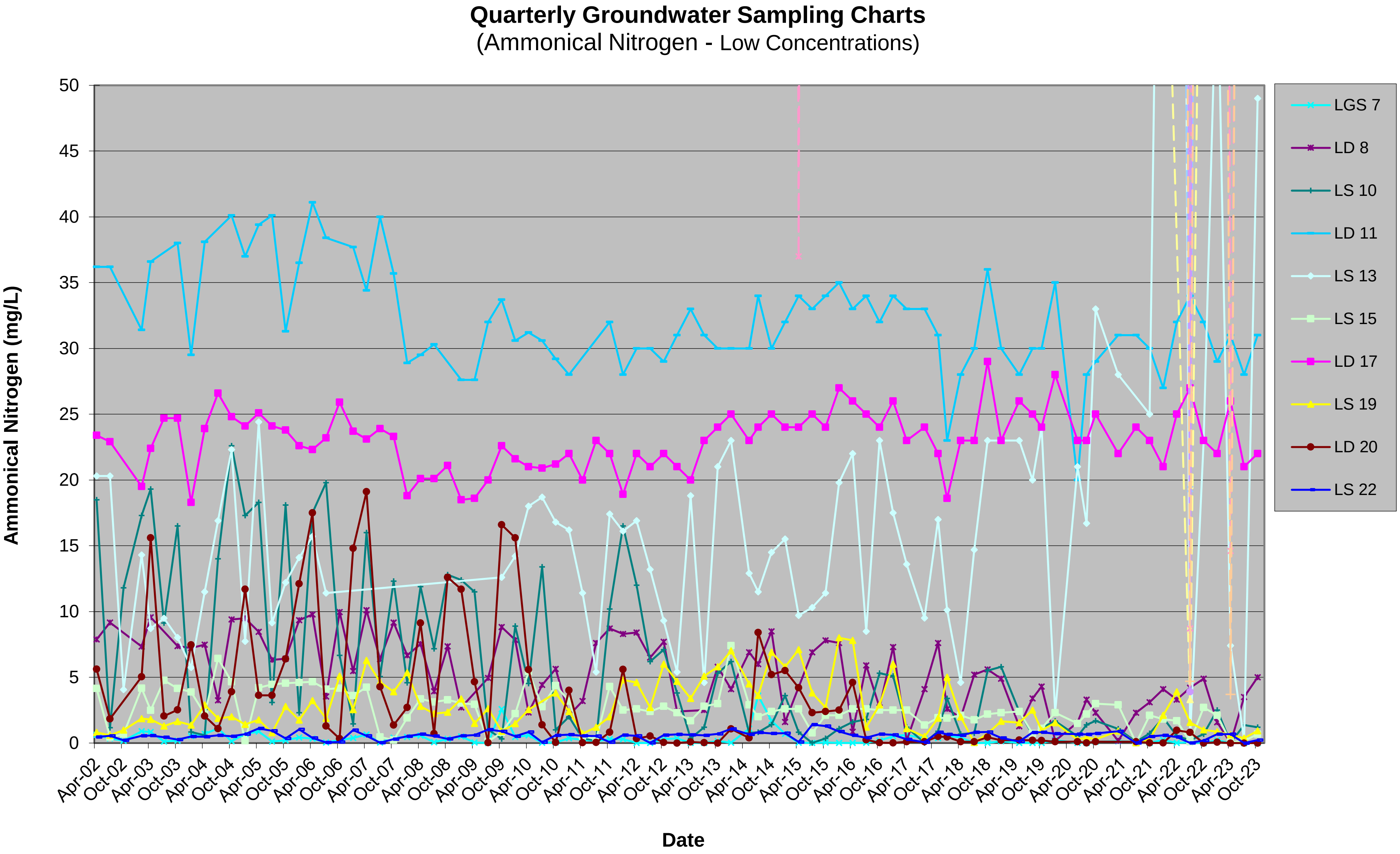
Quarterly Groundwater Sampling Charts
(pH)

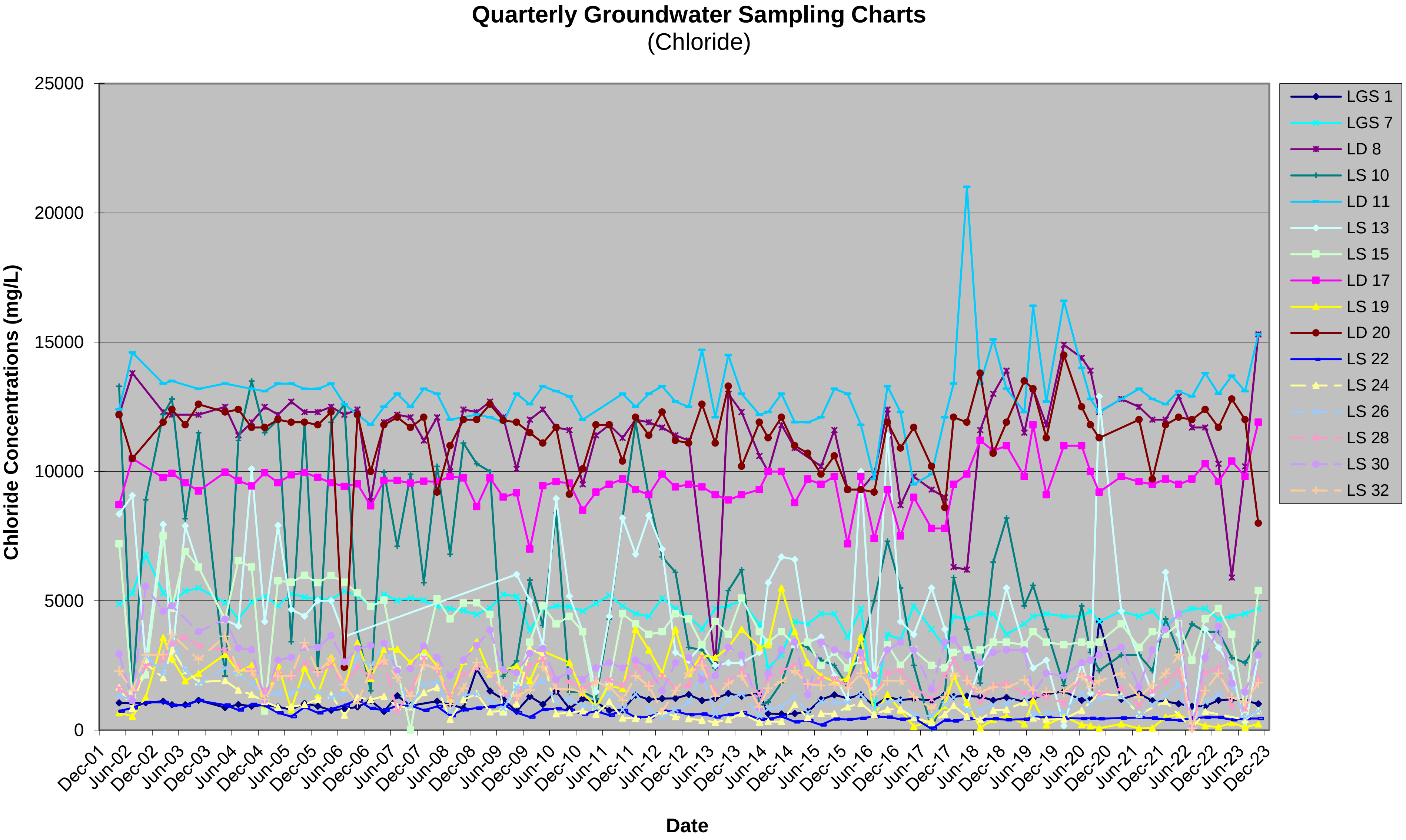


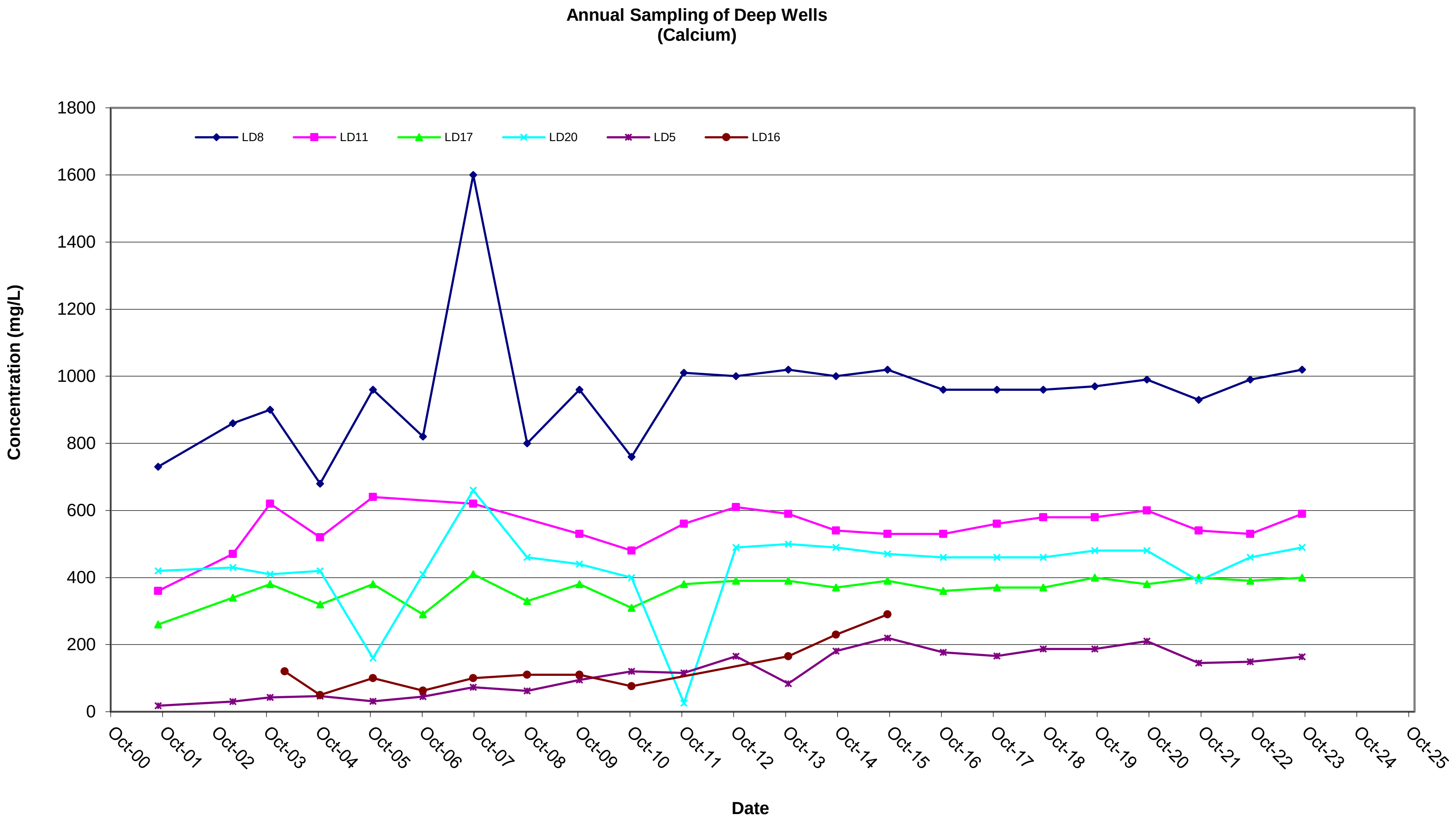

Quarterly Groundwater Sampling Charts
(Conductivity)
Conductivity (mS/cm)
45
40
35
30
25
20
15
10
5
0
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
Nov-05
May-06
Nov-06
May-07
Nov-07
May-08
Nov-08
May-09
Nov-09
May-10
Nov-10
May-11
Nov-11
May-12
Nov-12
May-13
Nov-13
May-14
Nov-14
May-15
Nov-15
May-16
Nov-16
May-17
Nov-17
May-18
Nov-18
May-19
Nov-19
May-20
Nov-20
May-21
Nov-21
May-22
Nov-22
May-23
Nov-23
Date
LGS 1
LGS 7
LD 8
LS 10
LD 11
LS 13
LS 15
LD 17
LS 19
LD 20
LS 22
LS 24
LS 26
LS 28
LS 30
LS 32
LD16

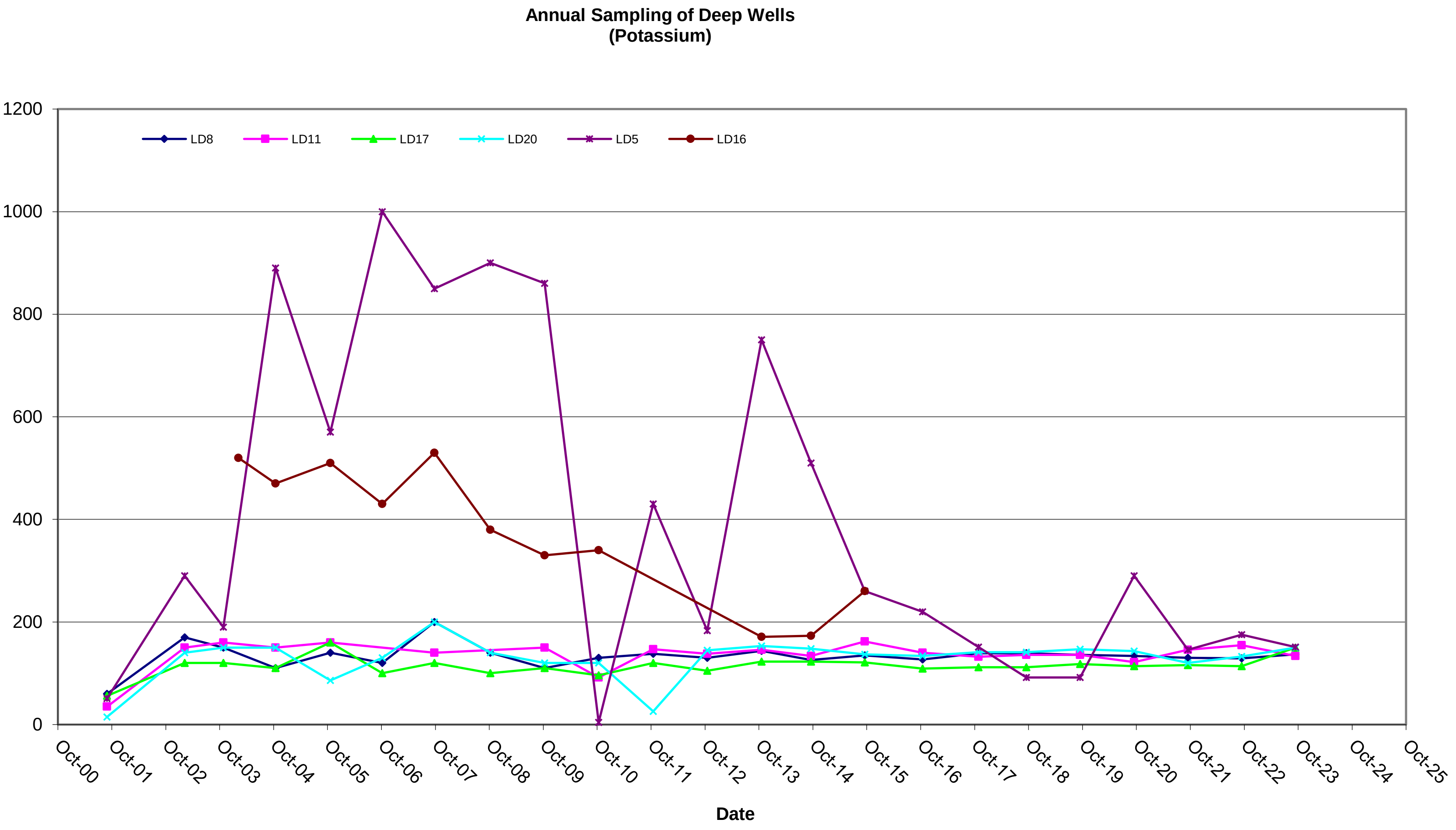

Quarterly Groundwater Sampling Charts
(Temperature)
Temperature (ºC)
24
19
14
9
4
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Jun-21
Dec-21
Jun-22
Dec-22
Jun-23
Dec-23
Date
LGS 1
LGS 7
LD 8
LS 10
LD 11
LS 13
LS 15
LD 17
LS 19
LD 20
LS 22
LS 24
LS 26
LS 28
LS 30
LS 32

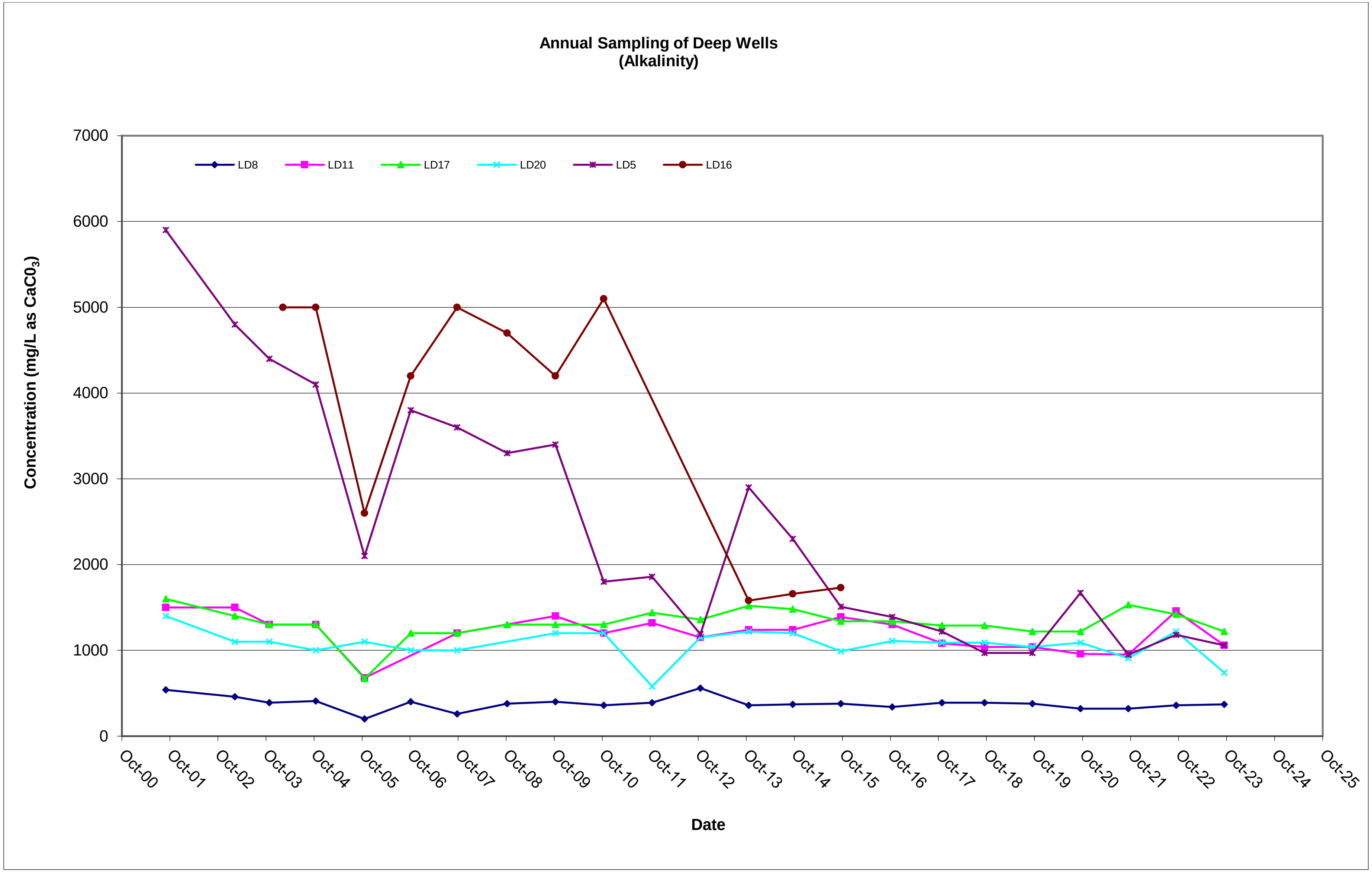

Quarterly Groundwater Sampling Charts
(Ammonical Nitrogen)
Ammonical Nitrogen (mg/L)
600
500
400
300
200
100
0
Apr-02
Oct-02
Apr-03
Oct-03
Apr-04
Oct-04
Apr-05
Oct-05
Apr-06
Oct-06
Apr-07
Oct-07
Apr-08
Oct-08
Apr-09
Oct-09
Apr-10
Oct-10
Apr-11
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Apr-16
Oct-16
Apr-17
Oct-17
Apr-18
Oct-18
Apr-19
Oct-19
Apr-20
Oct-20
Apr-21
Oct-21
Apr-22
Oct-22
Apr-23
Oct-23
Date
LGS 1
LGS 7
LD 8
LS 10
LD 11
LS 13
LS 15
LD 17
LS 19
LD 20
LS 22
LS 24
LS 26
LS 28
LS 30
LS 32

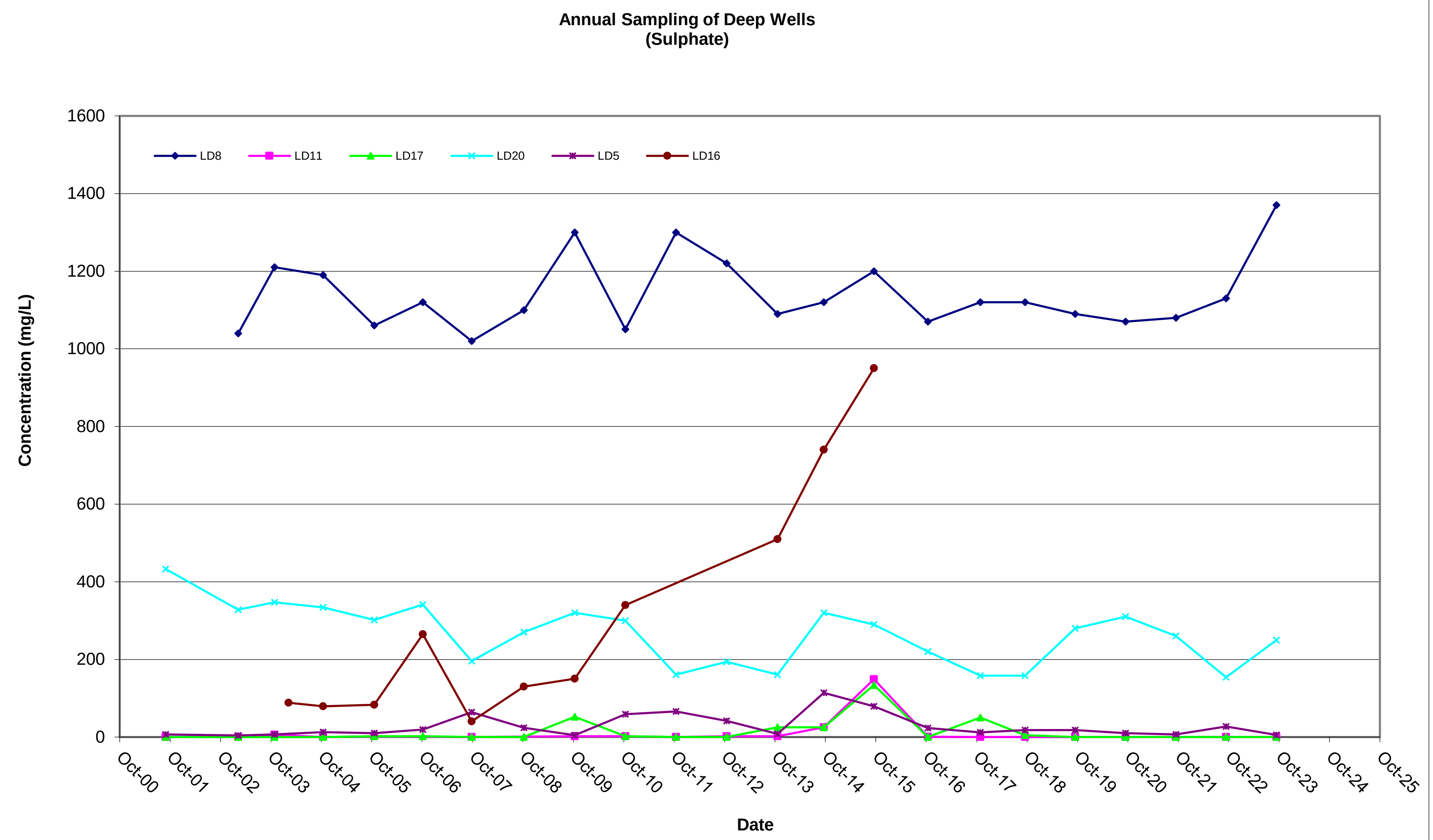

Quarterly Groundwater Sampling Charts
(Ammonical Nitrogen - Low Concentrations)
Ammonical Nitrogen (mg/L)
50
45
40
35
30
25
20
15
10
5
0
Apr-02
Oct-02
Apr-03
Oct-03
Apr-04
Oct-04
Apr-05
Oct-05
Apr-06
Oct-06
Apr-07
Oct-07
Apr-08
Oct-08
Apr-09
Oct-09
Apr-10
Oct-10
Apr-11
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Apr-16
Oct-16
Apr-17
Oct-17
Apr-18
Oct-18
Apr-19
Oct-19
Apr-20
Oct-20
Apr-21
Oct-21
Apr-22
Oct-22
Apr-23
Oct-23
Date
LGS 7
LD 8
LS 10
LD 11
LS 13
LS 15
LD 17
LS 19
LD 20
LS 22

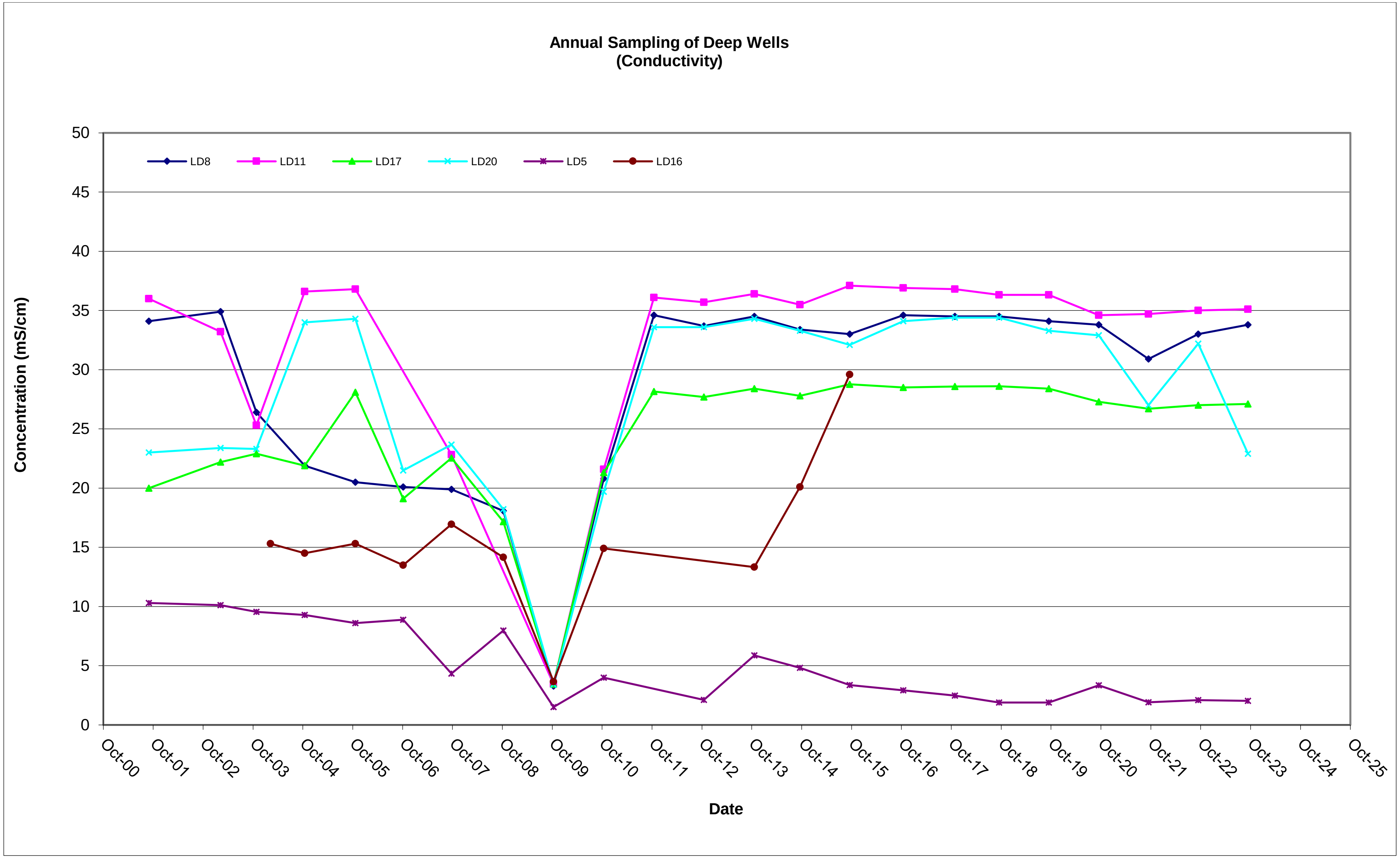

Quarterly Groundwater Sampling Charts
(Chloride)
Chloride Concentrations (mg/L)
25000
20000
15000
10000
5000
0
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Jun-21
Dec-21
Jun-22
Dec-22
Jun-23
Dec-23
Date
LGS 1
LGS 7
LD 8
LS 10
LD 11
LS 13
LS 15
LD 17
LS 19
LD 20
LS 22
LS 24
LS 26
LS 28
LS 30
LS 32

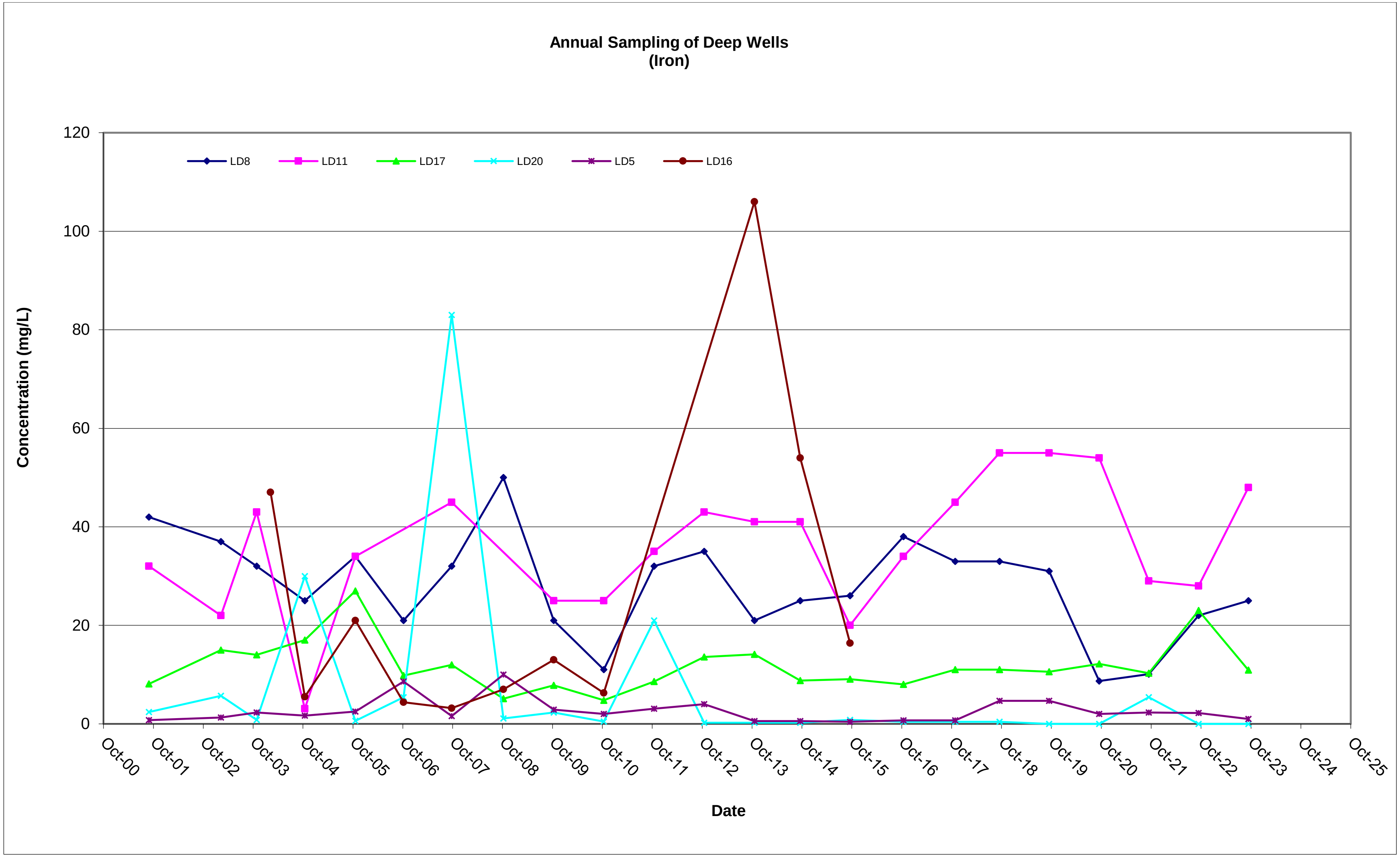

Annual Sampling of Deep Wells
(Calcium)
LD8
LD11
LD17
LD20
LD5
LD16
Concentration (mg/L)
0
200
400
600
800
1000
1200
1400
1600
1800
Date
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25

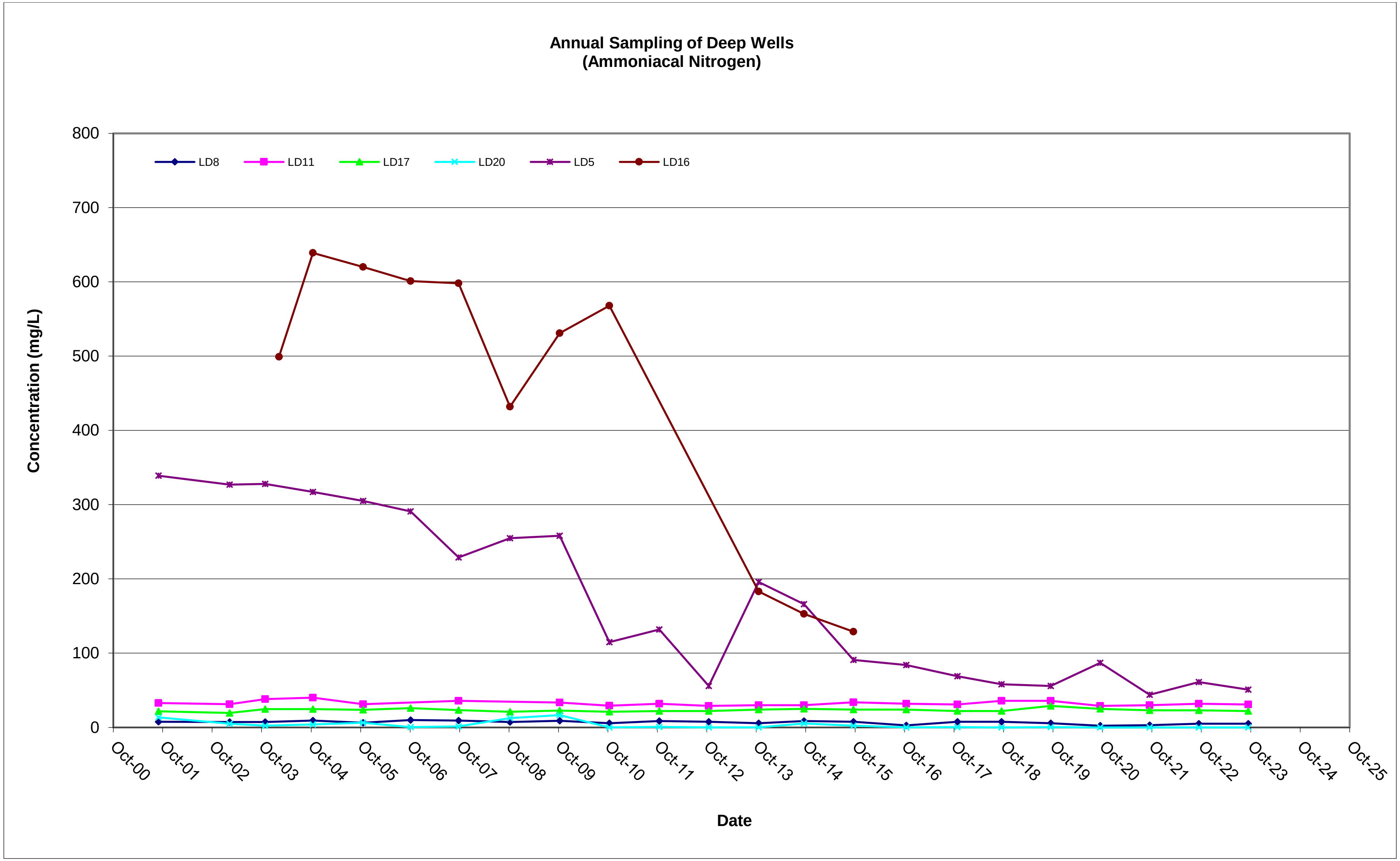

Annual Sampling of Deep Wells
(Potassium)
1200
1000
800
600
400
200
0
LD8
LD11
LD17
LD20
LD5
LD16
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

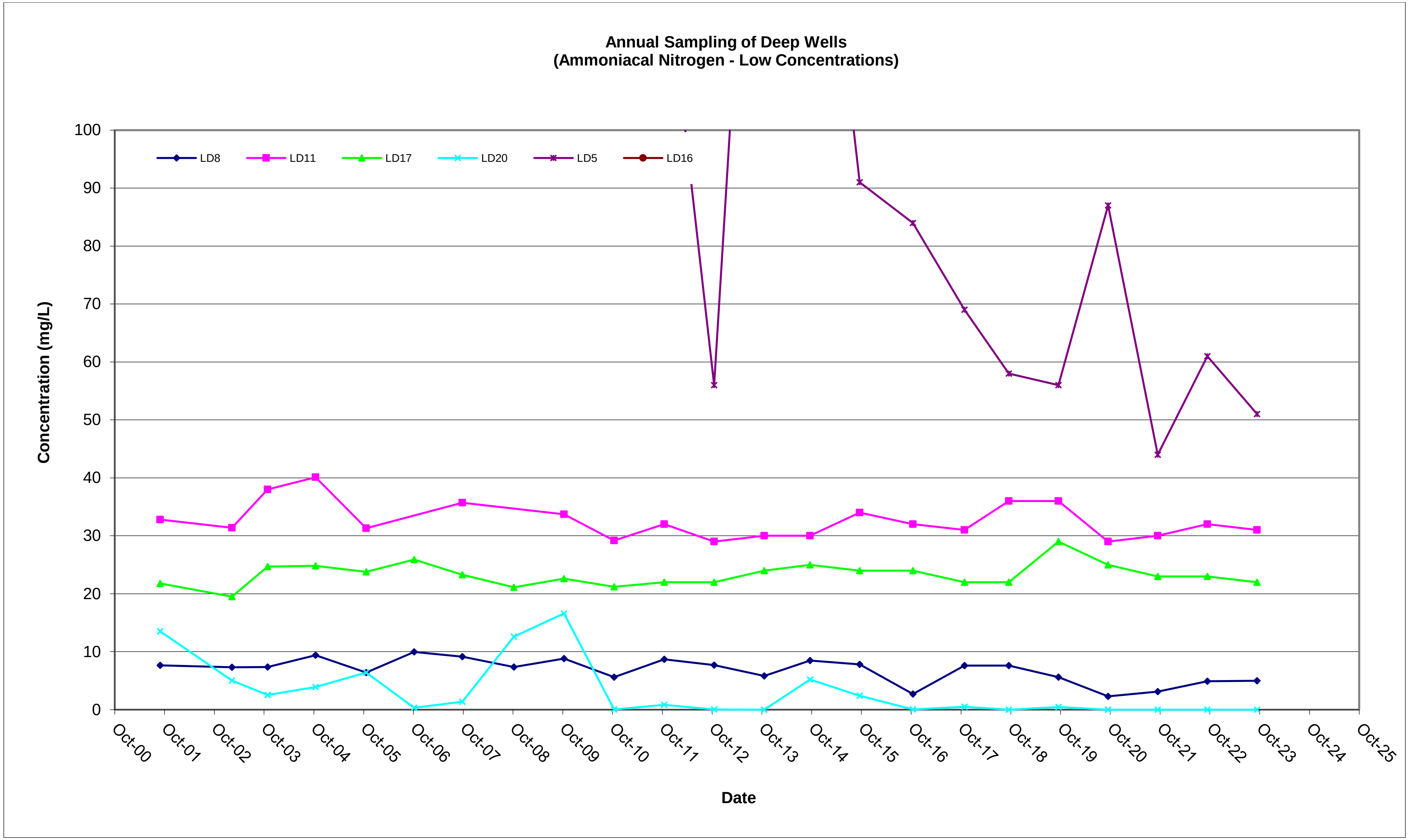

Annual Sampling of Deep Wells
(Alkalinity)
LD8
LD11
LD17
LD20
LD5
LD16
Concentration (mg/L as CaC0$_3$)
7000
6000
5000
4000
3000
2000
1000
0
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

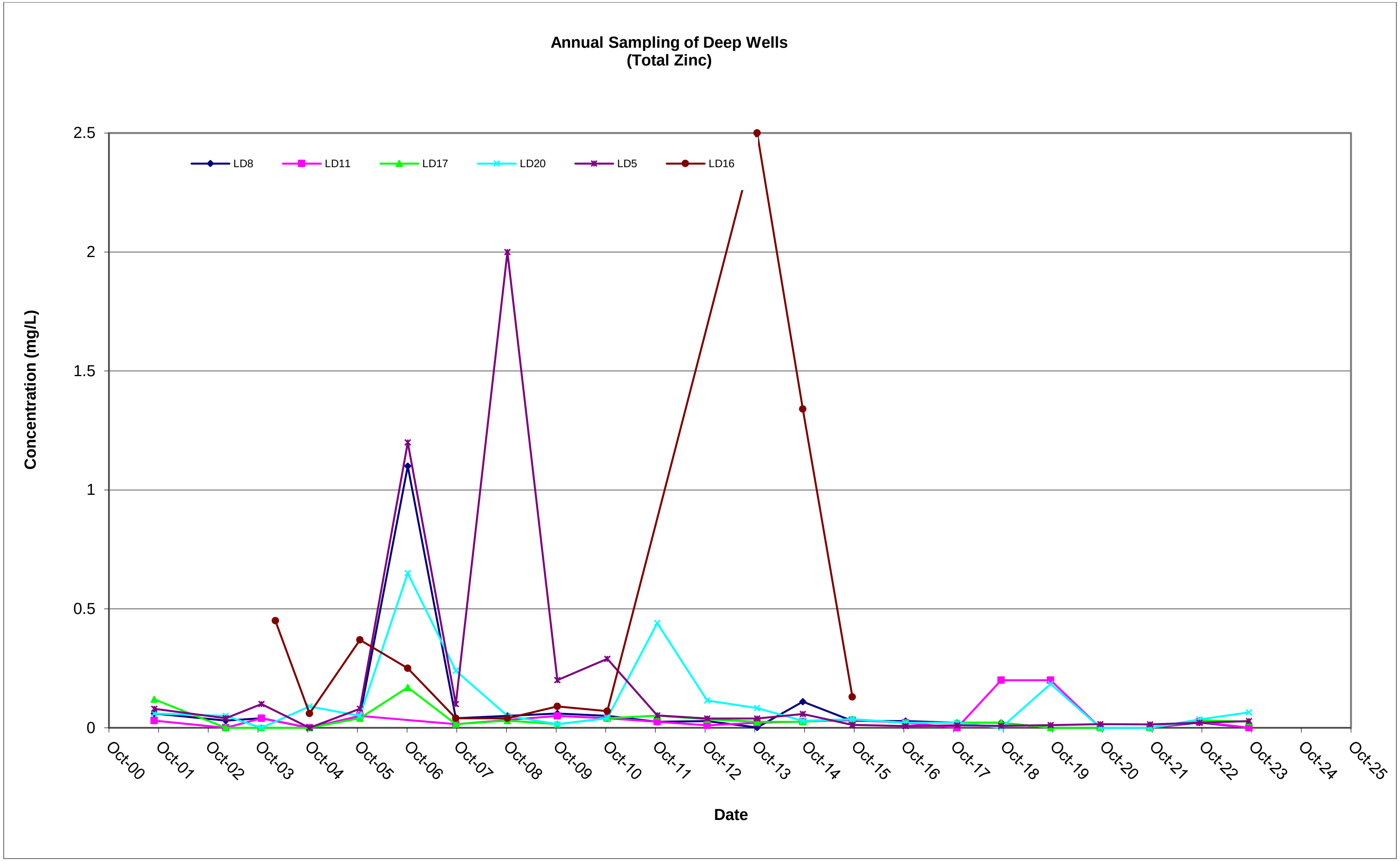

Annual Sampling of Deep Wells
(Sulphate)
LD8
LD11
LD17
LD20
LD5
LD16
Concentration (mg/L)
1600
1400
1200
1000
800
600
400
200
0
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

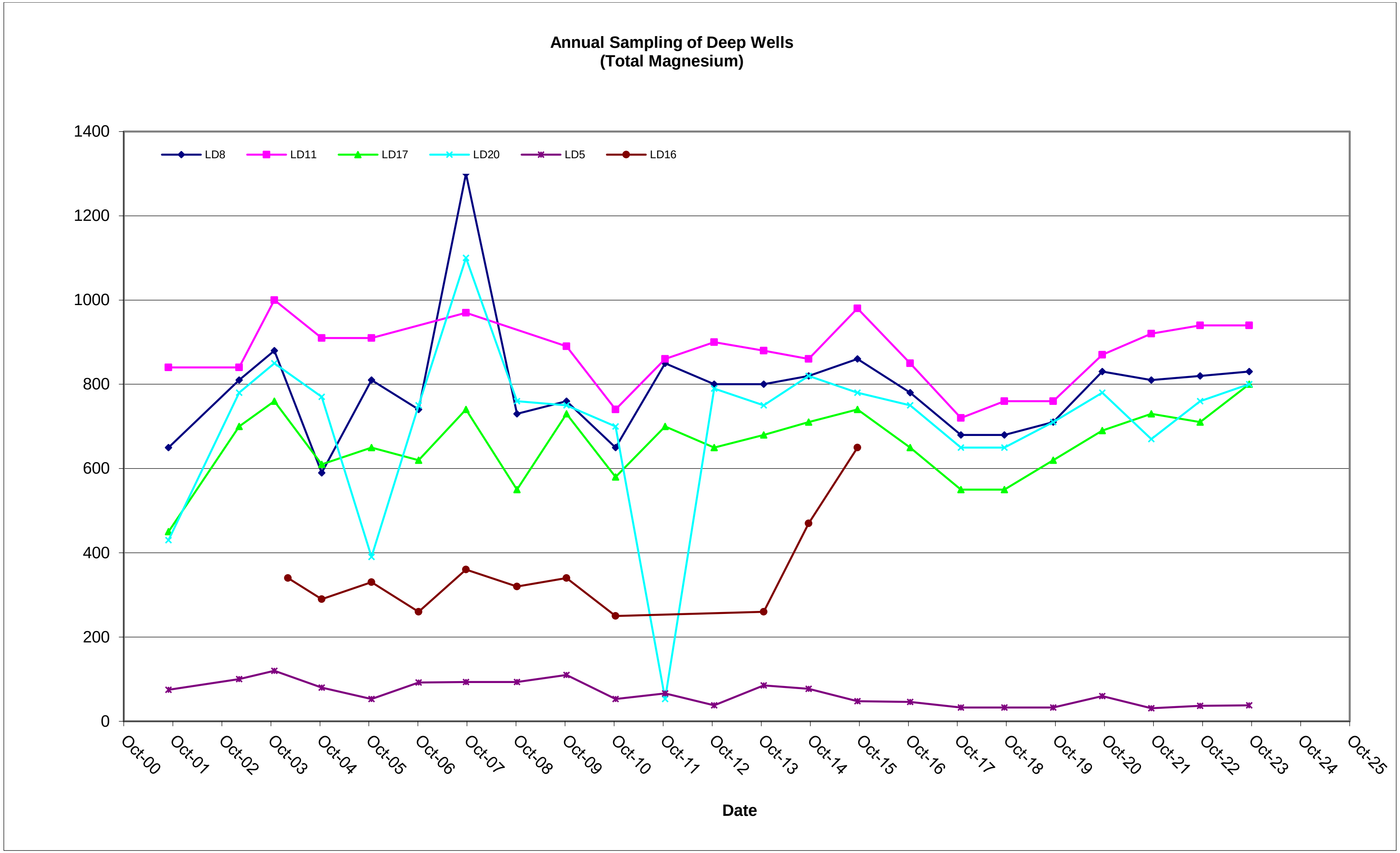

Annual Sampling of Deep Wells
(Conductivity)
Concentration (mS/cm)
Date
LD8
LD11
LD17
LD20
LD5
LD16
0
5
10
15
20
25
30
35
40
45
50
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25

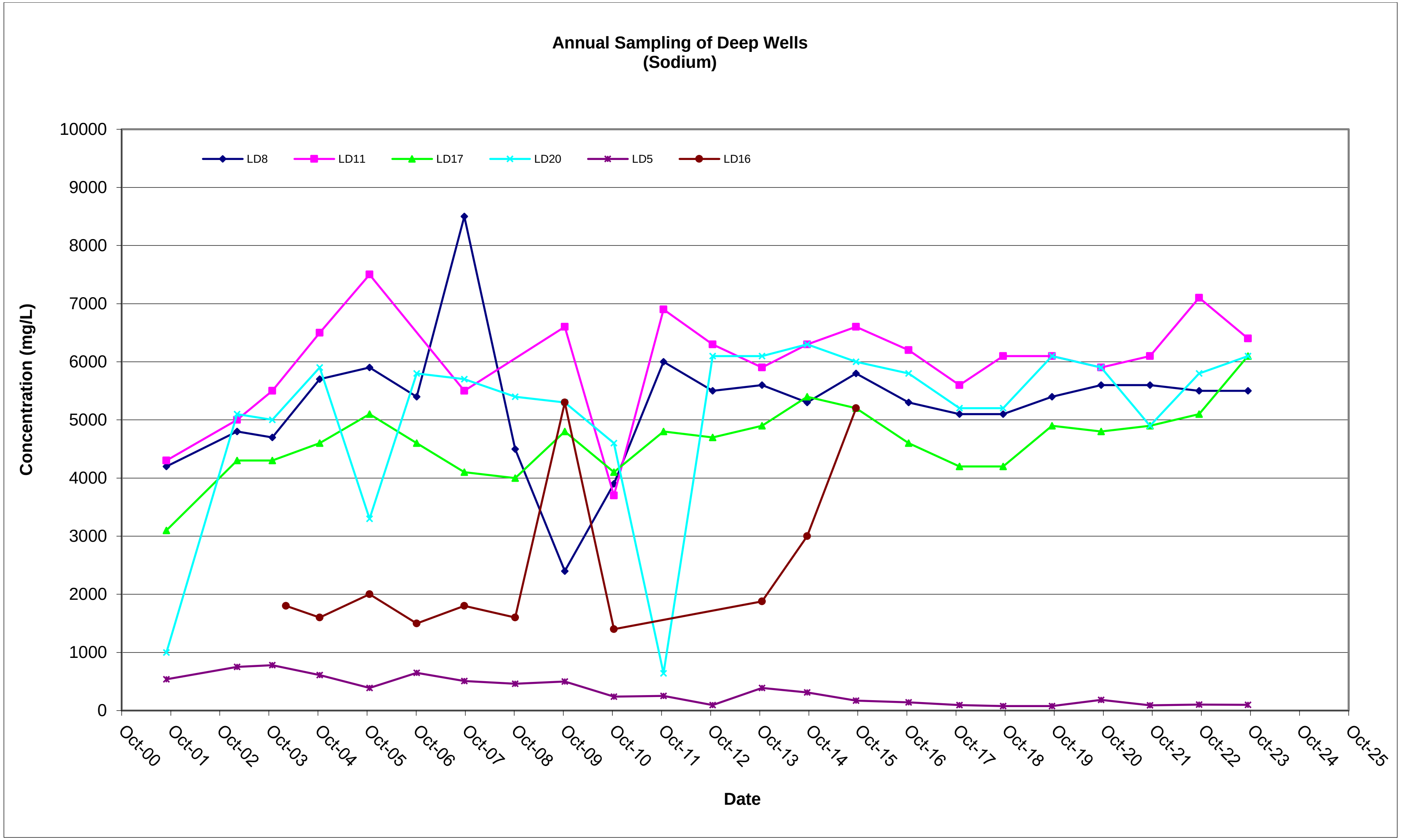

Annual Sampling of Deep Wells
(Iron)
Concentration (mg/L)
120
100
80
60
40
20
0
LD8
LD11
LD17
LD20
LD5
LD16
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

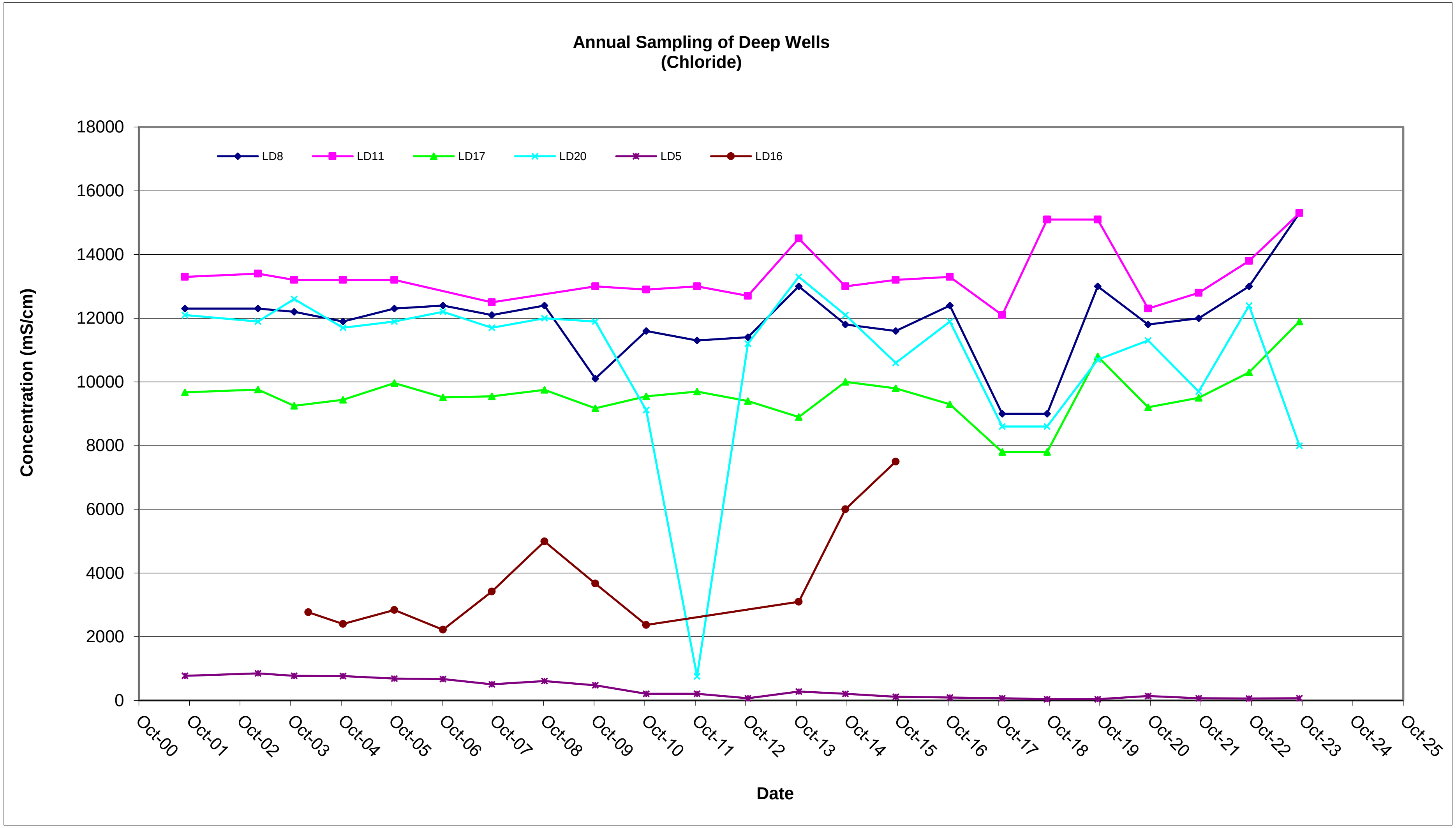

Annual Sampling of Deep Wells
(Ammoniacal Nitrogen)
LD8
LD11
LD17
LD20
LD5
LD16
Concentration (mg/L)
800
700
600
500
400
300
200
100
0
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

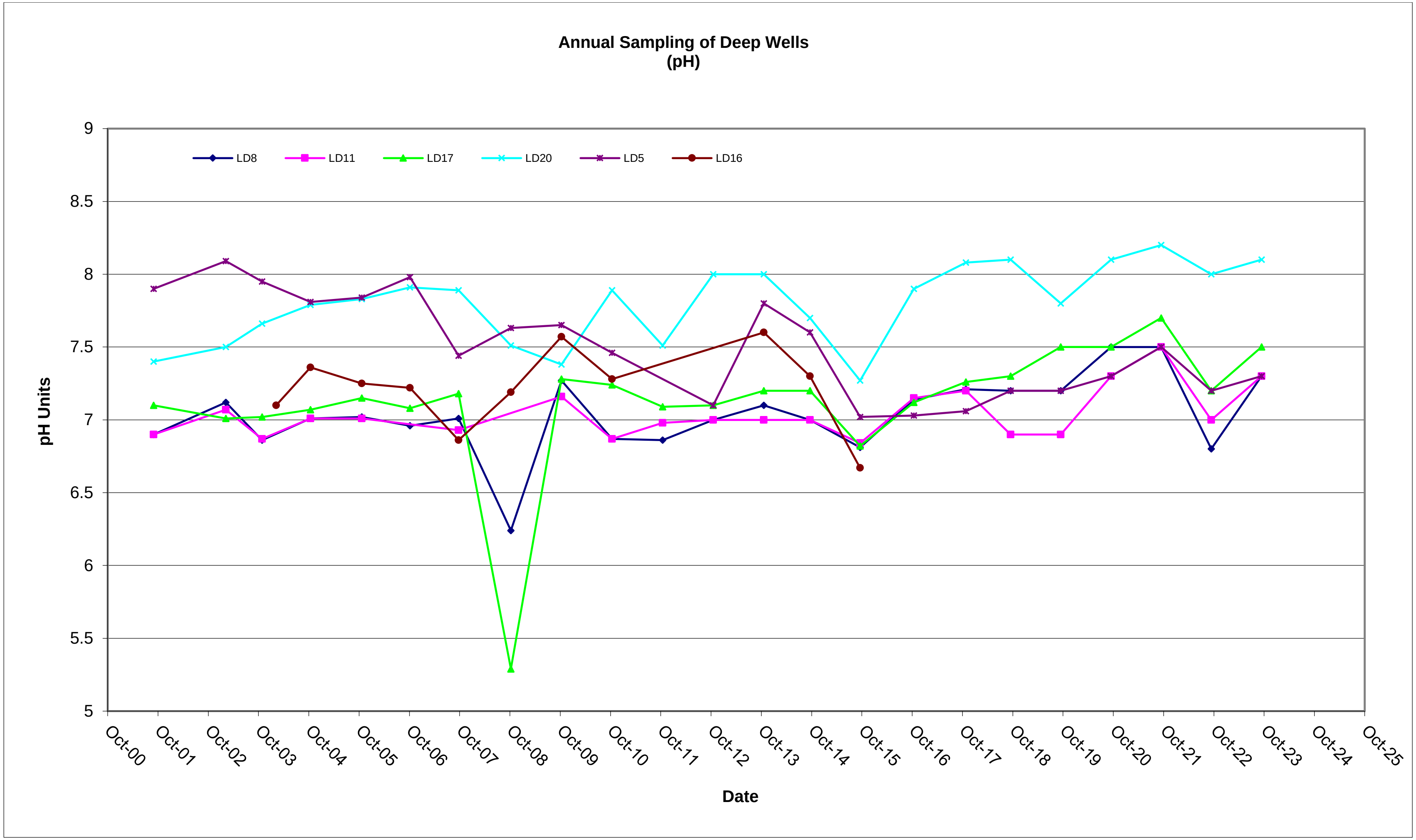

Annual Sampling of Deep Wells
(Ammoniacal Nitrogen - Low Concentrations)
LD8
LD11
LD17
LD20
LD5
LD16
Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
Date
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25

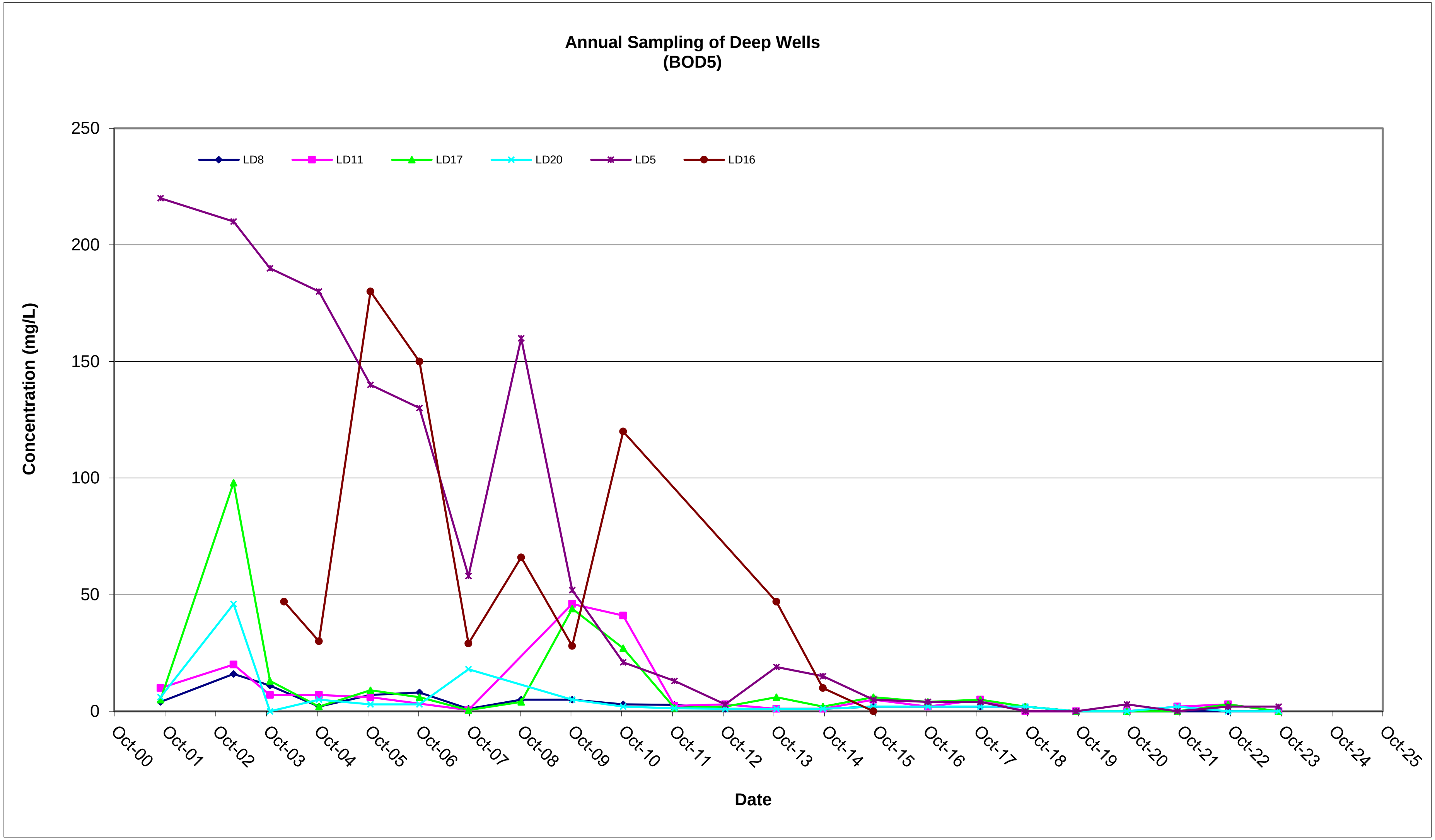

Annual Sampling of Deep Wells
(Total Zinc)
Concentration (mg/L)
Date
LD8
LD11
LD17
LD20
LD5
LD16
0
0.5
1
1.5
2
2.5
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25

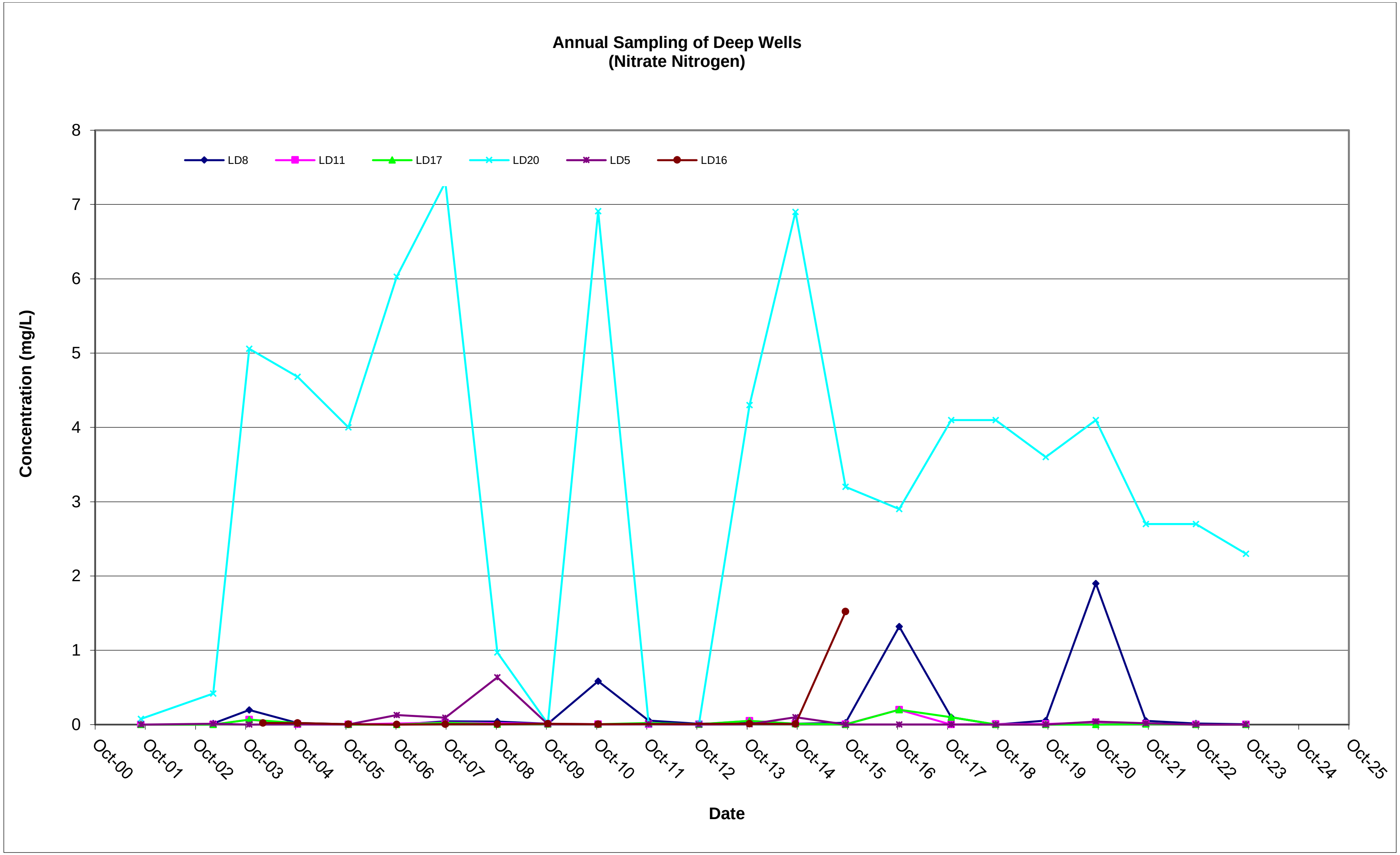

Annual Sampling of Deep Wells
(Total Magnesium)
1400
1200
1000
800
600
400
200
0
LD8
LD11
LD17
LD20
LD5
LD16
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

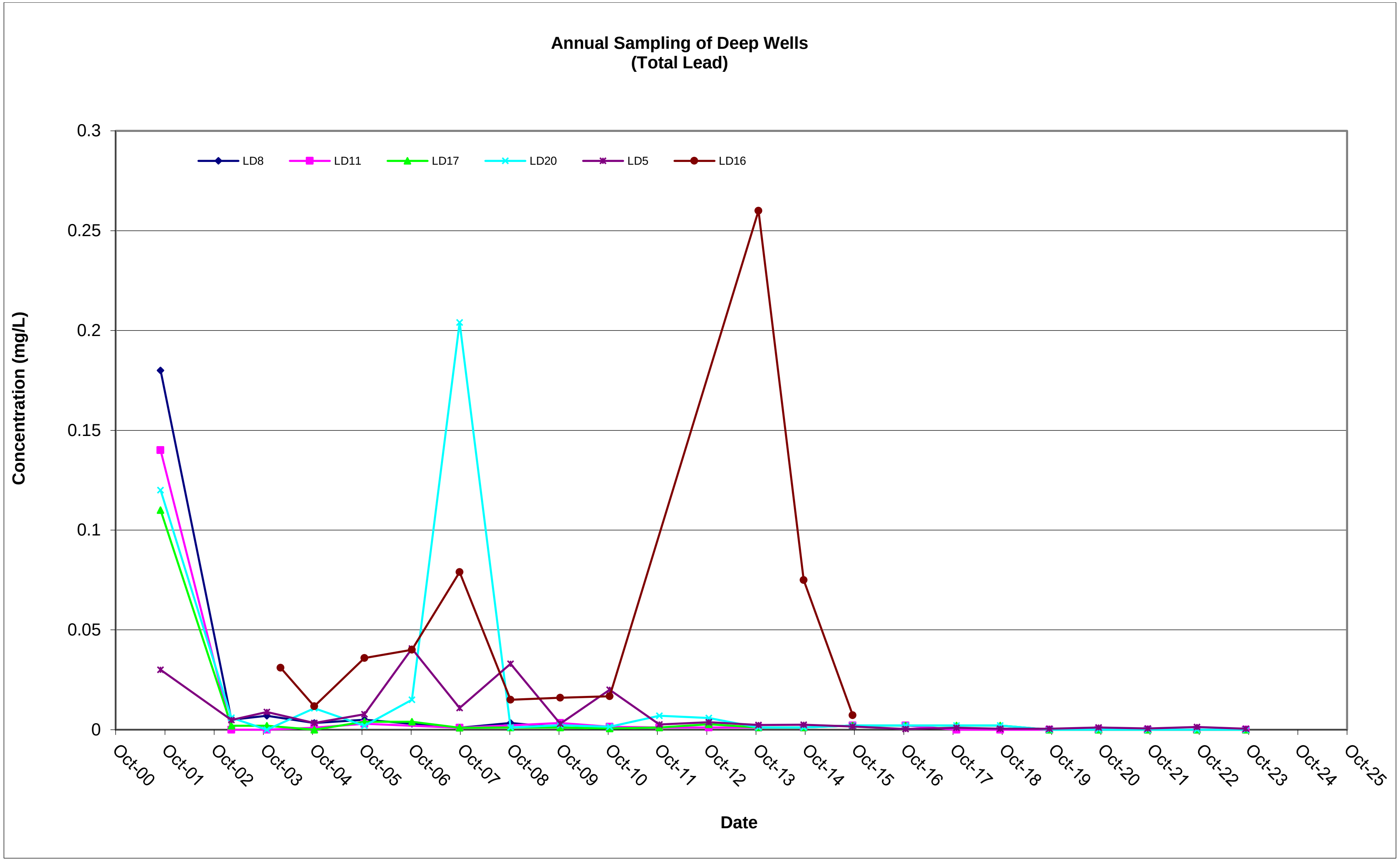

Annual Sampling of Deep Wells
(Sodium)
LD8
LD11
LD17
LD20
LD5
LD16
Concentration (mg/L)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

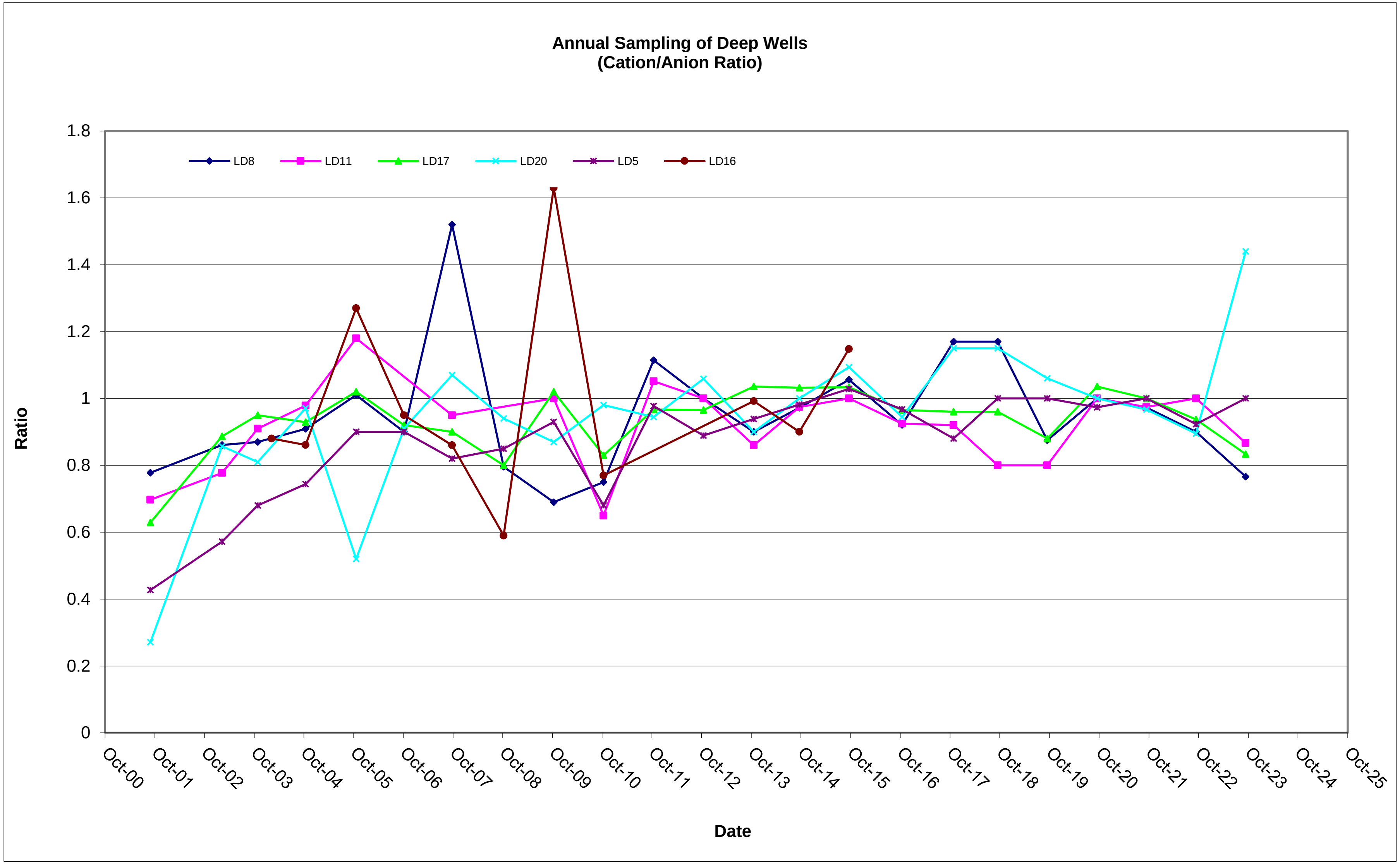

Annual Sampling of Deep Wells
(Chloride)
Concentration (mS/cm)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
LD8
LD11
LD17
LD20
LD5
LD16
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

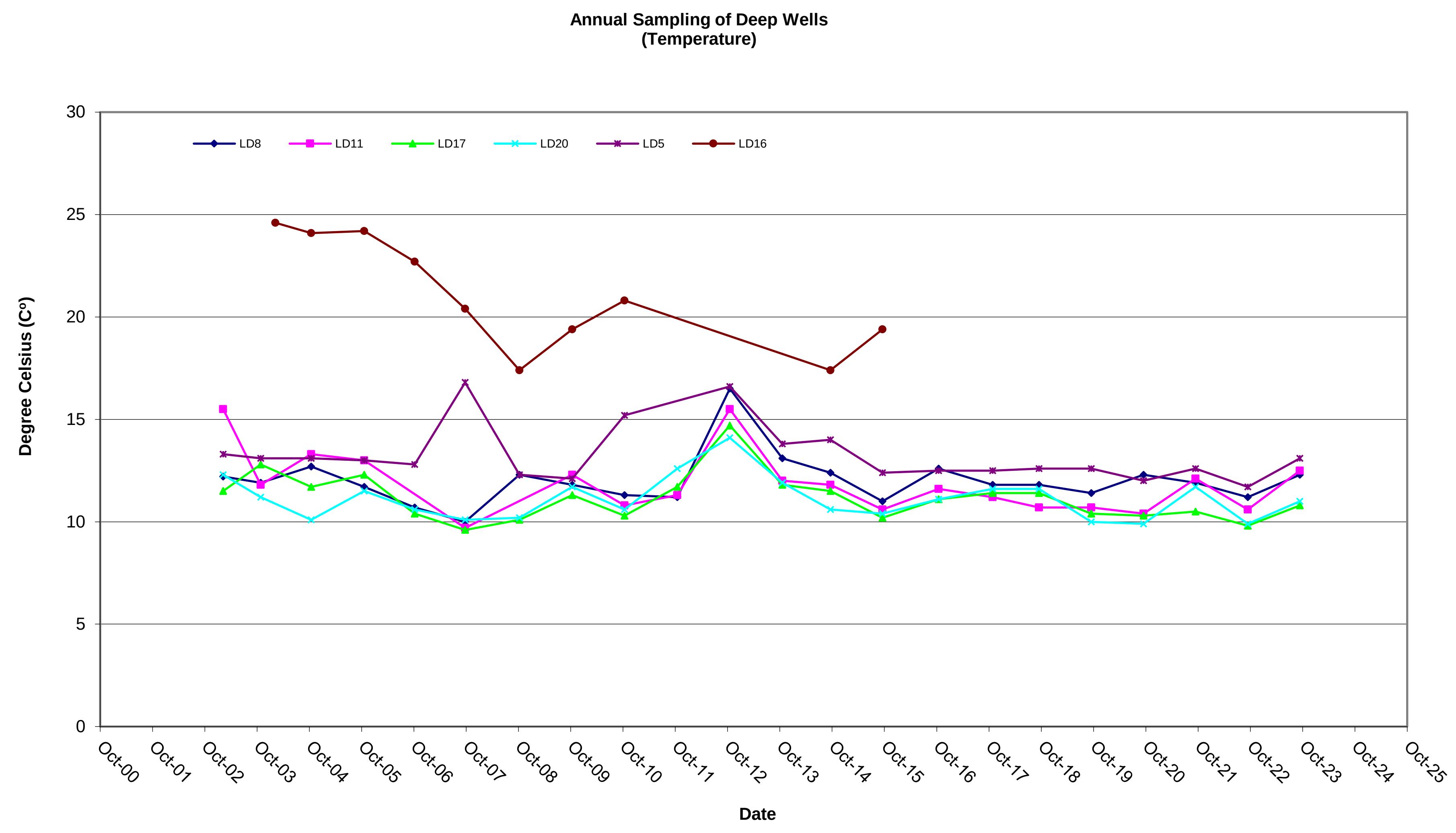

Annual Sampling of Deep Wells
(pH)
pH Units
9
8.5
8
7.5
7
6.5
6
5.5
5
LD8
LD11
LD17
LD20
LD5
LD16
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date


Annual Sampling of Deep Wells
(BOD5)
Concentration (mg/L)
250
200
150
100
50
0
LD8
LD11
LD17
LD20
LD5
LD16
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date


Annual Sampling of Deep Wells
(Nitrate Nitrogen)
LD8
LD11
LD17
LD20
LD5
LD16
Concentration (mg/L)
0
1
2
3
4
5
6
7
8
Date
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25


Annual Sampling of Deep Wells
(Total Lead)
Concentration (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
LD8
LD11
LD17
LD20
LD5
LD16
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date


Annual Sampling of Deep Wells
(Cation/Anion Ratio)
LD8
LD11
LD17
LD20
LD5
LD16
Ratio
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date


Annual Sampling of Deep Wells
(Temperature)
LD8
LD11
LD17
LD20
LD5
LD16
Degree Celsius (C°)
30
25
20
15
10
5
0
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Oct-20
Oct-21
Oct-22
Oct-23
Oct-24
Oct-25
Date

Appendix E: Estuary Groundwater Quality

Table E1: Groundwater Sample Results - Heavy Metals, Nutrients

Sample Name	**SP5**	**SP6**	**SP7**	**SP8**	**SP9**	**SP10**
Sample Depth (m)	1.7	1.6	1.5	1.7	1.6	1.7
Laboratory Reference	1068201.31	1068201.32	1068201.33	1068201.34	1068201.35	1068201.36
Date	8 November 2012	8 November 2012	8 November 2012	8 November 2012	8 November 2012	8 November 2012
pH	7.4	7.1	7.1	7.0	7.0	7.0
Heavy Metals						
Arsenic	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Cadmium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chromium	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Copper	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Lead	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Nickel	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zinc	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nutrients						
Total Ammoniacal-N	9.9	8.9	1.4	7.0	8.0	2.9
Nitrate-N	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Dissolved Reactive Phosphorus	0.038	0.76	0.010	0.142	0.086	0.193

All results in g/m^3. pH results in pH units.

Appendix F: Landfill Gas Monitoring Data

LANDFILL GAS MONITORING RESULTS

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LGS1	Groundwater well (outside landfill)	6/01/2006	0.0	0.0	19.0	-	-
		5/04/2006	0.0	0.0	19.7	-	-
		25/07/2006	0.0	0.0	20.6	-	-
		28/11/2006	0.0	0.0	20.7	-	-
		23/02/2007	0.0	0.0	21.1	-	-
		17/02/2009	0.0	0.0	21.5	0	0
		29/04/2009	0.1	0.5	21.9	0	0
		23/07/2009	0.0	0.0	20.9	0	0
		19/10/2009	0.0	0.1	20.4	0	0
		20/01/2010	0.1	0.2	20.0	0	0
		23/04/2010	0.1	0.3	20.3	0	0
		28/07/2010	0.1	0.2	20.6	0	0
		8/10/2010	0.0	0.1	19.4	0	0
		31/01/2011	0.1	0.4	20.0	0	0
		6/05/2011	0.2	1.1	18.4	0	0
		2/09/2011	1.0	12.5	15.9	0	0
		25/11/2011	0.1	0.2	20.0	0	0
		26/01/2012	0.1	0.2	20.0	0	0
		27/04/2012	0.2	2.6	17.3	0	0
		10/07/2012	0.1	0.8	18.6	0	0
		3/10/2012	0.1	0.4	20.3	0	0
		16/01/2013	0.1	1.1	20.0	3	4
		10/04/2013	0.2	1.3	19.4	0	0
		29/07/2013	0.4	1.5	19.8	0	0
		18/10/2013	0.3	1.4	20.3	0	0
		28/01/2014	0.2	1.0	19.9	0	0
		14/05/2014	0.3	1.5	19.7	0	0
		26/11/2014	0.4	5.4	18.7	0	0
		27/01/2015	0.1	0.6	20.2	2	6
		19/05/2015	0.0	0.1	21.5	0	0
		10/07/2015	0.4	4.4	18.2	0	0
		20/10/2015	0.1	0.5	20.3	0	0
		12/01/2016	0.1	0.5	20.1	2	0
		6/04/2016	0.1	0.6	20.3	0	0
		11/07/2016	0.2	3.2	18.4	0	0
		19/10/2016	0.1	1.6	19.3	0	0
		24/01/2017	0.1	1.0	19.2	2	0
		22/05/2017	0.2	1.0	19.2	0	0
		26/07/2017	0.0	1.6	19.6	0	2
		18/12/2017	0.0	0.9	20.9	0	0
		25/01/2018	0.0	0.6	18.9	0	7
		1/05/2018	0.0	1.9	19.1	0	0
		16/07/2018	0.0	0.8	19.8	4	4
		17/10/2018	0.0	0.8	20.4	1	1
		10/01/2019	0.0	0.4	19.6	3	0
		23/01/2019	0.0	0.9	19.7	0	0
		1/05/2019	0.0	1.0	19.8	0	0
		20/08/2019	0.0	4.7	17.8	0	0
		30/10/2019	0.0	0.6	19.7	0	2
		26/02/2020	0.0	1.2	18.7	0	0
		16/06/2020	0.0	0.2	22.2	0	1
		21/08/2020	0.2	0.7	21.0	0	4
		16/10/2020	0.0	1.2	18.7	0	0
		25/02/2021	0.0	1.2	19.0	0	0
		15/04/2021	0.0	1.1	19.1	0	0
		14/07/2021	0.0	1.0	19.0	0	0
		5/10/2021	0.0	0.6	20.0	0	2
		9/12/2021	0.0	1.1	18.7	0	0
		15/02/2022	0.0	2.1	19.1	0	0
		9/03/2022	0.0	0.1	20.4	0	0
		10/06/2022	0.1	1.5	20.2	0	0
		27/09/2022	0.1	1.2	19.7	0	2
		17/01/2023	0.1	2.0	19.8	0	3
		26/04/2023	0.1	0.3	21.0	0	0
		31/07/2023	0.2	0.2	20.9	0	1
		22/11/2023	0.0	0.5	20.5	0	3

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LS4	Groundwater well (within landfill)	6/01/2006	7.4	4.7	17.3	-	-
		5/04/2006	51.2	36.2	1.4	-	-
		25/07/2006	28.1	21.5	9.6	-	-
		28/11/2006	61.8	40.1	0.0	-	-
		23/02/2007	61.7	39.9	0.0	-	-
		17/04/2007	61.5	39.3	0.0	-	-
		4/07/2007	63.6	40.6	0.1	-	-
		17/02/2009	56.1	38.0	1.3	51	4
		29/04/2009	50.3	32.1	4.9	48	2
		23/07/2009	59.8	42.1	0.4	55	1
		19/10/2009	58.3	37.9	0.7	47	11
		20/01/2010	54.6	36.9	2.0	40	7
		23/04/2010	54.5	36.7	1.2	39	5
		28/07/2010	56.0	35.2	1.3	36	3
		8/10/2010	62.6	34.8	0.7	28	6
		31/01/2011	62.4	37.7	0.6	27	16
		6/05/2011	61.5	35.9	0.7	36	12
		2/09/2011	45.8	26.0	5.5	10	0
		25/11/2011	54.0	34.3	3.5	71	14
		26/01/2012	56.6	40.1	0.9	106	19
		27/04/2012	Well not accessible				
		10/07/2012	24.4	20.2	10.9	62	43
		3/10//12	45.5	33.9	4.4	Over limit (>500)	80
		16/01/2013	56.7	41.7	0.4	Over limit (>500)	119
		10/04/2013	57.9	43.4	0.0	Over limit (>500)	111
		29/07/2013	62.1	42.6	0.0	Over limit (>500)	104
		18/10/2013	60.2	42.6	0.0	Over limit (>500)	84
		28/01/2014	60.5	42.1	0.0	Over limit (>500)	86
		14/05/2014	60.3	40.0	0.0	161	33
		26/11/2014	58.0	41.6	0.4	Over limit (>500)	104
		27/01/2015	53.3	38.7	1.1	192	72
		19/05/2015	61.7	40.4	0.3	181	3
		10/07/2015	65.0	41.0	0.0	Over limit (>500)	69
		20/10/2015	60.1	41.2	0.0	171	59
		12/01/2016	59.3	40.8	0.1	146	49
		6/04/2016	59.9	41.2	0.2	183	61
		11/07/2016	65.4	40.2	0.0	157	65
		19/10/2016	62.6	39.9	0.0	142	71
		24/01/2017	62.3	40.1	0.0	119	62
		22/05/2017	66.0	39.8	0.0	104	81
		26/07/2017	64.2	39.5	0.0	92	9
		18/12/2017	66.7	40.1	0.0	83	0
		25/01/2018	67.0	40.3	0.0	88	14
		1/05/2018	66.9	38.8	0.0	94	0
		16/07/2018	57.2	39.1	0.0	89	5
		17/10/2018	60.6	38.8	0.0	66	10
		10/01/2019	55.1	38.9	0.2	90	5
		23/01/2019	59.3	39.8	0.0	78	5
		1/05/2019	61.8	38.7	0.3	73	3
		20/08/2019	52.3	34.7	2.2	55	0
		30/10/2019	Buried - no longer able to be monitored				

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LD5	Groundwater well (outside operational landfill although installed within historical landfill - deep well)	6/01/2006	0.0	0.0	19.0	-	-
		5/04/2006	0.0	0.0	19.7	-	-
		25/07/2006	0.0	0.0	20.6	-	-
		28/11/2006	0.0	0.0	20.7	-	-
		23/02/2007	0.0	0.0	21.1	-	-
		17/04/2007	0.0	0.0	20.4	-	-
		17/02/2009	0.0	0.0	21.5	0	0
		29/04/2009	0.0	0.0	21.6	0	0
		23/07/2009	0.0	0.1	20.9	0	0
		19/10/2009	0.5	3.0	16.5	0	0
		20/01/2010	0.2	0.2	19.9	0	0
		23/04/2010	0.0	0.1		0	0
		28/07/2010	0.1	0.4	20.4	0	0
		8/10/2010	2.5	9.3	11.3	0	0
		31/01/2011	0.2	1.9	18.7	0	0
		6/05/2011	0.2	2.0	17.7	0	0
		2/09/2011	0.2	5.5	13.8	0	0
		25/11/2011	0.4	3.0	17.7	0	0
		26/01/2012	0.4	2.0	18.1	0	0
		27/04/2012	0.2	1.8	17.7	0	0
		10/07/2012	0.2	4.5	16.3	0	0
		3/10/2012	1.7	9.1	15.4	0	0
		16/01/2013	1.0	4.6	15.4	2	6
		10/04/2013	0.3	3.2	17.3	0	0
		29/07/2013	0.4	4.0	16.6	0	0
		18/10/2013	1.1	7.3	11.8	0	0
		28/01/2014	0.4	6.8	13.3	0	0
		14/05/2014	0.7	3.7	19.1	0	0
		26/11/2014	0.0	5.2	16.4	0	0
		27/01/2015	0.1	0.9	19.2	2	7
		19/05/2015	0.5	2.4	19.7	0	0
		10/07/2015	0.8	6.0	16.6	0	0
		20/10/2015	0.2	5.8	16.2	0	0
		12/01/2016	0.2	1.9	18.5	0	0
		6/04/2016	0.2	1.5	19.5	0	0
		11/07/2016	1.4	5.2	17.8	0	0
		19/10/2016	0.6	3.5	17.7	0	0
		24/01/2017	0.0	0.5	19.5	2	0
		22/05/2017	0.2	1.2	18.6	3	0
		26/07/2017	0.6	3.2	18.4	0	1
		18/12/2017	0.0	2.3	19.6	0	0
		25/01/2018	0.0	1.1	18.4	0	7
		1/05/2018	0.0	1.5	19.2	0	0
		16/07/2018	0.1	8.0	15.2	2	4
		17/10/2018	0.0	1.1	20.0	1	1
		10/01/2019	0.0	0.7	19.2	4	0
		23/01/2019	0.0	0.1	20.8	0	0
		1/05/2019	0.0	0.0	20.7	0	0
		20/08/2019	0.0	0.2	21.3	0	0
		22/10/2019	0.0	0.0	19.7	0	3
		26/02/2020	0.0	0.1	19.7	0	0
		16/06/2020	0.1	0.5	20.8	0	0
		21/08/2020	0.1	0.2	21.2	0	4
		16/10/2020	0.0	0.2	19.7	0	0
		25/02/2021	0.0	0.1	19.9	0	0
		15/04/2021	0.0	0.1	20.0	0	0
		14/07/2021	0.0	0.2	18.8	0	0
		5/10/2021	0.3	2.7	19.3	0	2
		9/12/2021	0.0	0.4	19.8	0	1
		15/02/2022	0.0	1.2	19.6	0	1
		9/03/2022	0.0	1.1	20.1	0	0
		10/06/2022	1.8	4.7	18.7	0	1
		27/09/2022	0.0	3.5	18.0	0	1
		17/01/2023	0.0	0.8	20.3	0	3
		26/04/2023	0.2	2.5	19.2	0	0
		31/07/2023	1.4	7.3	16.9	0	0
		22/11/2023	0.1	6.4	15.9	0	3

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LGS7	Groundwater well (outside landfill)	6/01/2006	0.0	0.0	19.5	-	-
		5/04/2006	0.0	0.0	19.7	-	-
		25/07/2006	0.0	0.0	20.2	-	-
		28/11/2006	0.0	0.0	20.2	-	-
		23/02/2007	0.0	0.0	20.3	-	-
		17/04/2007	0.0	0.0	20.0	-	-
		4/07/2007	0.0	0.0	19.9	-	-
		17/02/2009	0.0	0.0	20.9	0	0
		29/04/2009	0.0	0.0	21.2	0	0
		23/07/2009	0.0	2.0	20.7	0	0
		19/10/2009	0.0	0.2	20.4	0	0
		20/01/2010	0.2	2.4	19.3	0	0
		23/04/2010	0.0	1.1	20.2	0	0
		28/07/2010	0.1	0.8	20.3	0	0
		8/10/2010	0.1	0.4	19.3	0	0
		31/01/2011	0.0	0.5	20.2	0	0
		6/05/2011	0.2	7.1	16.9	0	0
		2/09/2011	0.1	1.7	18.8	0	0
		25/11/2011	0.1	0.7	19.6	0	0
		26/01/2012	0.1	0.9	18.8	0	0
		27/04/2012	0.1	0.9	18.3	0	0
		10/07/2012	0.1	0.9	19.2	0	0
		3/10/2012	0.1	0.3	20.4	0	0
		16/01/2013	0.0	0.3	20.3	2	5
		10/04/2013	0.1	1.1	20.3	0	0
		29/07/2013	0.1	2.7	19.7	0	0
		18/10/2013	0.1	1.0	20.8	0	0
		28/01/2014	0.2	0.4	20.4	0	0
		14/05/2014	0.2	3.4	19.9	0	0
		26/11/2014	0.0	0.4	20.6	0	0
		27/01/2015	0.0	0.2	20.2	2	2
		19/05/2015	0.0	2.4	21.1	0	0
		10/07/2015	0.3	3.9	18.9	0	0
		20/10/2015	0.1	1.7	20.2	0	0
		12/01/2016	0.0	0.4	20.5	1	0
		6/04/2016	0.1	0.6	20.6	0	0
		11/07/2016	0.2	0.1	21.0	0	0
		19/10/2016	0.1	0.1	20.1	0	0
		24/01/2017	0.0	0.3	19.7	1	0
		22/05/2017	0.1	0.5	19.0	3	0
		26/07/2017	0.0	1.6	19.6	0	1
		18/12/2017	0.0	0.1	21.3	0	0
		25/01/2018	0.0	0.0	19.7	0	3
		1/05/2018	0.0	0.9	20.2	0	0
		16/07/2018	0.0	3.8	19.3	1	4
		17/10/2018	0.0	0.6	20.6	1	1
		10/01/2019	0.0	0.1	19.7	4	0
		23/01/2019	0.0	0.1	20.7	0	0
		1/05/2019	0.0	0.1	20.7	0	0
		20/08/2019	0.0	2.1	20.8	0	0
		30/10/2019	0.0	0.5	19.5	0	3
		26/02/2020	0.0	0.2	19.7	0	2
		16/06/2020	0.0	4.5	19.5	0	0
		21/08/2020	0.1	1.3	21.0	0	4
		16/10/2020	0.0	0.2	19.7	0	2
		25/02/2021	0.0	0.2	20.0	0	1
		15/04/2021	0.0	0.2	19.7	0	1
		14/07/2021	0.0	0.2	18.6	0	1
		5/10/2021	0.2	1.6	19.8	0	4
		9/12/2021	0.0	0.1	20.3	0	1
		15/02/2022	0.0	0.4	20.7	1	1
		9/03/2022	0.0	0.4	20.3	0	0
		10/06/2022	0.0	4.7	19.4	0	0
		27/09/2022	0.0	0.3	19.9	0	2
		17/01/2023	0.0	0.2	20.5	0	3
		26/04/2023	0.1	3.0	20.5	0	0
		31/07/2023	0.2	0.3	21.0	0	0
		22/11/2023	0.0	2.8	19.0	0	3

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LGS27	Leachate collection system	6/01/2006	0.0	0.0	19.7	-	-
		5/04/2006	0.0	0.0	19.8	-	-
		25/07/2006	0.0	0.0	20.6	-	-
		28/11/2006	0.0	0.1	20.8	-	-
		23/02/2007	-	-	-	-	-
		17/04/2007	0.0	0.0	20.1	-	-
		4/07/2007	4.3	3.5	16.7	-	-
		17/02/2009	0.0	0.0	21.0	0	0
		29/04/2009	2.5	0.7	21.3	0	0
		23/07/2009	0.2	0.6	20.9	0	0
		19/10/2009	0.2	0.1	20.0	0	0
		20/01/2010	0.1	0.1	19.6	0	0
		23/04/2010	0.0	0.1	20.6	0	0
		28/07/2010	0.3	0.4	20.5	0	0
		8/10/2010	1.4	0.8	19.5	0	0
		31/01/2011	1.0	0.9	19.8	0	0
		6/05/2011	22.1	10.2	13.7	0	0
		2/09/2011	10.9	6.4	17.0	0	0
		25/11/2011	0.0	0.1	21.2	0	0
		26/01/2012	0.0	0.1	20.0	0	0
		27/04/2012	6.1	2.5	17.0	0	0
		10/07/2012	0.1	0.1	19.4	0	0
		3/10/2012	0.2	0.2	20.5	0	0
		16/01/2013	0.7	0.7	19.3	3	6
		10/04/2013	0.1	0.2	20.6	0	0
		29/07/2013	5.4	2.3	19.1	3	0
		18/10/2013	0.6	0.4	20.8	0	0
		28/01/2014	0.2	0.1	20.3	0	0
		14/05/2014	2.4	0.9	20.6	0	0
		26/11/2014	0.4	0.3	20.4	2	2
		27/01/2015	0.0	0.1	20.1	4	2
		19/05/2015	0.0	0.1	21.8	0	0
		10/07/2015	8.3	4.8	17.8	0	0
		20/10/2015	1.0	0.5	20.4	0	0
		12/01/2016	0.0	0.1	20.2	2	0
		6/04/2016	0.0	0.1	20.8	0	0
		11/07/2016	3.1	1.0	20.5	0	0
		19/10/2016	4.0	2.3	18.8	0	0
		24/01/2017	0.7	0.5	19.5	2	0
		22/05/2017	4.9	2.0	18.3	2	0
		26/07/2017	30.3	14.3	11.2	0	2
		18/12/2017	0.0	0.1	21.4	0	0
		25/01/2018	0.0	0.0	20.0	1	2
		1/05/2018	0.0	0.1	20.4	0	0
		16/07/2018	0.0	0.1	20.4	1	3
		17/10/2018	0.5	0.3	20.7	1	1
		10/01/2019	0.0	0.3	19.5	4	0
		23/01/2019	0.0	0.2	20.2	0	0
		1/05/2019	0.3	0.2	20.7	0	0
		20/08/2019	29.7	18.4	10.8	0	0
		30/10/2019	0.0	0.1	19.5	0	2
		26/02/2020	0.0	0.1	19.9	0	1
		16/06/2020	0.0	0.1	21.0	0	0
		21/08/2020	0.1	0.1	21.5	0	4
		16/10/2020	0.0	0.1	19.8	0	2
		25/02/2021	0.0	0.1	20.1	0	2
		15/04/2021	0.0	1.0	19.9	0	2
		14/07/2021	0.0	0.2	18.6	0	2
		5/10/2021	0.1	0.2	20.7	0	2
		9/12/2021	0.0	0.1	20.1	0	1
		15/02/2022	0.0	0.3	20.4	1	1
		9/03/2022	0.0	0.4	20.8	0	0
		10/06/2022	0.0	0.2	20.9	0	0
		27/09/2022	0.0	0.1	20.4	0	2
		17/01/2023	0.0	0.2	20.5	0	2
		26/04/2023	0.0	0.0	21.6	0	0
		31/07/2023	0.0	0.1	20.7	0	0
		22/11/2023	0.0	2.8	19.0	0	3

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LGS29	Leachate collection system	6/01/2006	0.0	0.0	19.2	-	-
		5/04/2006	0.0	0.0	19.8	-	-
		25/07/2006	23.8	12.9	12.1	-	-
		28/11/2006	9.9	5.6	17.1	-	-
		23/02/2007	0.0	0.0	20.8	-	-
		17/04/2007	0.2	0.1	20.1	-	-
		4/07/2007	22.3	11.7	12.9	-	-
		17/02/2009	7.2	7.2	15.9	0	0
		29/04/2009	0.5	0.6	21.6	0	0
		23/07/2009	0.0	0.0	21.1	0	0
		19/10/2009	0.1	0.1	20.7	0	0
		20/01/2010	0.3	0.2	19.7	0	0
		23/04/2010	0.0	0.1	20.6	0	0
		28/07/2010	0.5	0.4	20.5	0	0
		8/10/2010	0.1	0.0	20.1	0	0
		31/01/2011	0.0	0.0	20.6	0	3
		6/05/2011	0.3	0.2	19.3	0	0
		2/09/2011	0.5	0.3	19.8	0	0
		25/11/2011	0.5	0.3	20.9	0	0
		26/01/2012	0.1	0.1	20.2	0	0
		27/04/2012	0.6	0.3	19.1	0	0
		10/07/2012	0.1	0.2	19.2	0	0
		3/10/2012	0.3	0.2	20.5	0	0
		16/01/2013	0.0	0.0	20.3	3	7
		10/04/2013	0.1	0.1	20.7	0	0
		29/07/2013	0.5	0.3	20.5	2	0
		18/10/2013	0.2	0.2	20.9	0	0
		28/01/2014	0.2	0.2	20.3	0	0
		14/05/2014	0.2	0.1	21.3	0	0
		26/11/2014	0.0	0.0	20.5	1	2
		27/01/2015	0.1	0.1	20.0	2	5
		19/05/2015	0.1	0.1	21.7	0	0
		10/07/2015	0.3	0.5	19.7	0	0
		20/10/2015	0.9	0.6	20.3	0	0
		12/01/2016	0.4	0.3	20.3	2	1
		6/04/2016	0.1	0.1	20.7	0	0
		11/07/2016	0.3	0.2	21.0	0	0
		19/10/2016	0.8	0.5	19.8	0	0
		24/01/2017	0.0	0.1	19.8	2	0
		22/05/2017	2.1	1.2	18.8	2	0
		26/07/2017	0.0	0.1	20.3	0	2
		18/12/2017	5.2	3.3	19.7	0	0
		25/01/2018	10.0	5.5	17.3	2	3
		1/05/2018	0.8	0.6	20.3	0	0
		16/07/2018	0.0	0.1	20.5	1	3
		17/10/2018	0.3	0.1	20.8	1	1
		10/01/2019	57.2	36.5	0.2	23	10
		23/01/2019	0.8	0.4	20.3	0	0
		1/05/2019	63.8	37.4	0.3	13	1
		20/08/2019	53.4	32.3	2.6	18	0
		30/10/2019	63.7	35.5	0.0	0	2
		26/02/2020	0.0	0.2	19.8	0	2
		16/06/2020	0.1	0.1	21.0	0	1
		21/08/2020	0.5	0.3	21.7	0	4
		16/10/2020	0.0	0.1	19.8	0	2
		25/02/2021	0.0	0.1	20.1	0	2
		15/04/2021	0.0	0.1	19.7	0	2
		14/07/2021	0.0	0.1	20.2	0	2
		5/10/2021	0.1	0.1	20.8	0	3
		9/12/2021	0.0	0.0	19.7	0	1
		15/02/2022	0.2	0.1	20.5	1	1
		9/03/2022	61.0	37.2	2.0	1	5
		10/06/2022	0.3	0.2	21.0	0	1
		27/09/2022	56.2	30.9	2.6	12	4
		17/01/2023	54.3	30.9	2.2	23	4
		26/04/2023	0.1	0.1	21.6	0	0
		31/07/2023	0.5	0.2	20.8	0	0
		22/11/2023	0.4	0.4	21.0	0	3

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LS31	Leachate collection system	6/01/2006	0.0	0.0	20.3	-	-
		5/04/2006	0.0	0.0	19.9	-	-
		25/07/2006	0.0	0.0	20.6	-	-
		28/11/2006	0.0	0.0	20.8	-	-
		23/02/2007	0.0	0.0	20.8	-	-
		17/04/2007	0.0	0.0	20.4	-	-
		4/07/2007	0.1	0.0	20.1	-	-
		17/02/2009	0.0	0.0	21.0	0	0
		29/04/2009	0.0	0.0	21.8	0	0
		23/07/2009	0.0	0.0	21.2	0	0
		19/10/2009	0.1	0.1	19.0	0	0
		20/01/2010	0.1	0.1	19.6	0	0
		23/04/2010	0.0	0.1	20.7	0	0
		28/07/2010	0.1	0.2	20.7	0	0
		8/10/2010	0.0	0.0	20.4	0	0
		31/01/2011	0.0	0.0	20.9	0	3
		6/05/2011	0.1	0.1	19.3	0	0
		2/09/2011	0.1	0.1	20.1	0	0
		25/11/2011	0.1	0.0	21.3	0	0
		26/01/2012	0.0	0.1	20.2	0	0
		27/04/2012	0.3	0.1	19.6	0	0
		10/07/2012	0.1	0.1	19.1	0	0
		3/10/2012	0.1	0.1	20.6	0	0
		16/01/2013	0.0	0.0	20.2	3	8
		10/04/2013	0.1	0.1	20.8	0	0
		29/07/2013	0.1	0.1	20.6	2	0
		18/10/2013	0.1	0.1	20.9	0	0
		28/01/2014	0.2	0.1	20.3	0	0
		14/05/2014	0.4	0.2	21.2	0	0
		26/11/2014	0.0	0.1	20.4	1	3
		27/01/2015	0.1	0.0	20.1	3	7
		19/05/2015	0.0	0.1	21.8	0	0
		10/07/2015	0.2	0.1	20.2	0	0
		20/10/2015	0.1	0.1	20.6	0	0
		12/01/2016	0.1	0.0	20.5	2	2
		6/04/2016	0.0	0.0	20.8	0	0
		11/07/2016	0.2	0.1	21.0	0	0
		19/10/2016	0.1	0.1	20.0	0	0
		24/01/2017	0.0	0.2	19.9	2	0
		22/05/2017	0.1	0.2	19.5	0	0
		26/07/2017	0.0	0.1	20.3	0	2
		18/12/2017	0.0	0.1	21.5	0	0
		25/01/2018	0.0	0.0	20.2	1	2
		1/05/2018	0.0	0.2	20.7	0	0
		16/07/2018	0.0	0.3	20.5	1	1
		17/10/2018	0.0	0.1	20.8	1	1
		10/01/2019	0.0	0.1	19.8	4	96
		23/01/2019	0.0	0.1	20.6	0	0
		1/05/2019	0.2	0.2	20.8	0	0
		20/08/2019	0.0	0.3	21.6	0	0
		30/10/2019	0.0	0.9	18.9	1	0
		26/02/2020	0.0	0.2	20.1	0	1
		16/06/2020	0.0	0.1	21.1	0	0
		21/08/2020	0.0	0.1	21.7	0	4
		16/10/2020	0.0	0.2	19.8	0	2
		25/02/2021	0.0	0.2	19.9	0	2
		15/04/2021	0.0	0.2	20.0	0	2
		14/07/2021	0.0	0.2	19.9	0	2
		5/10/2021	0.1	0.1	21.0	0	1
		9/12/2021	0.0	0.4	19.5	0	1
		15/02/2022	0.0	0.2	19.8	1	2
		9/03/2022	0.3	0.2	20.5	0	0
		10/06/2022	0.0	0.2	21.0	0	1
		27/09/2022	0.1	0.6	19.6	0	2
		17/01/2023	0.4	1.4	19.4	0	3
		26/04/2023	0.1	0.9	21.1	0	0
		31/07/2023	0.3	1.8	20.0	0	0
		22/11/2023	0.0	0.6	20.9	0	2

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
LS32	Leachate collection system	23/02/2007	0.1	0.0	21.1	-	-
		17/04/2007	0.0	0.0	20.2	-	-
		4/07/2007	0.0	0.0	20.1	-	-
		17/02/2009	0.9	2.4	19.9	0	0
		29/04/2009	4.9	6.5	19.2	0	0
		23/07/2009	12.8	14.6	15.2	0	0
		19/10/2009	0.1	0.2	21.0	0	0
		20/01/2010	12.1	10.6	13.5	0	0
		23/04/2010	2.9	5.9	17.8	0	0
		28/07/2010	0.8	6.4	18.8	0	0
		8/10/2010	19.0	20.6	11.9	0	4
		31/01/2011	0.1	0.3	20.7	0	2
		6/05/2011	1.6	13.6	16.1	0	0
		2/09/2011	0.9	8.6	18.1	0	0
		25/11/2011	0.1	0.5	21.7	0	4
		26/01/2012	0.4	1.1	19.7	0	0
		27/04/2012	0.3	2.0	19.3	0	0
		10/07/2012	0.1	0.3	19.1	0	0
		3/10/2012	0.9	1.0	20.2	0	0
		16/01/2013	3.3	18.7	14.9	5	11
		10/04/2013	0.1	0.1	20.7	0	0
		29/07/2013	0.4	4.4	19.5	2	0
		18/10/2013	0.8	1.4	20.3	0	0
		28/01/2014	0.2	0.3	20.1	0	0
		14/05/2014	2.8	11.3	17.4	0	0
		26/11/2014	0.0	0.2	20.3	2	3
		27/01/2015	24.2	16.7	11.9	5	12
		19/05/2015	34.1	24.6	8.7	4	1
		10/07/2015	42.2	30.6	5.8	0	0
		20/10/2015	50.5	32.5	3.2	2	0
		12/01/2016	16.2	23.5	11.9	5	12
		6/04/2016	3.2	2.0	19.7	0	0
		11/07/2016	40.2	26.9	6.7	0	0
		19/10/2016	62.3	37.9	0.0	0	0
		24/01/2017	43.2	28.7	5.2	5	4
		22/05/2017	51.0	33.8	2.6	0	0
		26/07/2017	0.6	6.8	18.8	0	2
		18/12/2017	60.4	35.8	1.6	0	0
		25/01/2018	1.8	1.8	19.8	2	6
		1/05/2018	33.1	24.7	8.6	0	0
		16/07/2018	57.5	37.1	0.3	3	4
		17/10/2018	50.2	31.6	2.4	2	3
		10/01/2019	56.4	37.5	0.1	23	10
		23/01/2019	54.2	35.9	1.2	3	2
		1/05/2019	6.9	4.1	18.7	0	0
		20/08/2019	51.1	32.1	3.0	0	0
		30/10/2019	39.7	28.3	5.4	7	3
		26/02/2020	34.6	22.2	7.8	0	5
		16/06/2020	54.1	32.2	3.0	1	1
		21/08/2020	48.7	32.7	3.6	3	8
		16/10/2020	35.6	22.3	7.7	0	5
		25/02/2021	20.4	18.8	8.8	0	0
		15/04/2021	32.6	21.7	7.9	0	4
		14/07/2021	32.2	18.1	7.8	0	4
		5/10/2021	37.6	22.5	9.0	0	3
		9/12/2021	62.1	35.1	0.4	1	3
		15/02/2022	54.1	35.7	2.9	9	4
		9/03/2022	27.5	17.2	11.6	1	0
		10/06/2022	0.9	9.5	18.2	2	2
		27/09/2022	45.8	29.9	4.3	6	3
		17/01/2023	44.7	26.5	4.8	3	4
		26/04/2023	Not measured				
		31/07/2023	6.6	27.1	13.0	1	2
		22/11/2023	55.5	32.4	1.8	0	5

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
G34	Landfill gas well	6/01/2006	0.0	0.0	19.5	-	-
		5/04/2006	0.0	0.0	19.8	-	-
		25/07/2006	0.0	0.0	20.2	-	-
		28/11/2006	0.0	0.0	20.8	-	-
		23/02/2007	0.0	0.0	20.8	-	-
		17/04/2007	0.0	0.0	20.2	-	-
		4/07/2007	0.0	0.0	20.1	-	-
		17/02/2009	0.0	0.0	20.1	0	0
		29/04/2009	0.0	0.0	20.4	0	0
		23/07/2009	0.3	0.0	20.1	0	0
		19/10/2009	0.0	0.0	20.8	0	0
		20/01/2010	0.2	0.2	19.6	0	0
		23/04/2010	0.0	0.1	20.7	0	0
		28/07/2010	0.1	0.4	20.5	0	0
		8/10/2010	0.1	0.1	20.6	0	2
		31/01/2011	0.0	0.2	20.4	0	3
		6/05/2011	0.2	0.2	19.4	0	0
		2/09/2011	0.1	0.2	20.0	0	0
		25/11/2011	0.2	0.2	19.9	0	2
		26/01/2012	0.2	0.2	19.9	0	1
		27/04/2012	0.2	0.2	19.6	0	0
		10/07/2012	0.2	0.3	19.0	0	0
		3/10/2012	0.3	0.2	20.4	0	0
		16/01/2013	0.1	0.2	20.2	4	9
		10/04/2013	0.1	0.1	20.6	0	0
		29/07/2013	0.2	0.1	20.3	1	0
		18/10/2013	0.1	0.1	20.9	0	0
		28/01/2014	0.2	0.1	20.4	0	0
		14/05/2014	0.2	0.2	21.1	0	0
		26/11/2014	0.0	0.1	20.4	3	4
		27/01/2015	0.1	0.0	20.1	4	11
		19/05/2015	0.0	0.2	21.8	0	0
		10/07/2015	0.2	0.4	20.3	0	0
		20/10/2015	0.1	0.1	20.7	0	0
		12/01/2016	0.2	0.0	18.9	3	14
		6/04/2016	0.1	0.1	20.7	0	0
		11/07/2016	0.1	0.3	20.7	0	0
		19/10/2016	0.1	0.1	20.2	0	0
		24/01/2017	0.0	0.1	20.2	2	1
		22/05/2017	0.1	0.2	19.4	0	0
		26/07/2017	0.0	0.4	20.2	0	2
		18/12/2017	0.0	0.1	21.5	0	0
		25/01/2018	0.0	0.0	20.2	1	3
		1/05/2018	0.0	0.1	20.3	0	0
		16/07/2018	0.0	0.5	19.9	2	2
		17/10/2018	0.0	0.4	20.3	1	1
		10/01/2019	0.0	0.1	19.9	4	180
		23/01/2019	0.0	0.1	20.3	0	0
		1/05/2019	0.0	0.1	20.4	0	0
		20/08/2019	0.0	0.1	20.4	0	0
		30/10/2019	0.0				
		26/02/2020	0.0	0.1	19.9	0	2
		16/06/2020	0.1	0.2	21.1	0	0
		21/08/2020	0.1	0.1	21.3	0	0
		16/10/2020	0.0	0.1	19.8	0	2
		25/02/2021	0.0	0.2	19.9	0	1
		15/04/2021	0.0	0.1	20.0	0	2
		14/07/2021	0.0	0.1	19.9	0	2
		5/10/2021	0.1	0.2	20.8	0	1
		9/12/2021	0.0	0.1	20.0	0	3
		15/02/2022	0.0	0.1	19.8	0	1
		9/03/2022	0.0	0.2	20.1	0	2
		10/06/2022	0.0	0.2	20.0	1	1
		27/09/2022	0.0	0.3	18.9	0	2
		17/01/2023	0.0	0.1	20.2	1	3
		26/04/2023	0.1	0.2	21.4	0	0
		31/07/2023	0.2	0.1	21.0	0	0
		22/11/2023	0.0	0.1	20.9	0.0	3.0

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
G35	Cesspit	6/01/2006	0.0	0.0	20.0	-	-
		5/04/2006	0.0	0.0	19.8	-	-
		25/07/2006	0.0	0.0	20.1	-	-
		28/11/2006	0.0	0.0	20.7	-	-
		23/02/2007	0.0	0.0	20.4	-	-
		17/04/2007	0.0	0.0	20.4	-	-
		4/07/2007	0.0	0.0	20.1	-	-
		17/02/2009	0.0	0.0	21.6	0	0
		29/04/2009	0.0	0.1	21.6	0	0
		23/07/2009	0.0	0.0	21.0	0	0
		19/10/2009	0.0	0.0	21.2	0	0
		31/01/2011	0.1	0.4	20.1	0	0
		6/05/2011	0.1	0.1	19.5	0	0
		2/09/2011	0.1	0.0	21.0	0	0
		25/11/2011	0.1	0.1	20.5	0	0
		26/01/2012	0.0	0.1	21.0	0	0
		27/04/2012	0.1	0.1	19.6	0	0
		10/07/2012	0.1	0.1	19.0	0	0
		3/10/2012	0.1	0.1	20.7	0	0
		16/01/2013	0.1	0.1	20.4	2	3
		10/04/2013	0.1	0.1	20.9	0	0
		29/07/2013	0.1	0.0	20.4	1	0
		18/10/2013	0.1	0.1	20.7	0	0
		28/01/2014	0.2	0.1	20.7	0	0
		14/05/2014	0.2	0.1	21.4	0	0
		26/11/2014	0.0	0.1	20.5	0	0
		27/01/2015	0.0	0.0	20.8	2	5
		19/05/2015	0.0	0.1	21.6	0	0
		10/07/2015	0.2	0.1	20.6	0	0
		20/10/2015	0.0	0.0	21.1	0	0
		12/01/2016	0.2	0.1	18.5	2	20
		6/04/2016	0.1	0.1	20.5	0	0
		11/07/2016	0.1	0.1	21.1	0	0
		19/10/2016	0.1	0.1	20.3	0	0
		24/01/2017	0.0	0.0	20.5	4	5
		22/05/2017	0.2	0.1	19.2	0	0
		26/07/2017	0.0	0.0	20.6	0	3
		18/12/2017	0.0	0.1	20.9	0	0
		25/01/2018	0.0	0.1	20.8	0	0
		1/05/2018	0.0	0.2	20.3	0	0
		16/07/2018	0.0	0.1	20.4	1	3
		17/10/2018	0.0	0.0	19.8	0	1
		10/01/2019	0.0	0.0	19.8	6	180
		23/01/2019	0.0	0.2	20.5	0	0
		1/05/2019	0.0	0.1	20.4	0	0
		20/08/2019	0.0	0.0	20.9	0	0
		30/10/2019	0.0	0.1	19.9	0	2
		26/02/2020	0.0	0.1	19.7	0	0
		16/06/2020	0.0	0.1	21.0	0	0
		21/08/2020	0.0	0.0	21.1	0	3
		16/10/2020	0.0	0.1	19.9	0	0
		25/02/2021	0.0	0.1	21.4	0	0
		15/04/2021	0.0	0.1	21.4	0	1
		14/07/2021	0.0	0.1	21.0	0	0
		5/10/2021	0.0	0.1	20.3	0	0
		9/12/2021	0.0	0.1	20.1	0	0
		15/02/2022	0.0	0.1	20.2	0	1
		9/03/2022	0.0	0.0	20.8	0	0
		10/06/2022	0.0	0.2	20.9	0	0
		27/09/2022	0.0	0.1	20.5	0	1
		17/01/2023	0.0	0.2	20.8	0	3
		26/04/2023	0.0	0.1	20.2	0	0
		31/07/2023	0.0	0.1	20.6	0	0
		22/11/2023	0.0	0.0	21.0	0	2

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
G36	Basement of house	23/07/2009	0.0	0.0	20.8	0	0
		20/01/2010	0.1	0.1	20.1	0	0
		23/04/2010	0.0	0.1	20.7	0	0
		28/07/2010	0.1	0.1	20.3	0	0
		31/01/2011	-	-	-	-	-
		6/05/2011	0.1	0.1	19.4	0	0
		2/09/2011	0.1	0.0	20.8	0	0
		25/11/2011	-	-	-	-	-
		26/01/2012	0.1	0.1	20.7	0	0
		27/04/2012	-	-	-	-	-
		10/07/2012	0.1	0.1	19.0	-	-
		3/10/2012	-	-	-	-	-
		16/01/2013	0.1	0.1	20.0	2	2
		10/04/2013	0.1	0.1	21.0	0	0
		29/07/2013	0.1	0.0	20.5	1	0
		18/10/2013	0.1	0.1	20.9	0	0
		28/11/2014	0.2	0.1	20.8	0	0
		14/05/2014	0.2	0.1	21.4	0	0
		26/11/2014	0.0	0.1	20.7	0	0
		27/01/2015	0.0	0.0	20.7	2	6
		19/05/2015	0.1	0.1	20.9	0	0
		10/07/2015	0.2	0.1	20.6	0	0
		20/10/2015	0.0	0.0	21.1	0	0
		12/01/2016	0.2	0.0	19.6	2	22
		6/04/2016	0.1	0.1	20.5	0	0
		11/07/2016	0.1	0.1	21.1	0	0
		19/10/2016	0.1	0.0	20.2	0	0
		24/01/2017	-	-	-	-	-
		22/05/2017	0.1	0.1	19.2	0	0
		26/07/2017	0.0	0.0	20.7	0	3
		18/12/2017	0.0	0.1	20.9	0	0
		25/01/2018	0.0	0.0	21.2	2	7
		1/05/2018	0.0	0.2	20.5	0	0
		6/07/2018	0.0	0.1	20.4	2	2
		17/10/2018	0.0	0.1	19.8	0	0
		10/01/2019	0.0	0.0	20.0	5	58
		23/01/2019	0.0	0.2	20.4	0	0
		1/05/2019	0.0	0.1	20.2	0	0
		20/08/2019	0.0	0.1	20.2	0	0
		30/10/2019	0.0	0.1	20.1	0	1
		26/02/2020	0.0	0.1	19.9	0	0
		16/06/2020	0.0	0.1	21.9	0	0
		21/08/2020	0.0	0.0	21.0	0	2
		16/10/2020	0.0	0.1	19.9	0	0
		25/02/2021	0.0	0.1	21.5	0	0
		15/04/2021	0.0	0.0	21.2	0	1
		14/07/2021	0.0	0.2	20.0	0	0
		5/10/2021	0.0	0.1	20.3	0	0
		9/12/2021	0.0	0.1	20.2	0	0
		15/02/2022	0.0	0.0	20.3	0	1
		9/03/2022	0.0	0.1	20.9	0	0
		10/06/2022	0.0	0.2	20.9	0	0
		27/09/2022	0.0	0.1	20.7	0	0
		17/01/2023	0.0	0.2	21.0	0	2
		26/04/2023	0.0	0.1	20.3	0	0
		31/07/2023	0.0	0.1	20.5	0	0
		22/11/2023	0.0	0.1	21.1	0	2

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
G37	Landfill gas well	6/01/2006	0.0	2.3	18.6	-	-
		5/04/2006	0.5	0.4	17.5	-	-
		25/07/2006	0.0	3.1	18.0	-	-
		28/11/2006	0.0	3.7	18.6	-	-
		23/02/2007	0.0	3.7	18.9	-	-
		17/04/2007	0.0	0.0	20.4	-	-
		4/07/2007	0.0	2.6	18.5	-	-
		17/02/2009	0.0	1.1	20.8	0	0
		29/04/2009	0.0	3.6	18.8	0	0
		23/07/2009	0.0	2.5	14.0	0	0
		19/10/2009	0.0	4.2	18.7	0	0
		20/01/2010	0.1	1.9	17.8	0	0
		23/04/2010	0.0	0.5	20.1	0	0
		28/07/2010	0.1	0.4	20.0	0	0
		8/10/2010	0.1	4.2	15.0	0	0
		31/01/2011	0.0	0.6	19.8	0	0
		6/05/2011	0.1	3.0	14.3	0	0
		2/09/2011	0.1	1.7	19.3	0	0
		25/11/2011	0.0	1.4	19.7	0	0
		26/01/2012	0.1	1.3	19.6	0	1
		27/04/2012	0.1	2.2	17.3	0	0
		10/07/2012	0.1	1.4	17.4	0	0
		3/10/2012	0.1	2.0	18.8	0	0
		16/01/2013	0.0	1.6	19.0	2	4
		10/04/2013	0.1	4.2	17.5	0	0
		29/07/2013	0.1	0.1	20.3	0	0
		18/10/2013	0.1	0.4	20.7	0	0
		28/01/2014	0.2	2.1	18.5	0	0
		14/05/2014	0.2	4.1	16.8	0	0
		26/11/2014	0.0	2.1	18.3	0	0
		27/01/2015	0.0	1.3	19.5	2	5
		19/05/2015	0.0	1.8	20.1	0	0
		10/07/2015	0.2	1.2	19.6	0	0
		20/10/2015	0.0	1.0	19.8	0	0
		12/01/2016	0.2	0.5	18.7	3	17
		6/04/2016	0.1	1.4	19.3	0	0
		11/07/2016	0.1	1.1	20.2	0	0
		19/10/2016	0.1	2.1	18.7	0	0
		24/01/2017	0.0	1.3	18.6	4	2
		22/05/2017	0.1	1.6	18.1	0	0
		26/07/2017	0.0	1.3	19.3	0	4
		18/12/2017	0.0	0.5	20.8	0	0
		25/01/2018	0.0	1.2	19.3	0	0
		1/05/2018	0.0	1.4	17.7	0	0
		16/07/2018	0.0	1.8	19.2	1	2
		17/10/2018	0.0	0.0	20.4	0	0
		10/01/2019	0.0	0.0	20.1	0	0
		23/01/2019	0.0	0.0	20.0	0	0
		1/05/2019	0.0	0.9	19.9	0	0
		20/08/2019	0.0	0.8	20.0	0	0
		30/10/2019	0.0	1.1	19.4	0	1
		26/02/2020	0.0	1.1	18.5	0	0
		16/06/2020	0.0	0.2	21.1	0	0
		21/08/2020	0.1	1.1	20.0	0	3
		16/10/2020	0.0	1.1	18.3	0	0
		25/02/2021	0.0	1.7	19.1	0	0
		15/04/2021	0.0	0.2	18.7	0	0
		14/07/2021	0.0	0.4	20.6	0	0
		5/10/2021	0.0	1.8	19.0	0	1
		9/12/2021	0.0	2.1	18.2	0	1
		15/02/2022	0.0	1.6	19.2	0	1
		9/03/2022	0.0	2.0	18.3	0	1
		10/06/2022	0.0	0.2	21.2	0	0
		27/09/2022	0.0	1.1	19.6	0	1
		17/01/2023	0.0	1.3	19.6	0	3
		26/04/2023	0.0	0.2	20.4	0	0
		31/07/2023	0.0	0.7	20.2	0	0
		22/11/2023	0.0	1.6	19.3	0	3

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
G38	Landfill gas well	6/01/2006	0.0	0.2	19.5	-	-
		5/04/2006	0.0	0.0	17.5	-	-
		25/07/2006	-	-	-	-	-
		28/11/2006	0.0	3.7	16.7	-	-
		23/02/2007	0.0	2.0	17.1	-	-
		17/04/2007	0.0	0.0	20.1	-	-
		4/07/2007	0.0	0.0	20.1	-	-
		17/02/2009	0.0	4.8	18.7	0	0
		29/04/2009	0.1	5.1	19.1	0	0
		23/07/2009	0.0	4.9	18.3	0	0
		19/10/2009	0.0	3.0	17.9	0	0
		20/01/2010	0.1	4.7	17.6	0	0
		23/04/2010	0.0	4.4	18.2	0	0
		28/07/2010	0.1	4.0	17.6	0	0
		8/10/2010	0.1	4.0	17.8	0	0
		31/01/2011	0.0	1.6	19.3	0	0
		6/05/2011	0.1	3.7	19.1	0	0
		2/09/2011	0.1	4.8	18.3	0	0
		25/11/2011	0.3	4.6	18.7	0	0
		26/01/2012	0.2	4.7	18.2	1	1
		27/04/2012	0.1	4.4	17.1	0	0
		10/07/2012	0.1	3.4	16.9	0	0
		3/10/2012	0.1	2.1	19.7	0	0
		16/01/2013	0.1	1.8	19.4	3	4
		10/04/2013	0.1	4.2	18.6	0	0
		29/07/2013	0.1	4.5	16.5	1	0
		18/10/2013	0.1	1.4	20.1	0	0
		28/01/2014	0.2	2.5	18.5	0	0
		14/05/2014	0.2	5.5	15.7	0	0
		26/11/2014	0.0	4.7	15.8	0	0
		27/01/2015	0.0	3.5	17.9	2	6
		19/05/2015	0.0	2.1	20.0	0	0
		10/07/2015	0.2	2.6	17.9	0	0
		20/10/2015	0.0	1.7	20.0	0	0
		12/01/2016	0.2	1.7	17.9	2	20
		6/04/2016	0.1	0.8	20.1	0	0
		11/07/2016	0.1	2.0	20.2	0	0
		19/10/2016	0.1	1.8	20.2	0	0
		24/01/2017	0.0	1.8	20.1	2	1
		22/05/2017	0.1	1.8	18.2	0	0
		26/07/2017	0.0	3.3	17.8	0	4
		18/12/2017	0.0	2.8	19.4	0	0
		25/01/2018	0.0	2.4	18.6	0	5
		1/05/2018	0.0	1.7	18.4	0	0
		16/07/2018	0.0	2.6	18.0	1	2
		17/10/2018	0.0	0.0	20.6	0	1
		10/01/2019	0.0	0.0	20.0	0	0
		23/01/2019	0.0	0.0	20.0	0	0
		1/05/2019	0.0	0.1	20.4	0	0
		20/08/2019	0.0	0.1	20.4	0	0
		30/10/2019	0.0				
		26/02/2020	0.0	1.6	18.3	0	0
		16/06/2020	0.0	1.9	20.1	0	0
		21/08/2020	0.0	1.8	20.0	0	3
		25/02/2021	0.0	1.9	18.7	0	0
		15/04/2021	0.0	1.3	19.0	0	0
		14/07/2021	0.0	2.2	19.5	0	0
		5/10/2021	0.0	2.0	19.0	0	2
		9/12/2021	0.0	2.4	18.2	0	1
		15/02/2022	0.0	4.0	17.6	0	1
		9/03/2022	0.0	3.9	18.4	0	1
		10/06/2022	0.0	3.0	19.6	0	0
		27/09/2022	0.0	1.3	19.9	0	1
		17/01/2023	0.0	2.6	18.5	0	3
		26/04/2023	0.1	3.8	17.4	0	0
		31/07/2023	0.2	1.9	18.9	0	0
		22/11/2023	0.0	2.2	18.9	0	3

Parameters	Type of sampling point	Date	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	Peak Hydrogen Sulphide (ppm)	Peak Carbon Monoxide (ppm)
MW1	Landfill gas well	20/06/2022	0.0	10.7	10.5	0	0
		27/09/2022	39.4	24.8	6.8	5	3
		17/01/2023	0.0	22.5	2.4	0	3
		26/04/2023	12.2	22.2	1.2	0	0
		31/07/2023	61.8	36.2	0.9	2	1
		22/11/2023	49.4	28.8	4.7	0	4
MW2	Landfill gas well	20/06/2022	64.2	38.1	1.3	2	7
		27/09/2022	0.1	16.3	7.9	3	2
		17/01/2023	0.0	10.9	10.5	1	3
		26/04/2023	19.1	28.2	0.2	1	0
		31/07/2023	11.5	9.8	13.7	1	2
		22/11/2023	2.4	12.5	9.5	0	3
MW3	Landfill gas well	20/06/2022	67.2	39.6	0.5	2	10
		27/09/2022	64.7	36.1	0.0	15	4
		17/01/2023	50.4	29.3	3.1	4	12
		26/04/2023	64.7	36.5	0.0	2	7
		31/07/2023	65.3	37.5	0.1	13	2
		22/11/2023	69.8	34.5	0.2	6	5

Appendix G:
Retention Pond Monitoring Data

NORTH POND STORMWATER WATER SAMPLING RESULTS

Parameter		North Pond																	ANZECC Trigger Levels $^{(1)}$ (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor$^{(5)}$ and DGV$^{(6)}$ (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	19/10/2009	21/01/2010	15/04/2010	27/07/2010	21/10/2010	25/01/2011	18/04/2011	29/07/2011	25/10/2011	25/01/2012	26/04/2012	18/07/2012	17/10/2012	29/01/2013	24/04/2013	22/07/2013	30/10/2013		
pH	pH units	7.81	7.89	7.66	7.3	7.46	7.47	7.61	7.78	7.26	7.32	6.98	7.13	7.93	7.41	7.17	8.16	7.85	7.0 - 8.5 $^{(2)}$	-
Conductivity	mS/cm	0.32	0.35	0.38	0.31	0.30	0.31	0.27	0.30	0.27	0.33	0.24	0.40	9.3$^{(4)}$	0.30	0.32	0.27	0.27	-	-
Ammoniacal Nitrogen	mg/L	0.08	0.14	<0.01	0.34	0.30	<0.010	0.049	0.07	0.031	0.048	0.03	0.031	0.066	<0.010	0.02	0.012	<0.010	0.91 $^{(3)}$	0.91 $^{(5)}$
BOD$_5$	mg/L	2	1	2	3	2	1.7	<1	<1	<1	<1	<2	<2	<2	<2	9	8	6	-	-
Turbidity	NTU	16	17	8.3	31	39	12.2	16.5	32	25	10.6	3.5	13.2	15.6	7.2	30	32	22		-
Suspended Solids	g/m^3	4	17	10	12	26	13	6	7	5	5	<3	<3	7	10	25	20	27	-	-

Parameter		North Pond																	ANZECC Trigger Levels $^{(1)}$ (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor$^{(5)}$ and DGV$^{(6)}$ (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	28/01/2014	14/05/2014	24/07/2014	22/10/2014	27/01/2015	20/04/2015	22/07/2015	12/10/2015	26/01/2016	26/10/2016	28/07/2016	26/10/2016	11/01/2017	20/04/2017	1/08/2017	9/11/2017	25/01/2018		
pH	pH units	8.92	6.78	6.8	6.57	6.82	6.47	6.62	6.79	7.32	6.85	6.53	6.78	7.45	6.62	6.54	7.81	7.8	7.0 - 8.5 $^{(2)}$	-
Conductivity	mS/cm	0.29	0.27	0.27	0.29	0.31	0.33	3.52	0.34	0.37	0.39	0.40	0.38	0.38	0.36	0.38	0.36	0.41	-	-
Ammoniacal Nitrogen	mg/L	0.015	<0.010	0.25	0.38	0.049	0.111	0.155	0.089	<0.010	<0.010	<0.010	< 0.010	0.012	<0.010	0.047	<0.010	0.128	0.91 $^{(3)}$	0.91 $^{(5)}$
BOD$_5$	mg/L	11	11	7	<2	<2	<2	3	<2	2	<2	4	<2	<2	3	<2	2	<2	-	-
Turbidity	NTU	16.3	22	17.6	7.6	4.5	19.5	70	18.5	7.8	6.0	7	2.3	1.96	5.4	7.4	2.4	4.8		-
Suspended Solids	g/m^3	19	14	12	5	5	7	26	5	7	4	6	< 3	<3	8	5	<3	6	-	-

Parameter		North Pond																	ANZECC Trigger Levels $^{(1)}$ (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor$^{(5)}$ and DGV$^{(6)}$ (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	24/04/2018	26/07/2018	9/10/2018	16/01/2019	1/05/2019	17/07/2019	22/10/2019	12/02/2020	11/06/2020	10/08/2020	28/10/2020	25/03/2021	14/07/2021	27/10/2021	25/01/2022	26/04/2022	26/07/2022		
pH	pH units	7.47	7.62	9.74	7.6	7.7	7.52	9	8.01	8.6	8.52	9.76	8.35	7.46	8.78	7.43	7.49	7.63	7.0 - 8.5 $^{(2)}$	-
Conductivity	mS/cm	0.35	0.362	0.319	0.314	0.342	0.321	0.286	0.328	0.341	0.346	0.304	0.391	0.385	0.254	0.396	0.429	0.421	-	-
Ammoniacal Nitrogen	mg/L	<0.010	0.012	<0.010	0.053	0.012	0.022	0.021	0.063	<0.01	<0.01	0.024	0.042	0.181	0.013	0.38	<0.010	0.103	0.91 $^{(3)}$	0.91 $^{(5)}$
BOD$_5$	mg/L	<2	<2	5	<2	<2	<2	<2	3	<2	<2	3	<2	<2	<2	3	3	8	-	-
Turbidity	NTU	2.3	4.4	6.2	1.49	3.5	5.0	2.2	2.9	2.5	5	1.64	1.9	6.3	2.4	4.7	17.2	15.5		-
Suspended Solids	g/m^3	4	6	11	4	3	<3	<3	5	<3	4	<3	<3	6	<3	6	22	12	-	-

Parameter		North Pond																	ANZECC Trigger Levels $^{(1)}$ (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor$^{(5)}$ and DGV$^{(6)}$ (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	26/10/2022	17/01/2023	26/04/2023	26/07/2023	26/10/2023														
pH	pH units	7.1	8.32	7.45	7.31	8.6													7.0 - 8.5 $^{(2)}$	-
Conductivity	mS/cm	0.463	0.471	0.464	0.418	0.438													-	-
Ammoniacal Nitrogen	mg/L	0.57	0.025	<0.010	0.28	0.035													0.91 $^{(3)}$	0.91 $^{(5)}$
BOD$_5$	mg/L	<2	7	2	2	<2													-	-
Turbidity	NTU	4.3	4.4	5.6	9.7	2.9														-
Suspended Solids	g/m^3	<3	6	8	4	3													-	-

Notes:
1. Australian and New Zealand Guidelines for Fresh and Marine water Quality 2000 (ANZECC 2000).
2. Trigger level for physical and chemical stresses for a slightly disturbed system (Estuaries - South East Austrialia in the absence of any NZ trigger level)
3. Trigger level based on a pH of 8.0 and temperature of 20^{0}C (Marine Water)
4. Suspected to be a calibration error with the field meter
5. ANZG 2018 REC Guideline Value
6. ANZG 2018 DGV for 95% protection of aquatic species

▨ Concentration above the ANZECC Trigger Value

WEIGHBRIDGE STORMWATER WATER SAMPLING RESULTS

Parameter		Weighbridge Pond																	ANZECC Trigger Levels (1) (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor(5) and DGV(6) (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	19/10/2009	21/01/2010	15/04/2010	27/07/2010	21/10/2010	25/01/2011	18/04/2011	29/07/2011	25/10/2011	25/01/2012	26/04/2012	18/07/2012	17/10/2012	29/01/2013	24/04/2013	22/07/2013	30/10/2013		
pH	pH units	8.45	8.62	9.15	8.06	8.78	8.87	8.4	9.42	8.72	Dry	7.02	8.19	7.98	Dry	7.22	8.18	Dry	7.0 - 8.5 (2)	-
Conductivity	mS/cm	1.4	1.3	1.8	2.2	1.5	1.2	1.1	1.4	1.15		2.92	1.677	122.3(4)		0.752	2.72		-	-
Ammoniacal Nitrogen	mg/L	**11.3**	0.83	<0.04	**35.5**	**14.2**	0.021	**2.3**	**6.3**	**3.7**		0.56	**15.3**	0.89		0.2	**67**		0.91 (3)	0.91 (5)
BOD$_5$	mg/L	34	32	54	410	14	20	13	42	15		<2	2	4		11	32		-	-
Turbidity	NTU	90	310	300	140	14	59	88	69	168		31	59	49		390	44		-	-
Suspended Solids	g/m^3	90	200	340	47	25	26	83	126	138		41	47	41		270	62		-	-

Parameter		Weighbridge Pond																	ANZECC Trigger Levels (1) (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor(5) and DGV(6) (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	28/01/2014	14/05/2014	24/07/2014	22/10/2014	27/01/2015	20/04/2015	22/07/2015	12/10/2015	26/01/2016	27/04/2016	28/07/2016	26/10/2016	11/01/2017	20/04/2017	1/08/2017	10/11/2017	25/01/2018		
pH	pH units	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	7.0 - 8.5 (2)	-
Conductivity	mS/cm																		-	-
Ammoniacal Nitrogen	mg/L																		0.91 (3)	0.91 (5)
BOD$_5$	mg/L																		-	-
Turbidity	NTU																		-	-
Suspended Solids	g/m^3																		-	-

Parameter		Weighbridge Pond																	ANZECC Trigger Levels (1) (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor(5) and DGV(6) (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	24/04/2018	26/07/2018	9/10/2018	16/01/2019	1/05/2019	17/07/2019	22/10/2019	12/02/2020	11/06/2020	10/08/2020	28/10/2020	25/03/2021	14/07/2021	27/10/2021	25/01/2022	26/04/2022	26/07/2022		
pH	pH units	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	7.0 - 8.5 (2)	-
Conductivity	mS/cm																		-	-
Ammoniacal Nitrogen	mg/L																		0.91 (3)	0.91 (5)
BOD$_5$	mg/L																		-	-
Turbidity	NTU																		-	-
Suspended Solids	g/m^3																		-	-

Parameter		Weighbridge Pond																	ANZECC Trigger Levels (1) (95% level of Protection - Marine Water)	ANZG (2018) REC Physical and Chemical Stressor(5) and DGV(6) (95% Level of Protection) Trigger Level Concentrations (Freshwater)
	Date	26/10/2022	26/10/2023																	
pH	pH units	Dry	Dry																7.0 - 8.5 (2)	-
Conductivity	mS/cm																		-	-
Ammoniacal Nitrogen	mg/L																		0.91 (3)	0.91 (5)
BOD$_5$	mg/L																		-	-
Turbidity	NTU																		-	-
Suspended Solids	g/m^3																		-	-

Notes:

1. Australian and New Zealand Guidelines for Fresh and Marine water Quality 2000 (ANZECC 2000).
2. Trigger level for physical and chemical stresses for a slightly disturbed system (Estuaries - South East Austrialia in the absence of any NZ trigger level)
3. Trigger level based on a pH of 8.0 and temperature of 20^{0}C (Marine Water)
4. Suspected to be a calibration error with the field meter

▨	Concentration above the ANZECC Trigger Value
11.3	Concentration above the ANZG Trigger Value

Appendix H: Surface Water Quality

Table H1: Long term median and 95th percentile water quality measured in the main tributaries of the Kaikorai Swamp and the tip of the estuary stream flowing through the swamp

Parameter	Site	5-year median (± s.d.)	5-year 95th percentile	20-year median (± s.d.)	20-year 95th percentile
Dissolved oxygen (mg/L)	FH38	5.0 (± 2.1)	8.8	5.7 (± 2.4)	9.4
	FH39	7.2 (± 2.6)	8.7	7.5 (± 2.8)	11.4
	EW43	9.1 (± 1.5)	10.7	9.6 (± 1.9)	12.6
	FH40	8.2 (± 0.9)	9.5	8.5 (± 1.6)	11.3
Dissolved oxygen (%)	FH38	44 (± 18)	80	52 (± 20)	82
	FH39	64 (± 25)	82	67 (± 29)	119
	EW43	82 (± 8)	88	88 (± 14)	111
	FH40	80 (± 10)	101	84 (± 16)	112
pH	FH38	**5.9 (± 0.4)**	**6.4**	**5.9 (± 0.6)**	**6.7**
	FH39	**6.9 (± 0.3)**	7.4	**7.0 (± 0.4)**	7.7
	EW43	7.3 (± 0.3)	7.8	7.2 (± 0.4)	**7.9**
	FH40	7.3 (± 0.5)	**8.2**	7.2 (± 0.4)	7.7
Temperature (°C)	FH38	10.9 (± 2.7)	15.3	10.9 (± 3.0)	14.6
	FH39	11.2 (± 4.4)	17.0	11.4 (± 5.0)	19.5
	EW43	10.5 (± 4.9)	18.9	11.5 (± 4.7)	19.5
	FH40	13.6 (± 4.8)	19.8	13.1 (± 4.9)	20.7
Conductivity (mS/cm)	FH38	0.5 (± 0.2)	0.6	0.6 (± 1.1)	1.0
	FH39	1.6 (± 4.1)	11.0	1.1 (± 1.3)	4.0
	EW43	0.4 (± 1.9)	5.2	0.3 (± 1.2)	4.3
	FH40	6.2 (± 8.6)	26.9	6.1 (± 6.4)	19.1
Total ammoniacal nitrogen (mg/L)	FH38	0.8 (± 1.7)	**1.6**	**1.1 (± 2.3)**	**2.5**
	FH39	**1.3 (± 1.4)**	**4**	**1.1 (± 1.3)**	**4.0**
	EW43	0.1 (± 0.1)	0.3	0.1 (± 0.2)	0.3
	FH40	0.3 (± 0.9)	**2.1**	0.3 (± 0.8)	**2.3**
Nitrate-nitrogen (mg/L)	FH38	0.1 (± 0.2)	0.5	0.1 (± 0.2)	0.5
	FH39	0.6 (± 0.2)	1.0	0.7 (± 0.5)	1.8
	EW43	0.4 (± 0.3)	1.1	0.3 (± 0.3)	1.1
	FH40	0.20 (± 0.25)	0.63	0.22 (± 0.26)	0.81

Table H1: Long term median and 95th percentile water quality measured in the main tributaries of the Kaikorai Swamp and the tip of the estuary stream flowing through the swamp

Parameter	Site	5-year median (± s.d.)	5-year 95th percentile	20-year median (± s.d.)	20-year 95th percentile
BOD_5 (mg/L)	FH38	2 (± 1)	4	2 (± 1)	5
	FH39	2 (± 2)	6	2 (± 7)	6
	EW43	<2 (± 0)	<2	<2 (± 0)	<2
	FH40	2 (± 4)	9	2 (± 3)	9
Dissolved iron (mg/L)	FH38	5.9 (± 2.6)	9.4	6.0 (± 6.0)	18
	FH39	0.3 (± 0.4)	1.0	0.4 (± 0.9)	2.3
	EW43	0.39 (± 0.16)	0.61	0.42 (± 0.89)	1.09
	FH40	0.22 (± 0.11)	0.42	0.23 (± 0.65)	1.40
Dissolved lead (mg/L)	FH38	0.0001 (± 0.0002)	0.0007	0.0001 (± 0.0006)	0.0015
	FH39	0.0001 (± 0.00005)	0.0002	0.0003 (± 0.0022)	0.004
	EW43	0.0003 (± 0.0002)	0.0007	0.0005 (± 0.0007)	0.0023
	FH40	0.0003 (± 0.0006)	0.0021	0.0005 (± 0.0013)	0.0020
Dissolved zinc (mg/L)	FH38	**0.127 (± 0.062)**	**0.230**	**0.120 (± 0.079)**	**0.280**
	FH39	0.025 (± 0.017)	**0.066**	0.028 (± 0.016)	**0.062**
	EW43	0.017 (± 0.007)	0.028	0.017 (± 0.023)	**0.047**
	FH40	0.017 (± 0.028)	**0.07**	0.011 (± 0.021)	**0.044**
Dissolved boron (mg/L)	FH38	**0.38 (± 14)**	**0.54**	**0.39 (± 0.22)**	**0.67**
	FH39	**0.68 (± 0.27)**	**1.26**	**0.72 (± 0.21)**	**1.0**
	EW43	0.10 (± 0.12)	**0.41**	0.08 (± 0.09)	**0.29**
	FH40	**0.81 (± 0.57)**	**1.99**	**0.69 (± 1.60)**	**5.53**

Notes:

Values in bold indicate exceedance of the ANZG (2018) default guideline values for the 95% protection level of freshwater species.

Values underscored indicate exceedance of the ANZG (2018) default guideline values for the 80% protection level of freshwater species.

Appendix I:
Groundwater, Surface Water and Landfill Gas Monitoring Plan

Table: Proposed Monitoring Plan

Type	Purpose/Location	Parameters	Frequency
Groundwater/Surface water	Discrete water/leachate level monitoring. - Groundwater wells within the landfill (LGS1, LS2, LS6, LS9, LS14, LD5 and LD16); - Groundwater wells outside the landfill (LGS7, LS10, LS13, LS15, LS19, LS21A, LS22, LD8, LD11, LD17 and LD20); - Leachate interception drain wells (LS23, LS24, LS25, LS26, LGS27, LS28, LGS29, LS30, LS31, LS32 and LS33); - Leachate pumping chamber (EPS42); and - Surface water level sites (SP1, SP2, SP3 and SP5).	Water/leachate levels	Quarterly (January, April, July and October)
Groundwater	Maintaining a phreatic depression in leachate interception drain. - Monitoring water/leachate levels in pump station EPS42; and - Monitoring surface water levels in the Estuary (SP5).	Water/leachate level monitoring	Continuously with transducers (downloaded quarterly)

Table: Proposed Monitoring Plan

Type	Purpose/Location	Parameters	Frequency
Groundwater	Discrete groundwater quality monitoring. - Leachate interception drain wells (LS24, LS26, LS28, LS30 and LS32); and - Groundwater wells outside the landfill (LGS1, LGS7, LS10, LS13, LS15, LS19, LS22, LD8, LD11, LD17 and LD20).	pH, conductivity, temperature, total ammoniacal nitrogen (TAN), phosphorus, dissolved reactive phosphorus, chloride.	Six Monthly (January and July)
Groundwater	- Deep groundwater wells LD5, LD8, LD11, LD17 and LD20	COD, BOD_5, total ammoniacal nitrogen (TAN), temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, lead	Annually (July each year)
Leachate	Leachate quality - Leachate pumping chamber (EPS42)	COD, BOD_5, total ammoniacal nitrogen (TAN), temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, bicarbonate. sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron,	Annually (July each year)

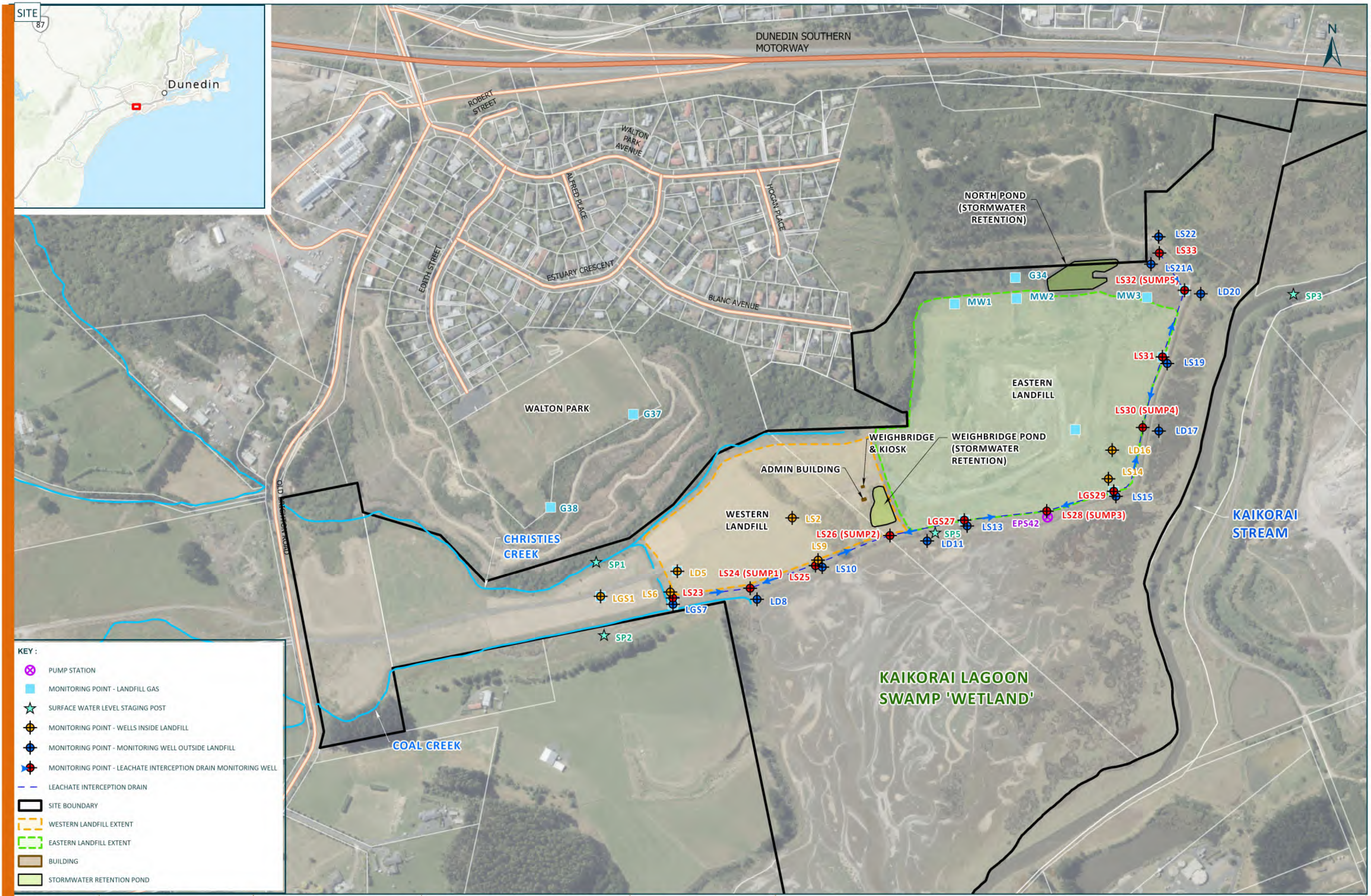
Table: Proposed Monitoring Plan

Type	Purpose/Location	Parameters	Frequency
		zinc, copper, lead and cation/anion ratio	
Leachate	Pumping volumes and rate	Instantaneous abstraction rate	Average 15 min rate (daily reporting to ORC)
Surface Water	Discrete surface water quality monitoring: - Surface water sampling locations (SW1, SW2, SW3, SW4, SW5, SW6, and SW7). These locations are preliminary only. Confirmation of the locations will be made following a site inspection to confirm access and also their suitability with respect to the area of groundwater upwelling, if determined.	pH, conductivity, salinity, temperature, dissolved oxygen, BOD_5, total ammoniacal nitrogen (TAN), temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, lead	Quarterly (January, April, July and October)
	Ecology - Surface water sampling locations (SW3, SW4, SW5 and SW7). These locations are preliminary only. Confirmation of the locations will be made following a site inspection to confirm	Habitat assessment	Annually first three years, then every 5 years
		Macroinvertebrate community composition	Annually first three years, then every 5 years
		Fish survey	Annually first three years, then every 5 years

Table: Proposed Monitoring Plan

Type	Purpose/Location	Parameters	Frequency
	access and also their suitability with respect to the area of groundwater upwelling, if determined.	Bird count	Annually first three years, then every 5 years
		Vegetation survey	Annually first three years, then every 5 years
Landfill Gas	Discrete LFG monitoring. ∴ Wells LGS1, LD5, LGS7, LS21A, LGS27, LGS29, LS31, LS32, G34, G37, G38, MW1, MW2 and MW3	Methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.	Quarterly (January, April, July and October)
Reporting	All monitoring to be reported in an annual report.		

1. *Monitoring programme to be reviewed every 5 yrs to ensure it continues to be suitable.*



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NO.	REVISION	DATE	BY
D	UPDATED	FEB 24	JR
C	UPDATED	AUG 23	JR
B	UPDATED	MAY 23	BR
A	ISSUED	AUG 22	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
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3. ALL DATA DERIVED FROM CADASTRAL DRAWINGS (MAY NOT BE SPATIALLY ACCURATE).

CLIENT
WASTE MANAGEMENT NZ LTD

FIGURE
PROPOSED SAMPLING LOCATIONS

PROJECT
FAIRFIELD LANDFILL RECONSENTING

C021878O2_Landfill_Figures.aprx - C021878OO_GIS0012

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NO.	REVISION	DATE	BY
E	UPDATED	FEB 24	JR
D	UPDATED	AUG 23	JR
C	UPDATED	MAY 23	BR
B	REVISED	FEB 23	BR
A	ISSUED	NOV 22	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017 - 2020) SOURCED FROM THE LINZ DATA SERVICE WWW.LINZ.GOVT.NZ/ABOUT-LINZ/LINZ-DATA-SERVICE/HELP/USING-LINZ-DATA/ATTRIBUTING-AERIAL-IMAGERY-DATA AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
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FIGURE
PROPOSED SURFACE WATER SAMPLING LOCATIONS

PROJECT
FAIRFIELD LANDFILL RECONSENTING

C02187802_Landfill_Figures.aprx - C02187800_GIS0011_Samples

APPENDIX 6:

Natural Hazard & Climate Assessment

Report titled 'Fairfield Closed Landfill – Natural Hazard and Climate Risk Assessment and Management Plan'
prepared by Pattle Delamore Partners Limited, dated February 2024

Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan

Prepared for

Waste Management NZ Limited

February 2024

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Quality Control Sheet

TITLE	Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan
CLIENT	Waste Management NZ Limited
VERSION	Final – V3
ISSUE DATE	27 February 2024
JOB REFERENCE	C02587802
SOURCE FILE(S)	C02187802R001.docx

DOCUMENT CONTRIBUTORS

Prepared by

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Jason Grieve

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Reviewed by

SIGNATURE

Andrew Smith

Approved by

Scott Wilson

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Waste Management New Zealand Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Waste Management New Zealand Limited for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

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Appendices

1.0 Introduction

Waste Management NZ Limited (WMNZ) has requested a Natural Hazard and Climate Assessment of the Fairfield Landfill site to support a resource consent application to renew existing regional resource consents for the site, which are due to expire in September 2024. The landfill is considered to be “closed” and currently in the “aftercare” stage.

This report has been prepared to outline the potential hazards and the implications associated with climate change for the closed Fairfield Landfill.

The location and extent of the closed landfill are indicated in Figure 1 (Appendix A).

1.1 Existing Management Plans

The following management plans for the Fairfield Landfill have been developed and implemented by WMNZ:

- Fairfield Closed Landfill Closure Management Plan
- Site Emergency Management Plan

While these are ‘live’ documents, an ‘Aftercare Management Plan’ will be appended to the consent application for the new regional resource consents. It is understood that the Aftercare Management Plan will be an updated version of the Closure Management Plan, with the updates reflecting the current status of the site (i.e., it is no longer operational and closure activities have been completed).

It is considered that the recommendations given in this report should be added to the proposed Aftercare Management Plan.

1.2 Landfill Background Information

The landfill is located at 127 Old Brighton Road in the suburb of Fairfield, Dunedin. Landfilling of the area commenced in 1967. Filling initially occurred in the area near Old Brighton Road and then progressed towards the east. It appears that the landfill waste was placed directly within a wetland area and there is no evidence to suggest that any earthwork or engineering works were undertaken prior to placement of the waste, in particular in the early stages (i.e., the landfill areas are unlined). The landfill ceased receiving waste in July 2017 and final contouring and capping works were completed in August 2022.

There are two defined filling areas considered as part of this assessment (refer Figure 1; Appendix A).

- The 'Western Landfill' adjoins Christies Creek and the Eastern Landfill. The date filling commenced in this area is unknown, but this area was closed in 1996. Cover material has been placed above the waste and is currently surfaced with grass, however, the nature and thickness of the cover and whether this constitutes an engineered cap is unknown.
- The 'Eastern Landfill' is the eastern most landfilling area and is the most recent operational area. Filling commenced in 1996 and ceased accepting waste in July 2017. Landfill closure and capping activities for this area were completed in August 2022 and comprised of at least 0.8 m of compacted clay and at least 0.2 m of topsoil with grass cover.

For the purposes of this assessment and the regional resource consent application (given the regional plan rules that apply to the site during the aftercare period), only the 'Eastern' and 'Western' landfill areas are being considered.

The Western Landfill area is filled with approximately 4 m of fill being (approximately 5 m RL on the existing top surface). The Eastern Landfill area has been filled in layers to form a landfill mound/dome with a maximum height of this landfill area reaching 31.5 m RL.

A leachate interception drainage system has been installed to intercept shallow groundwater/leachate as it migrates away from the Eastern and Western Landfill areas (refer Figure 1). The interception drain also satisfies existing resource consent condition 4 of Consent 93540, which requires a depression in the phreatic groundwater level to prevent the outward flow of groundwater from the landfill. The interception drain is a considered a critical piece of site infrastructure, both while it was operational and during the initial phases of the aftercare period (i.e., while active management of the leachate is still required), to mitigate effects to the environment from any ongoing landfill leachate being generated.

The interception drainage system comprises a trench system installed downgradient of the landfill (between the landfill and the estuary, and on the landfill side of the perimeter access track) which is backfilled with a permeable material (railway ballast) and lateral drainage pipes comprising perforated Megaflo pipe wrapped in filter cloth. The perimeter access track has a ground surface of approximately 2.3 m RL, with the laterals set at depths of between - 0.5 and -1.0 m RL (i.e., up to 3.3 m bgl). Lateral pipes extend from each side of a series of manhole sumps (LS24, LS26, LS28, LS30 and LS32). Groundwater containing landfill leachate enters the laterals and flows via gravity towards each respective sump before being directed via a separate gravity pipeline on the opposite side of the access track towards a large sump at the pumping station (EPS42). A pump controlled by level switches maintains the 'water' level within the pumping station sump at a low level to ensure the pipe network flows via gravity and that the depression in the phreatic zone (saturation zone) is maintained. The water/leachate collected in the system is pumped to the Dunedin City Council wastewater treatment plant.

Landfill gas (LFG) from the Eastern Landfill is captured using a series of LFG wells and a conveyance pipeline system. The pipeline system operates in a ring main. Three candlestick-style flares control the discharge of the captured LFG. There is no LFG extraction in the Western Landfill area based on its age and insufficient LFG generation to enable flaring. Any LFG generated from the Western Landfill is discharged passively (i.e., without flaring).

1.3 Environmental Setting

The closed landfill lies at the head of the Kaikorai Wetland – Estuary Complex. The wetland, referred to as Kaikorai Lagoon Swamp, is classified as a wetland of regional significance due to its significant conservation and Kai Tahu values. Natural discharge paths of Kaikorai Stream Catchment connect to the Kaikorai Lagoon Swamp. Tributaries include the major tributary of the Kaikorai Stream and the minor tributaries of Abbotts Creek (a tributary of the Kaikorai Stream), Christies Creek, and Coal Creek which drain through the site from Old Brighton Road into the north-western part Kaikorai Lagoon Swamp.

The landfill boundary is located approximately 3 km inland from the ocean mouth of the Kaikorai Estuary. Water levels in the Kaikorai Lagoon Swamp fluctuate between dry and flooded depending on conditions in the wider environment. Data logging of water levels in 2012 showed that there was no tidal effect on water levels. The water level variability is dependent on whether the ocean mouth of the Kaikorai Estuary is open or not and rainfall patterns. If the mouth is not regularly opened (naturally or mechanically by Otago Regional Council (ORC)) the backwater effect causes water levels in the estuary to rise. This has occasionally resulted in water levels to overtop the perimeter access track around the base of the landfill, which allows water to enter the permeable material in the top of the interception drainage system, and during extreme events can overtop the leachate pump chamber and flood the interception drainage system activating the ‘high -high’ alarm shutting the leachate pump down. If the ocean mouth is not opened, this can result in high water levels for long periods of time, whereas extreme rainfall events can result in intermittent flooding, but for a short time period only.

A review of flood hazard of Dunedin's urban streams undertaken by ORC in 2014 indicates that the western parts of the landfill located between Christies Creek and Coal Creek form part flood plain within the Kaikorai Stream catchment and has the potential for widespread inundation in future flood events.

2.0 Hazard Assessment

The following sections provide background information to the climate change and natural hazard assessment contained in Table 1.

2.1 Climate Change

The site is exposed to several hazards, some of which will be exacerbated by climate change. In terms of climate projections, the Representative Concentration Pathway (RCP) RCP4.5 and RCP8.5 scenarios are commonly used (where RCP4.5 can be considered a 'middle of the road' scenario, and RCP8.5 can be considered a 'high' scenario). Emissions have mostly been tracking along the RCP8.5 pathway – this scenario provides the most severe climatic changes and is therefore selected here to undertake a 'consequence' assessment (i.e., worst case scenario – though noting that we are using the mid-point of projections, not the maximum or upper quartile). Key hazards identified by PDP are outlined in Table 1.

The 2014 flood hazard assessment of Dunedin's urban streams published by ORC does not consider the effects of climate change. This is discussed in Table 1 within the 'Influence of Climate Change' column.

2.2 Seismic Considerations

For this assessment the landfill is an importance level 3 (IL3) as described in AS/NZS1170.0:2002 due to the potential for high environmental consequences in the event of a breach of the landfill.

Table 1: Identified Natural Hazards[1] at the Fairfield Landfill

Potential Hazard	Influence of Climate Change	Implications for the Landfill Site	Recommended Actions
Average temperatures	Average annual temperatures in Dunedin are projected to increase by around 0.6°C by 2040 and 1.8°C by 2090 under RCP8.5.	Higher temperature may result in cracking (desiccation) of the cohesive landfill cap and over time deeper cracks could allow the emission of landfill gas to atmosphere. Cracks could also form migration pathways for stormwater during the rainfall events and potentially increase the levels of leachate generation. Conversely, fewer consecutive dry days suggests less drought, and therefore lower risk of drying of the landfill cap. Although a slight reduction in maximum wind strength is projected, strong winds, when combined with warmer average temperatures, may result in increased drying of the landfill cap.	Periodic surveillance monitoring of the landfill as detailed in Section 3.1.
Maximum temperatures	Maximum annual temperatures are projected to increase by 0.8°C and 2.4°C respectively for the two time periods.		
Dry periods	By the end of the century the maximum number of consecutive dry days is projected to decrease by up to 5 days.		
Strong winds	The strongest (99th percentile) winds are projected to <u>decrease</u> in Dunedin by around 0.3% by 2040 and 1.3% by 2100 under RCP8.5.		
Increased mean annual rainfall	Average annual rainfall in Dunedin is projected to increase by 4% by 2040 and 13% by 2090 under RCP8.5.	Groundwater levels become elevated, with temporary or permanent inundation of the landfill toe possibly threatening the integrity of the foot of the landfill's southern slope and the landfill face above (elevation of groundwater levels could at worst be in excess of the amount of sea level rise (SLR), but this is highly dependent on the characteristics of the underlying soil and changes in rainfall patterns). Increased pumping of leachate from the interception drainage system or possible overwhelming of the capacity of the system. Erosion risk, and threat to slope stability and integrity of landfill cap. Risk of a landfill breach (i.e., leachate release). An increased frequency of low periods of barometric pressure may promote additional landfill gas migration.	Periodic surveillance monitoring of the landfill as detailed in Section 3.1. Increase the height and armouring of the perimeter access road around the Eastern and Western Landfill areas. This will also mitigate the potential for inundation of the leachate interception drainage system. Design and implementation to be embedded into consent conditions. An important point to note is that SLR will continue far beyond 2100 - the implications of this ongoing rise for the site may also need to be considered. Periodic surveillance monitoring of the landfill as detailed in Section 3.1 to monitor any changes. Increase the height and armouring of the perimeter access road around the Eastern and Western Landfill areas. This will protect the landfill toe and also mitigate the potential for inundation of the leachate interception drainage system. Design and implementation to be embedded into consent conditions.
Extreme rainfall events	The amount of rainfall in <u>one hour</u> in an extreme event (100-year ARI) in Dunedin is projected to increase from a current depth of 32mm, to around 36mm (+13%) by 2040 and 43mm (+34%) by 2090 under RCP8.5.		
Changes in river flows	Increased flows of 5-10% in Dunedin rivers and streams are expected by 2050, with 20-50% by 2100 under RCP8.5.	Flood risk in the major tributary Kaikorai Stream and the minor tributaries (Christies and Coal Creeks) catchments is likely to increase. Flooding of Kaikorai Stream could result in low velocity flood waters. Considered limited potential for erosion of the Eastern Landfill area. Possible inundation of the landfill toe and leachate interception drainage system. Potential increase in frequency of flooding of the pumping chamber resulting in shutdown of the pump (potential for leachate to flow directly into the wetland/estuary). Christies and Coal Creek, although a much smaller catchment, have a much more confined channel and pass directly adjacent to, and for Christies Creek, through the middle of the landfill area. The potential for erosion of the Western Landfill area exists.	

Table 1: Identified Natural Hazards[1] at the Fairfield Landfill

Potential Hazard	Influence of Climate Change	Implications for the Landfill Site	Recommended Actions
Encroachment, Sea Level Rise (SLR)	Sea level is projected to increase by 0.25m by 2050 and 0.81m by 2100. There is negligible vertical land movement near the site[1] (i.e., any subsidence would exacerbate the effect of SLR, while uplift would reduce it). The water levels in the wetland/estuary are dependent on the ocean outlet and whether it is open or not. The future management of this is uncertain as it is under ORC control. However, it is assumed that the calculated levels could be realised at the site.	Temporary or permanent inundation/ flooding of the toe of the landfill, existing perimeter access road and leachate interception drain system. While landfill leachate is still being generated at the site and being actively managed, an increase in the volume of pumping/ discharge from the interception system and possible more frequent flooding of the pumping chamber may result in shutdown of the pump (potential for leachate to flow directly into the wetland/estuary). Increased sea level may cause regression of Kaikorai Stream leading to higher groundwater levels along the eastern side of the landfill. Increased water levels could threaten the stability of the toe of southern and eastern slopes.	Periodic surveillance monitoring of the landfill as detailed in Section 3.1. Increase the height and armouring of the perimeter access road around the Eastern and Western Landfill areas. This will protect the landfill toe and also mitigate the potential for inundation of the leachate interception drainage system. Design and implementation to be embedded into the consent conditions.
Storm surges, king tides and waves	With SLR, the chance of a high-level flood increases exponentially. A current 1 in 100 year exceedance event in Dunedin will happen every 2 years with 30cm of SLR, and every high tide with 90cm of SLR[1]. Increased risk of wave erosion, inundation of the landfill toe during storm surges, king tides.	The estuary channel is oriented approximately north south and could act as a funnel during southerly storm events. With more frequent higher water levels, and the chance of those coinciding with higher intensity storm events, the risk intensifies. The implication is that increased rates of overtopping/erosion may occur at the base of the southern landfill slope. Such erosion could at worst result in a landfill breach (i.e., leachate release, exposure of landfill material).	Periodic surveillance monitoring as detailed in Section 3.1. Increase the height and armouring of the perimeter access road around the Eastern and Western Landfill areas. This will protect the landfill toe and also mitigate the potential for inundation of the leachate interception drainage system. Design and implementation to be embedded into the consent conditions.

Table 1: Identified Natural Hazards[1] at the Fairfield Landfill

Potential Hazard	Influence of Climate Change	Implications for the Landfill Site	Recommended Actions
Earthquake Seismic risk	NIL	Mapped active faults in the proximity of the landfill. The Akatore fault[1] is located directly offshore, to the east, and the Titri fault located along the eastern side of the Taieri Plain directly west of the site. Seismically induced instability of landfill slopes could result in landfill breach (i.e., leachate release, exposure of landfill material), damage to the landfill cap.	Periodic surveillance monitoring of the landfill as detailed in Section 3.1. Stability assessment of the landfill slopes using the updated 2021 peak ground acceleration (PGAs) outlined in MBIE Module 1[6]. Assessment to also assess effects of elevated groundwater conditions and saturation of the toe on the landfill slopes. Assessment to be embedded into the consent conditions.
Tsunami	Nil	The Akatore Fault is seen as likely to generate a local-source tsunami affecting the nearby coast within minutes. Although located 3 km from the ocean, the estuary/wetland will funnel a tsunami directly towards the landfill. Implications of erosion and landfill breach/infrastructure damage.	Works to increase the height of the perimeter access road and armoring to protect from flooding/ inundation will also provide some protection from tsunamis.

Notes:

1. *Climate projections for Dunedin sourced from: Climate change projections for the Otago Region (Niwa, 2019)*
2. *Precipitation Trends for the Otago Region over the 21st century (Cameron et al, 2016)*
3. *As shown by NZSeaRise data.*
4. *Reported by the Parliamentary Commissioner for the Environment: Preparing New Zealand for rising seas: Certainty and Uncertainty (PCE, 2015)*
5. *Considered the most active fault in Otago, and highest hazard fault for Dunedin, with a predicted quake magnitude of up to 6.8-7.4 and peak ground acceleration of >0.5g (Newshub, 2019; Taylor-Silva, 2017).*
6. *MBIE - Earthquake geotechnical engineering practice, Module 1. Overview of guidelines. (2021).*

3.0 Recommended Actions

The hazard assessment identified the following primary risks/implications associated with climate change:

- Integrity of the cap associated with changes of temperature (cracking), erosion, subsidence, slumping or slope stability resulting in exposure of waste, leachate breach or landfill gas emissions; and
- Increased water levels, flooding and inundation of the leachate interception drain and pumping chamber resulting in shutdown of the pump (potential for leachate to flow directly into the wetland/estuary).

To reduce the risks/implications associated with climate change, the following sections provide further details to the recommended actions described in Table 1.

3.1 Landfill Surveillance Inspections

3.1.1 Inspection Requirements

To ensure the integrity of the landfill is maintained, it is recommended that frequent surveillance including visual inspections, data evaluation, and reporting on the condition of the landfill be undertaken.

Visual surveillance inspections must be completed by a competent and trained personnel who:

- Are familiar with the landfill and features.
- Understand the landfill's potential failure modes and vulnerabilities.
- Are aware of the characteristic behaviour of the landfill and installed instruments and monitoring / sampling locations (if applicable).
- Can detect, record and report any change in landfill condition.
- Are able to recognise indicators of adverse landfill performance and the initiation of potential failure modes.

3.1.2 Inspection Frequency

To ensure the additional hazards as identified in Table 1 are captured, it is recommended that landfill surveillance inspections are carried out at **6 monthly intervals**, the frequency should be reviewed after 5 years. Additional enhanced surveillance inspections are required after any of the following events:

- Following any significant storm / rainfall event
- Following any significant seismic event

- Following inundation from a tsunami or storm surge
- After a potential landfill safety deficiency

These inspection frequency and requirements must be included into the existing WMNZ management plans. Inspection records should be passed onto the relevant stakeholders in a timely manner. The inspection frequency can be reduced once leachate volumes significantly and consistency decrease.

3.1.3 Surveillance Inspection reports

Surveillance inspection forms are live documents and should be modified as required, revisions should be recorded on a register. If any trends or signs which may impact the landfill are identified this must be reported to Otago Regional Council in a timely manner.

Inspections should note the following which will feed into the maintenance requirements:

- Note any instances of surface cracking of the landfill cap.
- Note vegetation coverage, condition and size of vegetation, landfill surface is maintained clear of any trees, and any vegetation that prevents inspection of the landfill slopes.
- Note any signs of vegetation distress on the landfill surface, indicators of landfill gas emissions.
- Condition of surface drains and stormwater storage ponds.
- Any signs of erosion, seepages, inundation, flooding or tide marks etc.
- Signs or indications of slope instability.
- Condition of the leachate interception drainage system and monitoring wells.
- Condition of gas flares and associated wells.
- Condition of any groundwater monitoring wells.
- Signs of vandalism.

A photographic record of the above is recommended to monitor the condition over time.

3.1.4 Maintenance

Maintenance of the landfill cap and associated systems (stormwater runoff collection and leachate collection) will need to include:

- Vegetation control on the landfill surface and embankments,

- Ensuring the stormwater runoff drains and collection ponds are operational (not blocked with excess vegetation,
- Maintenance to any erosion or cracking of the landfill surface and slopes,
- Anything else noted during the surveillance inspections.

A record of maintenance carried out should be kept on file and form part of an annual report as the level of maintenance may provide indicators of the landfill's performance.

3.2 Leachate Interception Drainage System Protection

The leachate interception drainage system is a critical system for the management of leachate onsite and is required to continuously operate in order to intercept leachate from migrating with groundwater from the site until the level of leachate impacts is considered to have a less than minor effect to the environment. There have already been occasions when the perimeter access road has been inundated by backwater effects in the estuary resulting in the interception drain being flooded, and in more extreme events, overtopping the pumping chamber resulting in the leachate pump to stop. It is likely that the frequency of these events will increase with climate change and the expected increase of water levels and rainfall intensity.

To improve the reliability of the continuous operation of the pumping system in leachate interception drain, protection works will be required to be undertaken including lifting the level of the perimeter access road to minimise inundation of the drainage system and placement of armouring/rock protection to mitigate potential wave generated erosion. Increasing the height of the perimeter road will also provide further protection of the landfill toe and improve slope stability.

The height increase is to be determined through modelling and design.

3.3 Landfill Slope Stability Modelling

Based on the hazards identified in Table 1 the following scenarios need to be added to the slope stability modelling of the landfill completed to date (Eastern Landfill only), to accommodate climate change and seismic effects:

1. The seismic slope stability analyses of the landfill should be reassessed using the updated peak ground accelerations (PGAs) given in the MBIE - Earthquake geotechnical engineering practice, Module 1. Overview of guidelines. (2021).
2. To incorporate climate change into the analysis, reassess the static stability of the landfill slopes assuming an elevated groundwater within the landfill mass, this is to allow for increased seepage into the landfill through cracked cover or upward seepage from raising groundwater levels.

3. Re-assess the static performance of the slope from inundation at the toe of the landfill slopes. A multitude of flood inundations levels can be assessed as a sensitivity analysis to allow for varying flood levels and residence times.

As the actual effects of climate change over the consent period are difficult to quantify, scenarios 2 & 3 can be completed undertaking a sensitivity analysis using varying water levels, the relative difference in slope stability can then be assessed to quantify risk and provide recommendations for remedial solutions if warranted.

Appendix A: Site Plan

FIGURE 1: SITE LOCATION

RECONSENSTING FOR FAIRFIELD LANDFILL

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., DEPRECATED BASEMAP - EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

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REVISION: 04 | DATE: FEB 24 | BY: BR
CLIENT: WASTE MANAGEMENT NZ LTD

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APPENDIX 7:

Record of Consultation

(as at February 2024)

Waste Management Limited
Fairfield Closed Landfill – Regional Resource Consent Renewal
Record of Consultation (February 2024)

Party Consulted	**Date and Time**	**Participants**	**Consultation / Outcomes**
Department of Conservation (DOC)	Telephone Conversation – 5 December 2022	***From DOC:*** Hannah Zwalue, Ranger, Community ***On behalf of Waste Management:*** Carmen Taylor, Consultant Planner, Planz Consultants Limited	Phone call with DOC regarding the proposed resource consent. Preliminary information about the nature of the site and the proposed resource consent process was then emailed to DOC on 6 December 2022. DOC confirmed that they would check whether DOC were interested in the site, the consent process and whether DOC wished to meet with Waste Management.
	Email – 3 March 2023	As above	DOC advised that they were interested in the consent application and wished to be kept informed regarding it's process, but did not need to meet with Waste Management at this point. DOC also requested that copies of the technical reports be provided when they become available, in particular any technical reports relating to freshwater and ecological values.
	Email – 6 April 2023	-	A draft copy of the 'Air Quality Assessment' by Tonkin + Taylor (dated March 2023) was provided to DOC.
	Email – 31 August 2023	-	An update on the application was provided to DOC, including providing a brief overview of the status of technical assessments and advising that Waste Management intend to lodge the resource consent application no later than February 2024.
	Email – 8 September 2023	-	Copies of *"Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan"* (September 2023) and *"Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology"* (September 2023) provided to DOC.
	Email – 10 October 2023	-	DOC confirmed the two technical assessments, emailed on 8 September 2023, had been received. No further comments have been received from DOC.

Party Consulted	Date and Time	Participants	Consultation / Outcomes
Te Whatu Ora / Health New Zealand – Public Health (Public Health)	Meeting - 6 December 2022 (9am)	***From Public Health:*** Andrew Shand, Professional Leader Health Protection Dr Virginia McLaughlin, Medical Officer of Health Tom Scott, Team Leader Policy and Strategy ***On behalf of Waste Management:*** David Fitzmaurice, Senior Project Engineer South Island, Waste Management Carmen Taylor, Consultant Planner, Planz Consultants Limited	General discussion in relation to the nature of the site, the local area and the technical assessments being carried out. Public Health requested copies of technical reports when they become available.
	Email – 6 April 2023	-	A draft copy of the 'Air Quality Assessment' by Tonkin + Taylor (dated March 2023), was provided to Public Health.
	Email – 31 August 2023	-	An update on the application was provided to Public Health, including a brief overview of the status of technical assessments and advising that Waste Management intend to lodge the resource consent application no later than February 2024.
	Email – 8 September 2023	-	Copies of *"Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan"* (September 2023) and the *"Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology"* (September 2023) provided to Public Health.
	Email – 10 October 2023	-	Public Health confirmed that the technical assessments, emailed on 8 September 2023, had been received. Public Health also advised that they support the management controls in place, and the proposed monitoring, and have nothing further to add.
Otago Fish and Game Council (F&G)	Meeting - 19 January 2023 (10.30am)	***From F&G:*** Nigel Paragreen, Environmental Officer ***On behalf of Waste Management:*** David Fitzmaurice, Senior Project Engineer South Island, Waste Management (online)	General discussion in relation to the nature of the site, the local area and the technical assessments being carried out. F&G advised that it is interested in the Water Quality and Ecological Effects Assessment, particularly any adverse effects on the estuary, as well as any odour effects, and the 'trigger levels' for when leachate and gas will move to a passive management regime. F&G

Party Consulted	Date and Time	Participants	Consultation / Outcomes
		Carmen Taylor, Consultant Planner, Planz Consultants Limited	identified that it recognised the estuary is degraded, but did not want to see it abandoned, and consider that the city as a whole should strive to make whatever gains, or improvements, that can be made to the estuary. F&G requested copies of the technical reports, and the draft application when they become available.
	Email – 6 April 2023	-	A draft copy of the 'Air Quality Assessment' by Tonkin + Taylor (dated March 2023) was provided to F&G.
	Email – 31 August 2023	-	An update on the status of the application was provided to F&G, including a brief overview of the status of technical assessments and advising that Waste Management intend to lodge the resource consent application no later than February 2024.
	Email – 8 September 2023	-	Copies of *"Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan"* (September 2023) and the *"Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology"* (September 2023) were provided to F&G.
	Email – 8 September 2023	-	F&G confirmed the technical assessments, emailed on 8 September 2023, had been received. No further comments have been received from F&G.
Royal Forest and Bird Protection Society of New Zealand (F&B)	Meeting - 19 January 2023 (1pm)	***From F&B:*** Chelsea McGaw, Regional Conservation Manager – Otago & Southland ***On behalf of Waste Management:*** David Fitzmaurice, Senior Project Engineer South Island, Waste Management (online) Carmen Taylor, Consultant Planner, Planz Consultants Limited	General discussion in relation to the nature of the site, the local area and the technical assessments being carried out. In particular, discussions relating to existing and proposed monitoring, contingency management of the site and facilities (i.e., the leachate system etc) and potential alternatives for the site's gas management. F&B requested copies of the technical reports and the draft application when they become available.
	Email – 6 April 2023	-	A draft copy of the 'Air Quality Assessment' by Tonkin + Taylor (dated March 2023) was provided to F&B.

Party Consulted	Date and Time	Participants	Consultation / Outcomes
	Email – 31 August 2023	-	An update on the status of the application was provided to F&B, including providing a brief overview of the status of technical assessments and advising that Waste Management intend to lodge the resource consent application no later than February 2024.
	Email – 8 September 2023	-	Copies of *“Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan”* (September 2023) and the *“Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology”* (September 2023) were provided to F&B.
	Email – 10 October 2023	-	F&B advised that the technical assessments, emailed on 8 September 2023, had been received. No further comments have been received from F&B.
Te Rūnanga o Otakou / Aukaha	Meeting – 3 April 2023 (1.30pm)	***From Aukaha:*** Tim Vial, Senior Planner – Mana Taiao Pamela (Pam) Walker, Senior Planner – Mana Taiao ***On behalf of Waste Management:*** David Fitzmaurice, Senior Project Engineer South Island, Waste Management (online) Carmen Taylor, Consultant Planner, Planz Consultants Limited	Discussion in relation to the site and the upcoming resource consent process. Aukaha provided an overview of a recently completed Cultural Impact Assessment (**CIA**) for the Green Island Landfill, located on the eastern side of the estuary. General discussion about the next steps. It was agreed: - Aukaha would prepare a proposal, to be provided to Waste Management, for the preparation of a CIA. The scope of work for the CIA is to identify that a site visit, with representatives from Te Rūnanga ō Ōtakou in attendance, forming an initial stage of the CIA. - Waste Management to provide copies of technical assessments to Aukaha when they become available.
	Email – 6 April 2023	-	A draft copy of the ‘Air Quality Assessment’ by Tonkin + Taylor (dated March 2023) was provided to Aukaha.
	Email Correspondence – July 2023	-	Aukaha sent through a proposal to prepare a CIA on behalf of Te Rūnanga ō Ōtakou, with support from Mana Ahurea. Waste Management signed the engagement for the CIA on 17 July 2023.

Party Consulted	Date and Time	Participants	Consultation / Outcomes
	Meeting and Site Visit – 25 August 2023 (2.30pm)	***From Te Rūnanga ō Ōtakou:*** Nadia Wesley-Smith ***From Aukaha:*** Kate Timms-Dean, General Manager: Mana Taiao Tim Vial, Senior Planner – Mana Taiao Yvonne Takau, Planner – Mana Taiao ***On behalf of Waste Management:*** Te Teira Rawiri, Tumu-Tikanga Cultural Advisor, Waste Management Greg Nel, Regional Manager – Otago, Waste Management David Fitzmaurice, Senior Project Engineer South Island, Waste Management Carmen Taylor, Consultant Planner, Planz Consultants Limited	Meeting and site visit held to discuss the project and to enable Te Rūnanga ō Ōtakou and Aukaha to scope issues to be addressed/considered as part of the CIA process.
	Email – 8 September 2023	-	Copies of the *"Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan"* (September 2023) and the *"Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology"* (September 2023) were provided to Aukaha.
	Teams Meeting – 13 December 2023 (10.30am)	***From Aukaha:*** Tim Vial, Senior Planner – Mana Taiao Alex Gorrie, Kaipūkaha (Engineer) - Mana Taiao ***On behalf of Waste Management:*** David Fitzmaurice, Senior Project Engineer South Island, Waste Management Carmen Taylor, Consultant Planner, Planz Consultants Limited	An online meeting was held to discuss the status of the resource consent application and the CIA, and to discuss lodging the application no later than the end of February 2024. It was advised that the CIA would not be ready in time to be appended to the application and it was agreed that the application would be lodged without the CIA but would state that the CIA will be provided to the Otago Regional Council as soon as it is available. It was also discussed that Waste Management would request the application be placed on hold until the CIA becomes available. An email (dated 13 December 2023) was sent to Aukaha, which set out agreed outcomes/approach.

Party Consulted	Date and Time	Participants	Consultation / Outcomes
Local Residents / Neighbours	Letter – 13 March 2023 (and subsequent response)	-	A letter was delivered to Walton Park residences and rural residences located to the south of the landfill site. A copy of the letter is provided in **Attachment A** of this record. Waste Management received registrations of interest from two local residents. Waste Management contacted each of these parties individually to discuss how they would like to meet and/or be provided with information.
	Meeting – 27 April 2023 (7pm)	***Local Resident/s:*** A local resident who resides to the south of the landfill. ***On behalf of Waste Management:*** David Fitzmaurice, Senior Project Engineer South Island, Waste Management Carmen Taylor, Consultant Planner, Planz Consultants Limited	One local resident advised that as the landfill was closed the issues they experienced no longer existed (ie heavy traffic on Old Brighton Road). They also advised they are mainly interested in the long term vision for the site and area, (including in relation to vegetation, public access, and ownership), rather than the consent renewal process. A copy of the 'Air Quality Assessment' by Tonkin + Taylor was provided to the local resident following the meeting. The other local resident who expressed interest in attending this meeting was unable to attend.
	Telephone Conversation – After the 27 April 2023 Meeting	***Local Resident:*** The second local resident, who resides in Walton Park, and expressed an interest in being consulted. ***On behalf of Waste Management:*** David Fitzmaurice, Senior Project Engineer South Island, Waste Management.	A follow-up phone call was had with the local resident who was unable to attend the meeting to discuss the landfill site and the upcoming resource consent application process. The local resident advised their main interest is to ensure that the landfill site does not adversely affect the amenity they enjoy from their home and advised that they did not need to receive any further information or visit the site.
	Email – 11 September 2023	-	Copies of the *"Fairfield Closed Landfill - Natural Hazard and Climate Risk Assessment and Management Plan"* (September 2023) and the *"Fairfield Landfill – Technical Assessment of Effects on Groundwater, Surface Water and Ecology"* (September 2023) were provided to the local resident that attended the meeting on 27 April 2023. No further comments have been received from the landowner.

ATTACHMENT A

Community Consultation Invite

Letter, from Waste Management NZ Limited, dated 13 March 2023

Head Office

Waste Management New Zealand Limited

318 East Tamaki Road, East Tamaki

Auckland 2013

0800 10 10 10

www.wastemanagement.co.nz

13 March 2023

Fairfield Closed Landfill – Renewal of Regional Resource Consents
Community Consultation Invite

Dear Neighbour

Waste Management NZ Limited (Waste Management) own and operate the area associated with the now closed Fairfield Landfill. This landfill is located in Fairfield (Walton Park), adjacent to Kaikorai Estuary and located approximately 1km off Old Brighton Road as shown in Figure 1.

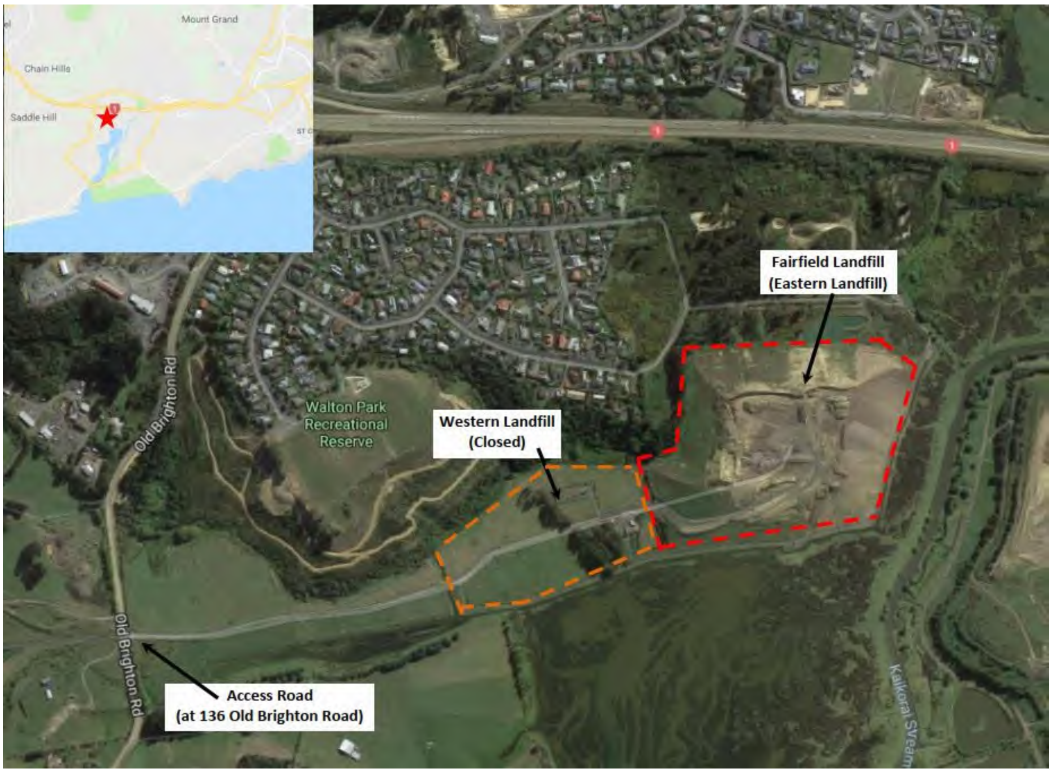


Figure 1 – Location of Waste Management NZ Limited's closed landfill in Fairfield, Dunedin (Source: Google Maps).

APPENDIX 8:

Proposed Consent Conditions

Waste Management NZ Limited

Fairfield Closed Landfill – Renewal of Regional Resource Consents

Proposed Consent Conditions

NOTE:

There are number of repeated conditions which are proposed to be attached to all four of the resource consents being sought by Waste Management. It is acknowledged that an alternative approach would be to place these repeated conditions into a schedule which could then be attached to each of the resource consents, along with a condition requiring compliance with the conditions contained in the schedule.

Waste Management are comfortable with either approach.

The land parcel legal descriptions that apply to the broader site and the following resource consents are as follows:

- The ***landholding***, as a whole, which is owned by Tartan Industries Limited (a subsidiary of Waste Management Limited) - Lot 2 DP566541 (RT 1021375), Part Lot B DP685 (RT OT8D/1045) and Part Section 41 Block VIII Dunedin & East Taieri Survey District and DP7227 (RT OT352/110).
- The land parcels associated with the Western and Eastern Landfills, or 'the landfill' or 'the landfill site', which are associated with the following resource consents are - Lot 2 DP566541 (RT 1021375) and Part Lot B DP685 (RT OT8D/1045).
- The Western Landfill is located in both Lot 2 DP566541 (RT 1021375) and Part Lot B DP685 (RT OT8D/1045).
- The Eastern Landfill is located solely in Lot 2 DP566541 (RT 1021375).

A. Discharge Permit – Discharges to Air

General

1. The discharge of landfill gas, and associated odour, to air must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert].

    a) [References to be inserted].

    If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.

2. The discharge of odour shall not cause a noxious, dangerous, offensive or objectionable effect beyond the site boundary.

    <u>Advice Note:</u> *For the purposes of this consent, whether an odour is objectionable and has, or is, causing an adverse effect is determined by a Council Officer, or delegated Council Officer, having regard to the frequency, intensity, duration, nature, location of the odour, and any previous odour complaints relations to the subject site.*

Landfill Gas Management

3. Until written notice has been provided to the Consent Authority in accordance with Condition 4, the Consent Holder must operate and maintain the gas management system

associated with the Eastern Landfill in a manner that ensures that adverse effects on the environment are minimised. The key components of the landfill gas management that must be maintained in accordance with this condition include, but are not limited to:

a) The landfill cap.

b) The landfill gas conveyance pipe network.

c) The landfill gas well/s and flare/s.

d) Any passive venting system, following the decommissioning of the flare/s, as provided for by Condition 4.

4. The Consent Holder may change to a passive landfill gas management system where the landfill gas at the Eastern Landfill is no longer flared, provided:

   a) The criteria, or trigger levels, specified in the AMP for changing to a passive landfill gas management system are met; and

   b) Written notice of the intended change has been given to the Consent Authority at least one month prior to changing to a passive landfill gas management system.

5. The Consent Holder must inspect the landfill site for evidence of uncontrolled landfill gas discharges and maintain a record of the inspections that have been carried out. The inspections are to be carried out in conjunction with the monitoring, required by Conditions 9 to 2, at the following frequency:

   a) While flaring of the landfill gas is occurring, at least monthly;

   b) Thereafter, at least quarterly.

   Where evidence of uncontrolled landfill gas discharges is identified during these inspections, the Consent Holder must register the discharge as an incident in the Complaints and Incidents Register in accordance with Condition 13.

   The Consent Holder must also investigate and then implement actions, in a timely manner, that remedies or mitigates the uncontrolled landfill gas discharge. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 13.

   <u>Advice Note:</u> *Evidence of uncontrolled discharges may include, but is not be limited to, the presence of landfill gas odours, gas bubbling within puddles and/or the leachate cut-off drain and from the development of fissures in the landfill cap.*

Aftercare Management Plan

6. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 8(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified.

7. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 8 of this consent.

8. The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert].

   The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address:

a) Compliance with the conditions of Consents [to insert] to [to insert].

b) The roles and responsibilities of parties with management and operational responsibilities at the site, including relevant contact details.

c) Site maintenance and inspection requirements, including during the different phases of the aftercare period.

d) The performance of the site infrastructure and environment monitoring requirements, including during the different phases of the aftercare period.

e) The criteria, or trigger levels, for changing from active management of the site's landfill leachate and landfill gas to a passive system, and a description of the stages or steps, including interim stages or steps, associated with the change from active to passive management of these systems.

f) Emergency management and contingency procedures, including, but not limited to, from natural hazards such as site flooding.

g) Recording and responding to complaints and incidents at the site.

h) The future use and management of the site, including, but not limited to, the basis for providing access to site by third parties.

i) Reviews of the AMP, which at a minimum, must occur:

    - at least every two years during the first 10 years of this consent, and thereafter at least every five years; and
    - whenever there is a significant change in the nature of site operations, which includes, but is not limited to, when the site changes from active to passive management of the landfill leachate and landfill gas.

Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.

Monitoring

9. While landfill gas is being flared at the Eastern Landfill, the Consent Holder must have in place a system, or systems, to monitor and record the flow rate of the landfill gas generated from the site. At a minimum, the landfill gas flow rate must be measured at least monthly.

10. The Consent Holder must monitor the composition of the landfill gas within the gas conveyance pipe network to the landfill gas flares/s and/or the passive vent/s at the following frequency:

    a) While flaring of the landfill gas is occurring, at least monthly;

    b) Thereafter, at least quarterly, during January, April, July and October each year, and only from the landfill gas well embedded in the landfill.

    The landfill gas parameters to be monitored are methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.

11. The Consent Holder must monitor the composition of the landfill gas at wells LGS1, LD5, LGS7, LS21A, LGS27, LGS29, LS31, LS32, G34, G37, G38, MW1, MW2 and MW3, as identified on Plan [to insert] attached to this consent, at the following frequency:

    a) At least quarterly, during January, April, July and October each year, unless Part (b) of this condition applies;

    b) The frequency of monitoring may be reduced, or monitoring may cease, provided that the following requirements have been met:

        - A review of the last two years of monitoring data, and an associated assessment of adverse effects on the environment has confirmed that the risks associated with landfill gas generation and/or migration are minimal as determined by a suitably qualified and experienced person; and

        - Written notice of the proposed amendments to monitoring programme required by this condition, including provision of the assessment carried out, has been provided to the Consent Authority and the Consent Authority certifies that the proposed amended monitoring programme is appropriate; and

        - The review to reduce or cease monitoring can only be undertaken by the Consent Holder at two yearly periods following the grant of this consent.

    c) The landfill gas parameters to be monitored are methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.

12. The results of all monitoring carried out in accordance with Conditions 9 to 11 must be provided to the Consent Authority annually as part of the annual report required by Condition 15, and at all other times must be available for inspection upon request by the Consent Authority.

Complaints and Incidents Register

13. The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert], including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to:

    a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred.

    b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred.

    c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information.

    d) In relation to discharges to air, a description of the weather conditions, including approximate wind speed and direction when the discharge was detected by the complainant or when the incident occurred.

    e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again.

    The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 15, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.

Reporting

14. a) The Consent Holder must notify the Consent Authority in a timely manner, and no longer than five working days, after the Consent Holder becomes aware of any sudden adverse change in gas levels, or if a trend of increasing gas concentrations of flow rates is indicated.

    b) The Consent Holder must also register such events as an incident in the Complaints and Incidents Register in accordance with Condition 13.

    c) The Consent Holder must investigate and then implement actions, if feasible, in a timely manner, that remedies or mitigates the incident. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 13, and must also be reported to the Consent Authority within one month of the action or outcome being resolved by the Consent Holder.

    Advice Note: *Sudden adverse change is where there is a significant increase in gas concentrations or flow rates which is inconsistent with previous monitoring data and/or the results are unexpected.*

15. By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report related to the closed landfill activities authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to:

    a) The results of all inspections and monitoring undertaken over the preceding 12 months;

    b) An assessment of the current state of effects on the receiving environment;

    c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill leachate, or landfill gas, to a passive system as described in the AMP required by Condition 8 of this consent;

    d) Proposed and / or agreed amendments to the monitoring programme; and

    e) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.

Review

16. The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority in relation to the exercise of this consent, for the purpose of:

    a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent;

    b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements;

    c) Reviewing the frequency of monitoring or reporting required under this consent.

B. Discharge Permit – Discharge of Landfill Leachate

General

1. The discharge of landfill leachate, to groundwater, by seepage, through the 21 hectare base of the Fairfield closed landfill which is bounded by the leachate interception drain, must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert].

   a) [References to be inserted].

   If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.

Closed Landfill Integrity – Inspections, Maintenance and Risk Modelling

2. The Consent Holder must ensure that the closed landfill is maintained in a manner that ensures that the structural integrity of the closed landfill is maintained, and that ensures leachate generation is being effectively controlled. The key components of the site that must be maintained in accordance with this condition, include, but are not limited to:

   a) Structurally sound landfill cap on the Eastern Landfill, and landfill surface over both the Western and Eastern Landfills, including ensuring there is no evidence of surface cracks, slope instability, erosion, seepages, inundation and/or flooding.

   b) Appropriate vegetation coverage of the landfill surface, which includes ensuring that trees and shrubs are not present on the landfill surface.

   c) Appropriate drainage systems, including surface drains and the stormwater management system (where required).

3. The Consent Holder must inspect the site to confirm that structural integrity of the closed landfill is being maintained and that leachate generation is being effectively controlled, and the Consent Holder must maintain a record of the inspections that have been carried out. The inspections are to be carried out at the following frequency:

   a) While active management of site’s landfill leachate system is occurring, at least every six months; and

   b) At least annually once passive management of landfill leachate is occurring, as provided for by the conditions of Consent [to insert]; and

   c) In a timely manner, and no more than two weeks after, any significant storm / rainfall event, significant seismic event or inundation from a tsunami or storm surge.

   The Consent Holder must maintain a record of the inspections that have been carried out.

4. Where issues are identified in relation to the structural integrity of the closed landfill or the systems that control leachate generation during these inspections, the Consent Holder must:

   a) register the issue as an incident in the Complaints and Incidents Register in accordance with Condition 9;

   b) investigate and then implement actions, in a timely manner, that remedies or mitigates the issues identified during the inspection. These actions and outcomes must also be recorded in the Complaints and Incidents Register required by Condition 9.

5. Within two years of the commencement of this resource consent, and every five years thereafter, the Consent Holder must reassess the slope stability of the Eastern Landfill only. The purpose of this reassessment is to ensure that climate change considerations and potential seismic effects have been appropriately identified, considered and assessed. At a minimum, the reassessment must consider:

    a) Update peak ground accelerations in line with the most recent guidance and New Zealand standard documents;

    b) The static stability of the slopes assuming elevated groundwater within the landfill mass and the associated risks from increased or upward seepage; and

    c) The static performance of the slope from inundation of the toe of the landfill slope by a range of flood inundation levels and residence times.

    Where a risk, or risks, are identified from the reassessment, the Consent Holder must register the risk as an incident in the Complaints and Incidents Register in accordance with Condition 9.

    The Consent Holder must also implement actions or recommendations identified during this assessment, in a timely manner, that remedies or mitigates the risk identified. These actions, recommendations or outcomes must be recorded in the Complaints and Incidents Register required by Condition 9.

Aftercare Management Plan

6. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 8(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified.

7. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 8 of this consent.

8. The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert].

    The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address:

    a) Compliance with the conditions of Consents [to insert] to [to insert].

    b) The roles and responsibilities of parties with management and operational responsibilities at the site, including relevant contact details.

    c) Site maintenance and inspection requirements, including during the different phases of the aftercare period.

    d) The performance of the site infrastructure and environment monitoring requirements, including during the different phases of the aftercare period.

    e) The criteria, or trigger levels, for changing from active management of the site's landfill leachate and landfill gas to a passive system, and a description of the stages or steps, including interim stages or steps, associated with the change from active to passive management of these systems.

f) Emergency management and contingency procedures, including, but not limited to, from natural hazards such as site flooding.

g) Recording and responding to complaints and incidents at the site.

h) The future use and management of the site, including, but not limited to, the basis for providing access to site by third parties.

i) Reviews of the AMP, which at a minimum, must occur:

    - at least every two years during the first 10 years of this consent, and thereafter at least every five years; and
    - whenever there is a significant change in the nature of site operations, which includes, but is not limited to, when the site changes from active to passive management of the landfill leachate and landfill gas.

Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.

Complaints and Incident Register

9. The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert], including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to:

a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred.

b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred.

c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information.

d) A description of the area's environmental conditions that are relevant to the matter detected by the complainant or the incident that occurred, including, but not limited to, the weather conditions.

e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again.

The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 10, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.

Reporting

10. By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report related to the closed landfill activities authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to:

a) The results of all inspections and assessments undertaken over the preceding 12 months;

b) An assessment of the current state of effects on the receiving environment;

c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill leachate, or landfill gas, to a passive system as described in the AMP required by Condition 8 of this consent; and

d) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.

Review

11. The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority in relation to the exercise of this consent, for the purpose of:

    a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent;

    b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements;

    c) Reviewing the frequency of monitoring or reporting required under this consent.

Advice Note/s:

A. Leachate, and related groundwater and receiving environment, monitoring requirements for the closed landfill are specified in Consent [to Insert] which authorises the take of groundwater containing leachate and other groundwater. This approach to monitoring has been adopted as the 'take of groundwater containing leachate' (and other groundwater) is a key component of the closed landfill's leachate management system. It this component of the system that captures the leachate from the landfill, that has been discharged, before the leachate migrates beyond the landfill boundary. As the take component of the system does not capture all leachate, attaching the monitoring programme requirements to the take component of the leachate management system is the most appropriate means of determining the effectiveness, and the resultant effects on the environment, of the discharge of leachate from the site.

C. Water Permit – Take of Groundwater Containing Leachate and Other Groundwater

General

1. The take of groundwater containing leachate and other groundwater, for the purpose of controlling landfill leachate and to maintain groundwater within the area bounded by the Fairfield closed landfill's leachate interception drain, must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert].

   a) [References to be inserted].

   If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.

Leachate Management

2. Until written notice has been provided to the Consent Authority in accordance with Condition 3, the Consent Holder must operate and maintain the leachate management system associated with the site in a manner that ensures the effective control of landfill leachate and to maintain the groundwater level depression within the interception drain system. The key components of the leachate management system that must be maintained in accordance with this condition including, but are not limited to:

   a) Lateral drainage network;

   b) Interception drainage trench;

   c) Sumps and pumping station;

   d) Water level monitoring system within the interception drainage trench, sumps and pumping station;

   e) Alarm systems notifying of any operations issues or when the pump station/s switches off; and

   f) Connection to the Dunedin City Council's wastewater network for disposal of the groundwater containing leachate.

   <u>Advice Note:</u> *Maintenance of the leachate management system to achieve the purpose of this condition includes maintaining a groundwater level depression in the phreatic zone (zone of saturation). The depression of the phreatic surface must be sufficient to cause the drain to intercept phreatic groundwater which would, ordinally, have flowed outward from the drain to adjacent groundwater and the Kaikorai Stream / Kaikorai Lagoon Swamp. The slope of the phreatic groundwater level must be inward towards the interception drain/trench.*

3. The Consent Holder may change to a passive leachate management system where the landfill leachate at the site is no longer intercepted and removed from the site, provided:

   a) The criteria, or trigger levels, specified in the AMP for changing to a passive leachate management system are met; and

   b) Written notice of the intended change has been given to the Consent Authority at least one month prior to changing to a passive leachate management system.

4. The Consent Holder must inspect the site to ascertain that site's leachate management system is operating as required, and the Consent Holder must maintain a record of the inspections that have been carried out. The inspections are to be carried out in conjunction with the monitoring, required by Conditions 10 and 11, at the following frequency:

a) While the site's leachate is being actively managed, at least quarterly;

b) Thereafter, once passive management of leachate commences, at least annually.

Where evidence of uncontrolled leachate discharges beyond the site boundary is identified during these inspections, the Consent Holder must register the discharge as an incident in the Complaints and Incidents Register in accordance with Condition 8.

The Consent Holder must also investigate and then implement actions, in a timely manner, that remedies or mitigates the uncontrolled landfill gas discharge. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 8.

Aftercare Management Plan

5. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 7(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified.

6. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 7 of this consent.

7. The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert].

   The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address:

   a) Compliance with the conditions of Consents [to insert] to [to insert].

   b) The roles and responsibilities of parties with management and operational responsibilities at the site, including relevant contact details.

   c) Site maintenance and inspection requirements, including during the different phases of the aftercare period.

   d) The performance of the site infrastructure and environment monitoring requirements, including during the different phases of the aftercare period.

   e) The criteria, or trigger levels, for changing from active management of the site's landfill leachate and landfill gas to a passive system, and a description of the stages or steps, including interim stages or steps, associated with the change from active to passive management of these systems.

   f) Emergency management and contingency procedures, including, but not limited to, from natural hazards such as site flooding.

   g) Recording and responding to complaints and incidents at the site.

   h) The future use and management of the site, including, but not limited to, the basis for providing access to site by third parties.

   i) Reviews of the AMP, which at a minimum, must occur:

- at least every two years during the first 10 years of this consent, and thereafter at least every five years; and
- whenever there is a significant change in the nature of site operations, which includes, but is not limited to, when the site changes from active to passive management of the landfill leachate and landfill gas.

Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.

Complaints and Incident Register

8. The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert], including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to:

   a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred.

   b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred.

   c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information.

   d) A description of the area's environmental conditions that are relevant to the matter detected by the complainant or the incident that occurred, including, but not limited to, the weather conditions.

   e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again.

   The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 22, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.

Monitoring

General

9. Unless stated otherwise, the results of all monitoring carried out in accordance with Conditions 10 to 18 must be provided to the Consent Authority annually as part of the annual report required by Condition 22, and at all other times must be available for inspection upon request by the Consent Authority.

Levels – Leachate Management System, Groundwater and Surface Water

10. While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must have in place a system, or systems, to continuously monitor (at 15-minute intervals) the water/leachate levels in the leachate pumping chamber (EPS42 as identified on Plan [to insert]). This monitoring data is to be downloaded at least quarterly, during January, April, July and October.

    Advice Note: *The purpose of this monitoring is to confirm that the pumping system has remained operational.*

11. While groundwater containing leachate is being taken in accordance with this consent, discrete water/leachate level monitoring must be carried out at least quarterly, during January, April, July and October, at the following monitoring locations identified on Plan [to insert]:

    a) Leachate interception drain wells (LS23, LS24, LS25, LS26, LGS27, LS28, LGS29, LS30, LS31, LS32 and LS33);

    b) Leachate pumping chamber (EPS42);

    c) Groundwater wells within the landfill footprint (LGS1, LS2, LS6, LS9, LS14 and LD5);

    d) Groundwater wells outside the landfill footprint (LGS7, LS10, LS13, LS15, LS19, LS21A, LS22, LD8, LD11, LD17 and LD20); and

    e) Surface water locations (SP1, SP2, SP3 and SP5)

Leachate

12. While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must have in place a system, or systems, to monitor and record the instantaneous abstraction rate of the leachate, and associated groundwater, that is taken from the site. The monitoring data is to be:

    a) Accurately recorded at an average rate of 15 minutes; and

    b) Provided to the Consent Authority within the annual report required by Condition 22, and available to the Consent Authority upon request.

13. While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must collect samples, at least every six months during January and July, from the leachate interception drain wells, at sampling locations LS24, LS26, LS28, LS30 and LS32 (as identified on Plan [to insert]). The samples must be analysed for the following parameters:

    a) pH, conductivity, temperature, total ammoniacal nitrogen, phosphorus, dissolved reactive phosphorus, chloride.

14. While groundwater containing leachate is being taken in accordance with this consent, the Consent Holder must collect a sample, annually in July, from the leachate pumping chamber (EPS42 as identified on Plan [to insert]). The sample must be analysed for the following parameters:

    a) COD, BOD_5, total ammoniacal nitrogen, temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, bicarbonate, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, copper, lead and cation/anion ratio.

Groundwater Quality

15. The Consent Holder must monitor the quality of groundwater from samples collected from wells LGS1, LGS7, LS10, LS13, LS15, LS19, LS22, LD8, LD11, LD17 and LD20, as identified on Plan [to insert] attached to this consent, at the following frequency:

    a) At least every six months, during January, and July each year, unless Condition 19 of this consent applies;

    b) The samples must be analysed for pH, conductivity, temperature, total ammoniacal nitrogen, phosphorus, dissolved reactive phosphorus, chloride.

16. The Consent Holder must monitor the quality of deep groundwater from samples collected from wells LD5, LD8, LD11, LD17 and LD20, as identified on Plan [to insert] attached to this consent, at the following frequency:

    a) At least annually, in July each year, unless Condition 19 of this consent applies;

    b) The samples must be analysed for COD, BOD_5, total ammoniacal nitrogen, temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, lead.

Surface Water Quality

17. The Consent Holder must monitor the quality of surface water, upstream and downstream of the site, as follows:

    a) At either:

        - The preliminary surface water sampling locations SW1, SW2, SW3, SW4, SW5, SW6 and SW7 shown on Plan [to insert]; or

        - The relocated and confirmed surface water locations SW1, SW2, SW3, SW4, SW5, SW6 and SW7, which have been confirmed by suitably qualified persons, following site inspection to confirm access and their suitability with respect to the area of groundwater upwelling. If the sampling locations are relocated, as provided for by this condition, this will be advised in the annual report required by Condition 22.

    b) At least quarterly, during January, April, July and October, unless Condition 19 of this consent applies;

    c) The samples must be analysed for salinity, dissolved oxygen, BOD_5, total ammoniacal nitrogen, temperature, conductivity, pH, calcium, magnesium, sodium, potassium, chloride, alkalinity, sulphate, nitrate, phosphorus, dissolved reactive phosphorus, iron, zinc, lead.

Ecology

18. The Consent Holder must ensure that an ecological monitoring programme, consisting of habitat assessment, macroinvertebrate community composition, vegetation survey, birds counts and fish surveys, is carried out at the following frequency:

    a) Annually, between the months of October to March, for the first three years following the grant of this consent; and

    b) Thereafter, unless Condition 19 applies, once every five years, between the months of October to March.

    At a minimum, sampling locations for the ecological monitoring programme must align with the locations for surface water monitoring required by Condition 17.

Reduction and/or Cessation of Monitoring

19. The frequency of monitoring required by Conditions 10 to 18 may be reduced, or monitoring may cease, provided that the following requirements have been met:

    a) A review of the last two years of monitoring data, and an associated assessment of adverse effects on the environment, has confirmed that the risks associated with the generation of landfill leachate and migration beyond the site boundary are minimal as determined by a suitably qualified and experienced person; and

b) Written notice of any proposed amendments to the monitoring programme under this condition, including provision of the assessment carried out under part (a), has been provided to the Consent Authority and the Consent Authority certifies that the proposed amended monitoring programme is appropriate; and

c) The review to reduce or cease monitoring can only be undertaken by the Consent Holder at two yearly periods following the grant of this consent.

If the Consent Holder has not received a response from the Consent Authority either certifying the proposed amendments or refusing to certify the proposed amendments within one month from the date of submission of the written notice being provided under (b), the proposed amendments are deemed to be certified.

Mitigation – Effects from Climate Change

20. Within two years of the grant of this resource consent, the Consent Holder must complete an assessment and/or modelling, and a design, for proposed mitigation works. The purpose of these mitigation works is to minimise the inundation of the leachate management system and to protect the landfill toe and landfill stability from the adverse climate change effects associated with the increased occurrence of high estuary levels and/or wave generated erosion.

    Advice Note: *At the time this resource consent was processed, an identified solution for the mitigation works is to increase the level of the site’s perimeter access road and put in place associated protection/armouring works. An alternative solution/s, that achieves the purpose of this condition, maybe identified as part of the assessment and/or modelling required by this condition. For this reason, a specific solution has not been identified within this condition.*

21. The outcomes, in terms of the identified design, required by Condition 20 must be provided to the Consent Authority within three months of completion of the required assessment. The Consent Holder, in providing the Consent Authority with the assessment carried out, must identify the timeframes for completing the construction of the design identified by the assessment.

    Advice Note: *Additional resource consents for the construction works (i.e., soil disturbance and/or earthworks) may be required to authorise the proposed works. If this is the case, the resource consents will need to be in place prior to construction works commencing.*

Reporting

22. By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report related to the closed landfill activities authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to:

    a) The results of all inspections and monitoring undertaken over the preceding 12 months;

    b) An assessment of the current state of effects on the receiving environment;

    c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill leachate, or landfill gas, to a passive system as described in the AMP required by Condition 7 of this consent;

    d) Proposed and / or agreed amendments to the monitoring programme; and

e) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.

Review

23. The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority in relation to the exercise of this consent, for the purpose of:

    a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent;

    b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements;

    c) Reviewing the frequency of monitoring or reporting required under this consent.

D. Discharge Permit – Discharge of Stormwater

General

1. The discharge of discharge stormwater runoff diverted from the Fairfield closed landfill into the Kaikorai Stream and Kaikorai Lagoon Swamp, after treatment through the stormwater treatment ponds, must be carried out in accordance with the plans and all information submitted with the application, detailed below, and all reference by the Consent Authority as consent number [to insert].

   a) [References to be inserted].

   If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.

Stormwater Management

2. Until written notice has been provided to the Consent Authority in accordance with Condition 3, the Consent Holder must operate and maintain the site's stormwater system at the site in a manner that ensures the effective control and treatment of the site's stormwater. The key components of the stormwater management system that must be maintained in accordance with this condition include, but are not limited to:

   a) Stormwater drainage network;

   b) The two stormwater retention / treatment ponds; and

   c) The discharge outfalls.

3. The Consent Holder may cease active management of the site's stormwater system and/or change the nature and purpose of the two stormwater ponds, provided:

   a) The criteria, or trigger levels, specified in the AMP for ceasing or changing the nature of stormwater management are met; and

   b) Written notice of the intended change has been given to the Consent Authority at least one month prior to ceasing or changing the nature of stormwater management.

   Advice Note: *An example of changing the nature or purpose of the stormwater ponds, could be the planting of the ponds and creating two wetlands on the site.*

4. The Consent Holder must inspect the site to ascertain that site's stormwater management system is operating as required, and the Consent Holder must maintain a record of the inspections that have been carried out. The inspections are to be carried at the following frequency:

   a) While the site's stormwater is being actively managed, at least quarterly;

   b) Thereafter, once active management of the stormwater ceases or is changed, at least annually.

   Where evidence of issues with the site's stormwater management system is identified during these inspections, the Consent Holder must register the issue as an incident in the Complaints and Incidents Register in accordance with Condition 8.

   The Consent Holder must also investigate and then implement actions, in a timely manner, that remedies or mitigates the issue with the stormwater management system. These actions and outcomes must be recorded in the Complaints and Incidents Register required by Condition 8.

Aftercare Management Plan

5. Within three months of the commencement of this consent, and thereafter following any amendments to the AMP made in accordance with Condition 7(i), the Consent Holder must submit an AMP to the Consent Authority for certification. If the Consent Holder has not received a response from the Consent Authority either certifying the AMP or refusing to certify the AMP within one month from the date of submission of the AMP, the AMP is deemed to be certified.

6. The Consent Holder is to ensure that all activities and operations at the closed landfill site are carried in accordance with the certified AMP required by Condition 7 of this consent.

7. The AMP must be based on the AMP submitted as part of the application and must apply to all aspects of the closed landfill as authorised by Consents [to insert] to [to insert].

   The purpose of the AMP is to ensure that procedures are in place that will ensure that the closed landfill, during the aftercare period, is appropriately managed so that adverse effects on the environment arising from the activities authorised by Consents [to insert] to [to insert] are avoided, remedied or mitigated. The AMP must contain procedures that, as a minimum, address:

   a) Compliance with the conditions of Consents [to insert] to [to insert].

   b) The roles and responsibilities of parties with management and operational responsibilities at the site, including relevant contact details.

   c) Site maintenance and inspection requirements, including during the different phases of the aftercare period.

   d) The performance of the site infrastructure and environment monitoring requirements, including during the different phases of the aftercare period.

   e) The criteria, or trigger levels, for changing from active management of the site's landfill leachate and landfill gas to a passive system, and a description of the stages or steps, including interim stages or steps, associated with the change from active to passive management of these systems.

   f) Emergency management and contingency procedures, including, but not limited to, from natural hazards such as site flooding.

   g) Recording and responding to complaints and incidents at the site.

   h) The future use and management of the site, including, but not limited to, the basis for providing access to site by third parties.

   i) Reviews of the AMP, which at a minimum, must occur:

      - at least every two years during the first 10 years of this consent, and thereafter at least every five years; and

      - whenever there is a significant change in the nature of site operations, which includes, but is not limited to, when the site changes from active to passive management of the landfill leachate and landfill gas.

   Any amendments to the AMP arising as a result of a review carried out in accordance with the requirements of part (i) of this condition, are to be submitted to the Consent Authority for re-certification before being implemented at the closed landfill site.

Complaints and Incident Register

8. The Consent Holder must maintain a record of complaints and incidents in relation to all activities at the closed landfill site authorised by Consents [to insert] to [to insert], including complaints received and incidents that have occurred in relation to the activity authorised by this consent. The register must include, but not be limited to:

    a) The location where the complainant detected the matter that is the subject of the complaint or where the incident occurred, and the associated date and time that the matter was detected, or the incident occurred.

    b) A description of the nature of matter detected by the complainant or the nature of the incident that occurred.

    c) The name, phone number and address of the complainant, unless the complainant elects not to supply this information.

    d) A description of the area's environmental conditions that are relevant to the matter detected by the complainant or the incident that occurred, including, but not limited to, the weather conditions.

    e) Action taken by the Consent Holder to avoid, remedy or mitigate the matter detected by the complainant or the incident that occurred, and any policies or methods put in place to avoid the matter or incident occurring again.

    The complaints and incident record must be provided to the Consent Authority annually as part of the annual report required by Condition 9, and at all other times the complaints and incident record must be available for inspection upon request by the Consent Authority.

Reporting

9. By 30 November each year, the Consent Holder must prepare and have submitted to the Consent Authority, an annual report assessing the effects on the environment associated with all activities at the closed landfill site authorised by Consents [to insert] to [to insert]. The annual report must include, but is not limited to:

    a) The results of all inspections undertaken over the preceding 12 months;

    b) An assessment of the current state of effects on the receiving environment;

    c) An evaluation of progress towards passive management practices at the site, including any stages or steps associated with this change, in the context of the criteria, or trigger levels, for changing from active management of the site's landfill leachate, or landfill gas, to a passive system as described in the AMP required by Condition 6 of this consent; and

    d) All complaints and incidences logged in the Complaints and Incidents Register over the preceding 12 months, and the actions in response to the complaint or incident.

Review

10. The Consent Authority may, in accordance with sections 128 and 129 of the RMA, serve notice on the Consent Holder of its intention to review the conditions of this consent each year, during the three month period either side of the date of granting this consent, or within two months of any enforcement action by the Consent Authority in relation to the exercise of this consent, for the purpose of:

    a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent;

b) Ensuring conditions of this consent are consistent with any national environmental standards, relevant regional plans and/or regional policy statements;

c) Reviewing the frequency of monitoring or reporting required under this consent.

APPENDIX 9:

Records of Title

(Tartan Industries Limited's landholding - Lot 2 DP566541 (RT 1021375), Part Lot B DP1685 (RT OT8D/1045) and Part Section 41 Block VIII Dunedin & East Taieri Survey District and DP7227 (RT OT352/110))

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Guaranteed Search Copy issued under Section 60 of the Land Transfer Act 2017

R.W. Muir
Registrar-General
of Land

Identifier **1021375**
Land Registration District **Otago**
Date Issued 01 March 2023

Prior References
OT13B/390

Estate Fee Simple
Area 29.9415 hectares more or less
Legal Description Lot 2 Deposited Plan 566541
Registered Owners
Tartan Industries Limited

Interests

Subject to a right (in gross) to drain sewage over part marked E on DP 566541 in favour of Dunedin City Council created by Transfer 791536.1 - 4.11.1991 at 9:56 am

Subject to a right (in gross) to drain sewage over part marked B on DP 566541 in favour of Dunedin City Council created by Transfer 975470.1 - 23.9.1999 at 9:10 am

12281925.3 Consent Notice pursuant to Section 221 Resource Management Act 1991 - produced 30.11.2022 at 8:48 am entered 1.3.2023 at 7:01 am

Subject to a right (in gross) to drain sewage over part marked ZF, a right (in gross) to convey water over part marked U and a right (in gross) to drain water over part marked H all on DP 566541 in favour of Dunedin City Council created by Easement Instrument 12281925.4 - produced 30.11.2022 at 8:48 am entered 1.3.2023 at 7:01 am

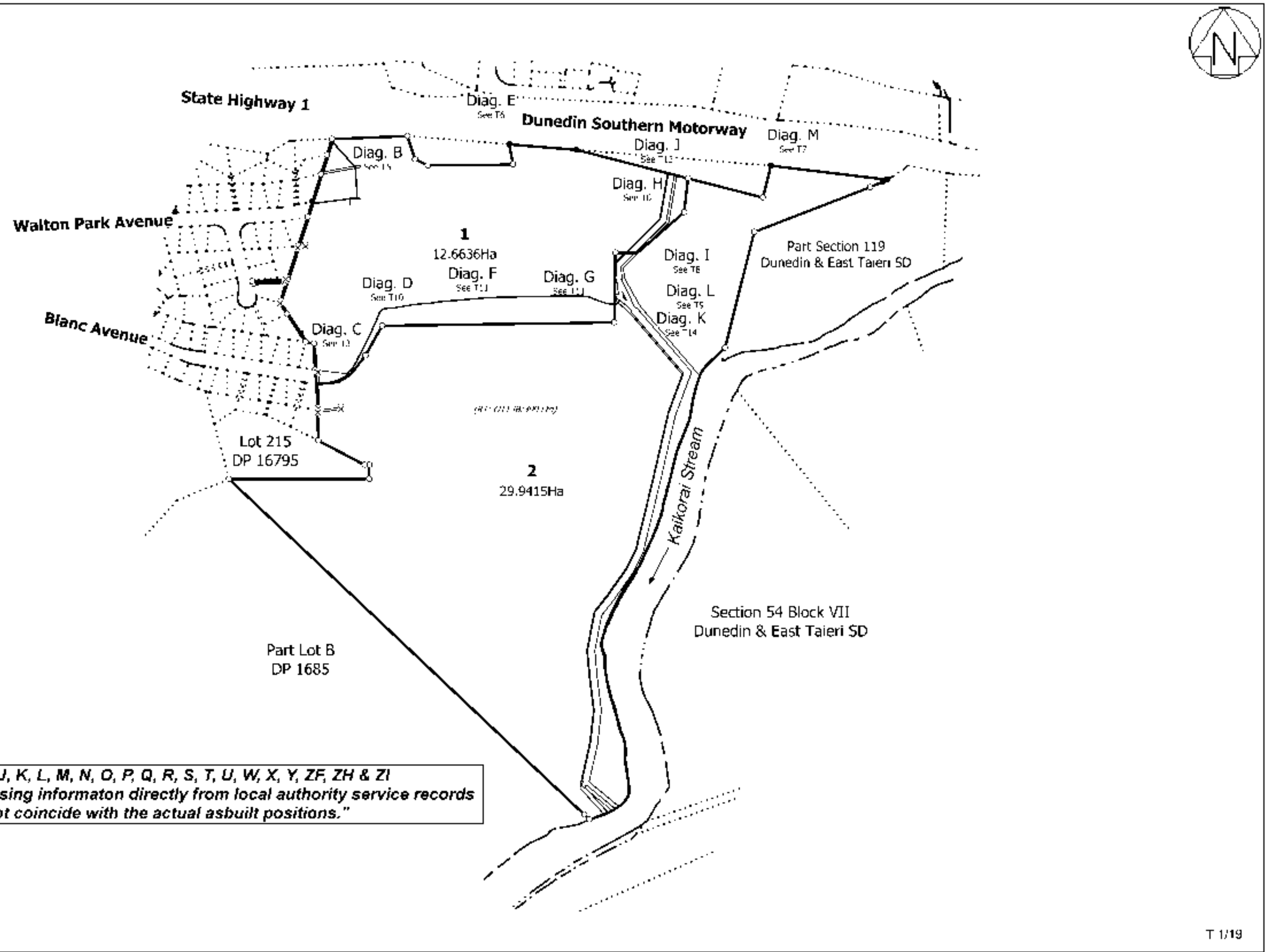
The easements created by Easement Instrument 12281925.4 are subject to Section 243 (a) Resource Management Act 1991

Appurtenant hereto is a right of way created by Easement Instrument 12281925.5 - produced 30.11.2022 at 8:48 am entered 1.3.2023 at 7:01 am

The easements created by Easement Instrument 12281925.5 are subject to Section 243 (a) Resource Management Act 1991

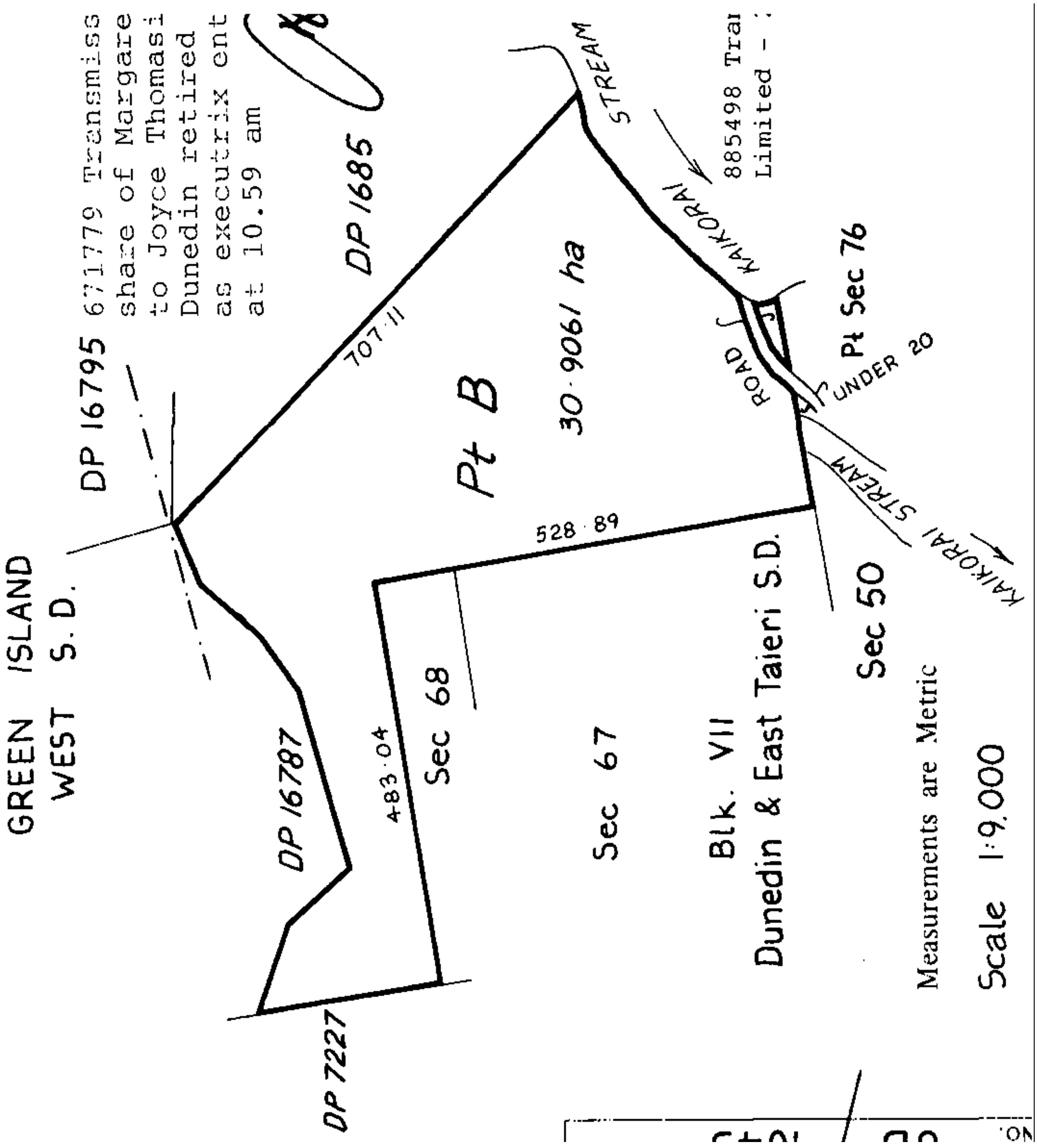
12687371.1 Variation of the conditions of the easement created by Easement Instrument 12281925.5 - 28.3.2023 at 10:46 am

Land Covenant in Covenant Instrument 12695919.2 - 6.4.2023 at 5:57 pm



"Easements H, I, J, K, L, M, N, O, P, Q, R, S, T, U, W, X, Y, ZF, ZH & ZI have been created by digitising informaton directly from local authority service records and may not coincide with the actual asbuilt positions."

Land District: Otago **Digitally Generated Plan** Generated on: 31/03/2022 4:52pm Page 6 of 24	Lots 1 & 2 Being a Subdivision of Part Lot C DP 1685 & Section 118 Block VII Dunedin & East Taieri Survey District	Surveyor: Paul Maxwell Haddon Firm: Terramark Ltd	Title Plan LT 566541 Approved on: 31/03/2022



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share of Margare
to Joyce Thomasi
Dunedin retired
as executrix ent
at 10.59 am

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Limited - :

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Guaranteed Search Copy issued under Section 60 of the Land Transfer Act 2017

R.W. Muir
Registrar-General
of Land

Identifier **OT352/110**

Part-Cancelled

Land Registration District **Otago**

Date Issued 02 August 1951

Prior References

OT221/188 OT41/55

Estate Fee Simple

Area 4.7538 hectares more or less

Legal Description Part Section 41 Block VII Dunedin & East Taieri Survey District and Deposited Plan 7227

Registered Owners

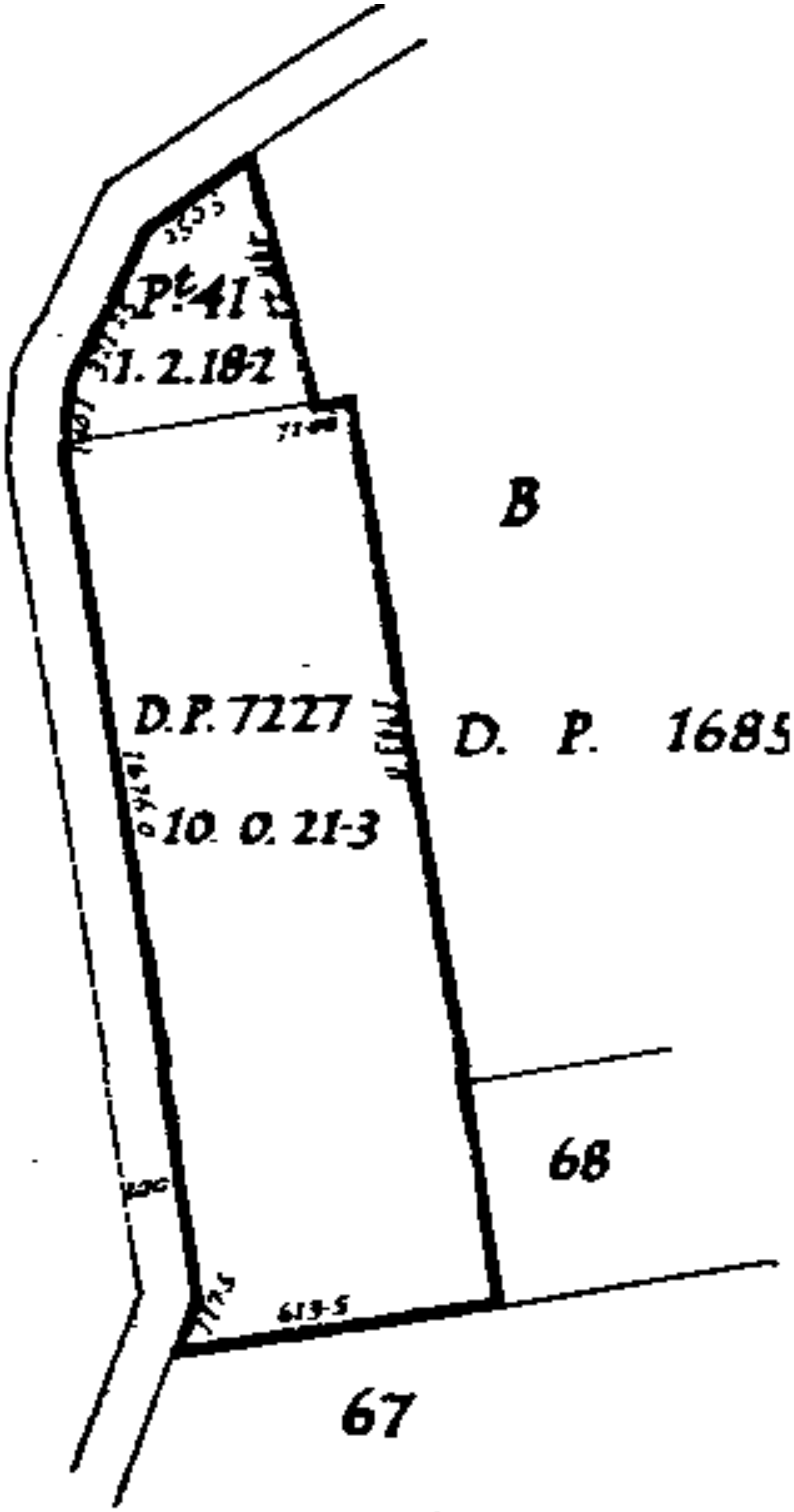
Tartan Industries Limited

Interests

511438.1 Transfer creating the following easements - 20.2.1979 at 1.55 pm

Type	Servient Tenement	Easement Area	Dominant Tenement	Statutory Restriction
Right of way	Part Section 41 Block VII Dunedin & East Taieri Survey District and Deposited Plan 7227 - herein	A DP 16788	Part Lot B Deposited Plan 16788 - CT OT6A/332	

7283416.1 Gazette Notice (2007/p803) declaring the land shown as Section 3 (340m2) and Section 4 (25m2) on SO 376155 to be road and vested in the Dunedin City Council - 20.3.2007 at 9:00 am


Pt 41
1. 2.18-2
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D. P. 1685
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