Appendix I Air Quality

Technical Memorandum

Subject:	Air quality and odour effects	**Reference No:**	1092369.4000
Author:	Jenny Simpson	**Date:**	14 November 2025

1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by WM New Zealand (WMNZ) to provide technical air quality and odour assessments to understand the effects from a proposal to reconsent Redvale Landfill, north of Auckland.

Redvale Landfill is currently scheduled to cease accepting waste in December 2028 and due to a delay in the authorisation and establishment of the replacement Auckland Regional Landfill (ARL) a transition plan is required. The proposal is to continue sending the current residual waste (around 600,000 tonnes per year) to Redvale Landfill, beyond the existing consent timeframe of December 2028. This would require new resource consents at Redvale Landfill.

To accommodate the on-going placement of waste at Redvale Landfill beyond 2028, the proposed works will involve the following:

- **Revised final surface profile of the existing landfill:** The current final design landfill ground profile varies but is less than 1V:3H across the footprint. That ground profile will be steepened up to a maximum grade of 1V:3H, to allow placement of additional waste within the existing landfill footprint. Bunds, varying in height between 2 and 6 m, will be constructed along the eastern and southern boundaries to accommodate the required additional waste volumes.
- **Class 2 extension:** The landfill is proposed to be extended to the south-west of the current landfill boundary, within the area currently occupied by the now decommissioned Managed Fill and Pond 6. The extension will comprise the excavation and lining of a new landfill cell, allowing the acceptance of waste that meets the Class 2 waste acceptance criteria, which will be constructed in a manner similar to the already constructed cells within the current landfill.
- **Relocation of ancillary activities:** the relocation of ancillary activities to allow for the placement of waste.
- **Sediment Retention Ponds:** The removal and filling in of Sediment Retention Pond 6 and the Office Pond while enlarging Pond 1 to capture and treat the stormwater from these catchments.

This memo provides an outline of the initial findings in relation to effects on air quality and odour and has been prepared for inclusion in an application for Ministerial referral of the project under the Fast-track Approvals Act 2024. Specifically, this memorandum responds to the requirements under section 3.4 of the Fast-track Approvals Referral Application Form. A full description of the draft proposal is included in the accompanying information attached to the application form for the referral.

2 Summary of findings

The discharges to air of odour and contaminants from the project are similar in nature to those of the existing, long-operating Redvale Landfill and are managed within a mature suite of controls that are reflected in the existing resource consent conditions[1] and the Landfill Management Plan.

Odour

WMNZ's complaints records indicate there is concern, particularly from a small number of regular complainants, with odour effects from the current landfilling operations. Notwithstanding proposed additional controls (discussed below), the proposed extension will generate some odour emissions and, as a result, there is the potential for odour effects.

Experience from the existing landfill operation has highlighted areas where odour can occur and how it affects the surrounding community. Complaints records show that while concerns are concentrated among a small number of regular complainants, wider dissatisfaction with odour impacts is evident. To inform the design of the proposed extension, a range of information sources has been reviewed using a 'multiple lines of evidence' approach recommended in good practice guidance.[2] This review has provided valuable insights into the nature and causes of odour effects from current operations and informed project development. Specific design and operational changes—beyond what is currently in place—will be incorporated to strengthen odour control and reduce the potential for future impacts. These changes include:

- Placement of putrescible (odorous) waste will be kept at least 500 m from any existing dwelling (non-putrescible waste will be placed in areas of the landfill footprint within that distance).
- At source controls will be tightened by limiting the working face to no more than 900 m² (down from about 1,200 m², typically) and by increasing cover depths to at least 300 mm for daily cover (from 150 mm) and 450 mm for intermediate cover (from 300 mm) to reduce the risk of fugitive emissions.
- During the colder months (from 1 May to 31 August), acceptance of putrescible waste will commence later than standard hours (i.e. after 7:30 am), reducing the overlap between daily cover removal and putrescible waste placement with unfavourable dispersion conditions.

These improvements are expected to result in **a material reduction in odour beyond the landfill boundary**. While odours may occasionally be detectable off-site, the improved controls mean the risk of offensive or objectionable odour effects from the proposed landfill extension beyond the site boundary is currently considered **low**.

[1] For completeness, it is noted that conditions relating to odour are included in the air discharge consent and land use consent for the landfill and ancillary activities and in the separate air discharge consent for the leachate evaporator.
[2] Ministry for the Environment. (2016). Good Practice Guide for Assessing and Managing Odour. Wellington

Air quality

The main discharges of contaminants to air from the project are from the destruction of landfill gas in generators or flares (principally combustion products), and from the leachate evaporator[3] (principally emissions of ammonia and volatile organic compounds). Discharges from the generators and leachate evaporator will continue after landfill closure, as both landfill gas and leachate will continue to be generated for some time, albeit at declining rates. For this reason, the cumulative effects of the ongoing emissions from the currently authorised landfilling activities and the project have been assessed.

As the maximum rate of landfill gas generated is only projected to increase slightly (less than 10 percent)[4] with the project (there will be only a correspondingly small change in the effects of combustion emissions. The discharges to air from the leachate evaporator will be unchanged from current operations.

The main discharges of contaminants to air from the project are from the destruction of landfill gas in generators or flares (principally combustion products), and from the leachate evaporator (principally emissions of ammonia and volatile organic compounds). Both landfill gas and leachate will continue to be generated, albeit at declining rates, for many years after landfill closure. For this reason, the effects of the ongoing emissions from the currently authorised landfilling activities and the project have been considered cumulatively.

As the maximum rate of landfill gas generated is only projected to increase slightly (less than 10 percent) with the project (there will be only a correspondingly small change in the effects of combustion emissions. The discharges to air from the leachate evaporator will be unchanged from current operations.

Dispersion modelling, informed by stack testing data, shows that ground level concentrations of contaminants will continue to comply with all relevant New Zealand ambient air quality standards and guidelines for all contaminants considered.

The model results have also been compared against the lower World Health Organization (WHO) air quality guidelines for context. The modelling, using conservative inputs, suggests possible exceedance of the 24-hour sulphur dioxide guideline, which is consistent with previous modelling of the existing landfill activities. A two-year ambient sulphur dioxide monitoring campaign (2019 to 2021) measured concentrations well below model predictions and within the WHO guideline. Based on this real-world monitoring, it is unlikely the WHO guideline value would be exceeded.

For nitrogen dioxide, the available assessment methods are intentionally conservative and limit reliable comparison with the lower WHO guidelines. The likelihood of exceeding these guidelines is **low**. However, to address this uncertainty, WMNZ is implementing ambient nitrogen dioxide monitoring at a representative location.

Overall, the effects of the project on air quality are currently assessed as being **low**.

3 Site and project context

The landfill is situated in a mixed rural setting where the most sensitive receptors for air quality and odour are dwellings in the local area. Other sensitive land uses include Dairy Flat School, Greenpark Preschool, and the Dairy Flat Community Hall.

[3] The leachate evaporator burns a landfill gas to generate the heat for leachate evaporation, but this is at a small scale compared to the amount of landfill gas burnt in the generators

[4] Based on modelling of landfill gas generation from the placement of additional waste compared to the existing consented activities

Topographically, the landfill sits between local valleys, with a broad north–south valley to the east. Under cool, calm, early-morning conditions, drainage flows can develop and, combined with temperature inversions, promote poor dispersion. Winds are predominantly from the southwest and northeast, with the highest incidence of calms during night and early morning—periods that can coincide with daily cover removal and initial tipping.

There is no air quality monitoring undertaken close to the site, and rural default background values have been adopted for air contaminants. This is consistent with the Ministry for the Environment's Good Practice Guide for Assessing and Managing Odour[5] (GPG Odour) and is appropriate given the rural setting and the lack of nearby major combustion sources.

Under this proposal. ancillary activities for managing the air emissions from landfill gas and leachate will continue in a similar manner to present. The Energy Centre will continue to primarily manage collected landfill gas by burning in landfill gas-fired electricity generators, with enclosed ground flares available as a backup. The site currently has 15 nominal 1 MW generators (typically 14 operating). Future landfill gas generation taking into account the extension is expected to be only slightly higher than current levels and able to be managed with 15 generators operating at any one time. The three existing flares will continue to be able to accommodate the entire volume of collected landfill gas if the generators are not available.

The project will maintain operation of the existing BeneVap leachate evaporator unit. The leachate evaporator is used to reduce the volume of leachate that needs to be managed and the residual sludge from the evaporator is returned to the landfill.

4 Assessment of odour effects

4.1 Assessment methodology

The approach to assessing odour effects is to characterise the effects of the current landfilling activities as a baseline for evaluating the expected effects of the proposed landfill extension taking into account the nature of the project and additional proposed odour controls.

4.2 Waste types

As discussed further below, the proposed improvements to odour controls recognise that different types of waste accepted at the landfill have differing potential to generate odour and that the separation of these wastes can assist in odour management. In the context of odour management, the waste received at the landfill falls into two broad classes[6]:

- Putrescible waste, which includes biodegradable organic material that breaks down quickly and produces odour, leachate, and landfill gas – for example, food scraps, garden organics, and biosolids.
- Non-putrescible waste, which comprises inert materials (e.g. bricks, concrete, soil) and slow-degrading organic materials (e.g. timber, paper, or cardboard) that are not odorous when received and will degrade slowly over time.

4.3 Odour effects of existing landfilling activities

Odour effects are characterised in terms of the frequency, intensity, duration, offensiveness, and location (FIDOL) of odour effects, to inform an overall judgement about the likelihood of offensive and objectionable effects occurring. Offensive and objectionable odour effects can result from a

[5] Ministry for the Environment. (2016). Good Practice Guide for Assessing and Managing Odour. Wellington

[6] For completeness, it is noted that these descriptors do not correspond with waste acceptance criteria for Class 1 and Class 2 landfills

single very high intensity event (acute effects) or from repeated exposure to lower intensity odours (chronic effects).

A range of assessment techniques, consistent with recommendations in the GPG Odour, have been used to characterise the effects of the existing landfilling activities. This includes reviewing records of:

- Odour complaints and investigations.
- Community Liaison Group minutes and feedback regarding odour, and any other concerns about air discharges.
- Odour patrols conducted at least twice daily by WMNZ on landfill operating days.
- Regular independent third-party odour observations.
- Weekly landfill surface walkovers to identify odours, distressed vegetation, cover defects, and leachate breakouts.
- Monthly instantaneous surface methane surveys on intermediate cover as indicators of fugitive landfill gas and potential odour pathways.
- Odour stack testing on the leachate evaporator and generators.
- Field observations to evaluate the efficacy of the odour fog cannons used around the landfill working face.

The odour complaints records indicate a level of concern, particularly amongst a small number of regular complainants, with odours from the landfill. As outlined in the GPG Odour, there is a range of factors that can influence complaints behaviour so, while they are an important consideration, they should be in conjunction with other odour assessment techniques. For this reason, the complaints information has been considered alongside other lines of evidence, such as the findings of the daily odour patrols and independent third-party odour observations, which use a consistent methodology to identify the absence/presence of odours and evaluate the intensity and character of observed odours.

For established activities where odour emissions are variable (such as the existing Redvale Landfill), the GPG Odour advises against comparing dispersion modelling predictions with numeric modelling criteria. However, dispersion modelling has been used to map the relative risk of odour at receptors using ‘odour-frequency’ contours. These contours show how the combined effects of meteorology (how often winds could carry odour to a location), terrain (how plumes disperse), and separation distance (dilution with distance) shape the relative risk of odour at different locations. The modelled patterns have been compared with field observations and complaint data to build a picture of the odour effects of the current operations.

Overall, it is concluded that for the existing landfilling activities:

- Short-term (acute) nuisance odour has the potential to occur within about 500 m of the landfill.
- Intermittent lower-intensity odour, that may be of sufficient intensity, frequency and duration to have a chronic effect, could occur within about 500 m of the site in most directions and up to approximately 1 km from the site along the NE/SW corridors, with the risk decreasing with increasing distance from the landfill.

WMNZ has already started implementing some of the odour improvements discussed in the next section, including tighter control of the working face size, so that it is kept as small as possible, and thickening the cover material.

4.4 Odour effects of the project

Specific changes to further improve the control of odours will be incorporated into the landfill extension project. These changes have been developed in consideration of the information described above and Environment Protection Authority Victoria's (EPA Victoria) 2024 Landfill Buffer Guideline[7], which provides guidance on separation distances between landfills and sensitive land uses to manage risks from odour. This Guideline does not have any status in New Zealand but is useful to inform this assessment because it compares EPA Victoria's experience with odour effects from a number of landfills with differing characteristics. The proposed odour controls include:

- Maintaining a minimum 500 m separation distance between placement of putrescible waste and dwellings by limiting waste placement within that distance to non-putrescible waste. This will provide a greater separation distance between sensitive locations and the placement of odorous waste compared to the currently consented landfill footprint, which is within 300 m of some dwellings.
- Limiting the size of the daily working face to no more than 900 m^2, which is smaller than the current typical working face size of around 1,200 m^2.
- Increasing the thickness of daily and intermediate cover to suppress odour in areas where filling is ongoing.
- Delaying the acceptance of putrescible waste from 1 May to 31 August until an hour after standard landfill operating hours (i.e. after 7:30 am), to minimise the time when placement of putrescible waste overlaps with very poor dispersive conditions.

With these proposed controls implemented as part of the project, it is concluded that, while there may be detectable odours from time-to-time at distances of up to 500 m from the landfill, there is a low risk of offensive or objectionable odour effects beyond the site boundary.

For the substantive application, further comparative dispersion modelling (consistent with the recommendations in the GPG Odour) will be conducted to demonstrate the effectiveness of the proposed odour controls and strengthen the conclusions of this assessment.

5 Assessment of air quality effects

5.1 Introduction

The Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (NESAQ) require landfill gas to be collected and burnt to destroy methane. At Redvale Landfill, gas from the site is burned to generate electricity that goes back to the grid.

The main discharges of contaminants to air from the project are from the destruction of landfill gas in generators or flares (principally combustion products), and from the leachate evaporator (principally emissions of ammonia and volatile organic compounds). Both landfill gas and leachate will continue to be generated, albeit at declining rates, for many years after landfill closure. For this reason, the cumulative effects of the ongoing emissions from the currently authorised landfilling activities and the project have been assessed.

As the maximum rate of landfill gas generated is only projected to increase slightly (less than 10 percent) with the project (there will be only a correspondingly small change in the effects of combustion emissions. The discharges to air from the leachate evaporator will be unchanged from current operations.

[7] EPA Victoria. (2024). Landfill buffer guideline. Publication 1950.

Dispersion modelling, using conservative assumptions, has been used to quantify expected ground-level concentrations of contaminants from combustion of landfill gas in generators or flares, and from the leachate evaporator unit (ammonia and representative volatile organic compounds).

The model results have been evaluated against New Zealand air quality standards[8] and guidelines[9]. Air quality guidelines apply at locations where people could be exposed over the relevant averaging period. Consistent with good practice guidance, compliance has been evaluated at the most impacted residential dwellings (where people may be present continuously) for 24-hour and annual average concentrations, and anywhere beyond the WMNZ site boundary for 1-hour average concentrations.

The model predictions have also been compared with the lower WHO 2021 air quality guidelines[10] for context. The WHO guidelines do not have any formal status in New Zealand but, consistent with a recent Environment Court decision[11], have been considered for completeness (and not as pass/fail criteria).

The effects of emissions of ammonia from the leachate evaporator have been assessed against New Zealand air quality guidelines for ecosystem protection.

5.2 Assessment methodology

Ground level concentrations of contaminants have been predicted using the CALMET/CALPUFF[12] modelling suite with 2022 and 2023 meteorology. These distinct years are intended to capture inter-annual variability in dispersion conditions.

The modelled scenario represents the year with the highest rate of landfill gas generation, which is the year of landfill closure.

Emission rates of contaminants from each of the generators have been characterised based on:

- Stack testing for particulate matter and carbon monoxide.
- The supplier's stated limit on emission of oxides of nitrogen (which is higher than the results of stack testing).
- Assuming all incoming sulphur in the landfill gas (in the form of hydrogen sulphide) is converted to sulphur dioxide (i.e. a mass balance calculation). This approach was used to overcome possible limitations in the stack testing methods, which could under-estimate sulphur dioxide emissions.

Minimum standards for landfill gas flares are set out in the NESAQ. Emission rates of contaminants from the three flares have been estimated using published emission factors, and a mass balance approach for sulphur dioxide.

The modelling shows that the air quality effects of all collected landfill gas being burnt in the flares are lower than the effects of all gas being burnt in the generators. This is largely due to differences in dispersion characteristics.

The emissions from the leachate evaporator are mainly ammonia and volatile organic compounds, which have been measured using stack testing. Combustion emissions have not been modelled

[8] Schedule 1 of the NESAQ

[9] Ministry for the Environment (2002). Ambient Air Quality Guidelines. Wellington

[10] World Health Organization. (2021). WHO global air quality guidelines: Particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide.

[11] *Allied Asphalt Limited* [2024] NZEnvC 247.

[12] The CALMET/CALPUFF dispersion modelling suite is a diagnostic 3D meteorological model and non-steady-state puff dispersion model commonly used in New Zealand for air quality assessments

separately for the leachate evaporator, as these are inherently covered through the conservative assumption of all collected gas being burnt in the generators or flares.

5.3 Air quality effects of the project

Comparison with New Zealand ambient air quality standards and guidelines

The predicted ground level concentrations of all contaminants are well within the relevant New Zealand ambient air quality standards and guidelines, including the guidelines for ecosystem protection.

Air quality monitoring for sulphur dioxide was conducted for a two-year period (2019–2021) at the site. These results are considered representative of the effects of current and ongoing emissions This provides evidence to corroborate the dispersion modelling results. The measured sulphur dioxide concentrations were well below model predictions. This over-prediction will be influenced by conservatism in the emissions estimates and inherent conservatism in the model.

Comparison with WHO air quality guidelines

As discussed in Section 5.1, the model results have also been compared against the more recent WHO air quality guidelines for context. For sulphur dioxide, the modelled concentrations exceed the WHO guideline at the worst-impacted receptor. However, the monitoring data demonstrates that actual levels are much lower and measured concentrations were well within the WHO guidelines.

Similarly, predicted concentrations of 24-hour and annual average nitrogen dioxide exceed the WHO guidelines at the worst-impacted receptor. These predictions are complicated by atmospheric chemistry, as emitted nitrogen oxide can be converted to nitrogen dioxide by reactions with ozone in the air. This reaction only occurs in the daytime and is reversed at night. The recommended methods to account for atmospheric chemistry are inherently conservative and do not enable a reliable comparison with the WHO guidelines. It is unlikely that these guidelines would be exceeded. However, to address this uncertainty, WMNZ is implementing ambient nitrogen dioxide monitoring at a representative location.

Conclusions

Overall, it is concluded that the effects of discharges of contaminants to air from the site are **low**. The suite of controls contained within the existing resource consent conditions and Landfill Management Plan are considered appropriate to manage air quality effects of the proposed landfill extension.

6 Applicability

This report has been prepared for the exclusive use of our client WMNZ, 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 WMNZ will submit this report to the Environmental Protection Authority in support of a referral application under the Fast-track Approvals Act 2024 for the works described herein, and that the Environmental Protection Authority will rely on this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

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