Appendix R Health Risk

Technical Memorandum

Subject:	Human health risk	**Reference No:**	1092369.5000
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1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by WM New Zealand (WMNZ) to provide technical 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 limit 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 the risk of effects on human health 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

A Screening Health Risk Assessment (SHRA) has been conducted to conservatively evaluate whether contaminants from the landfill could pose unacceptable health risks offsite. The assessment focuses on potentially "complete" exposure pathways, such as inhalation of airborne contaminants and indirect exposure via surface water used for crop irrigation. Other pathways, such as groundwater used for drinking water and dust exposure, have been screened out due to engineering controls, low contaminant concentrations, or absence of plausible receptors.

The key findings of the SHRA are:

- **Inhalation risks**: Airborne emissions from landfill gas generators, the leachate evaporator, and fugitive landfill gas were modelled. Even using highly conservative assumptions, cumulative exposure to all contaminants via all pathways was well below levels that would pose an unacceptable health risk to nearby residents and sensitive sites such as the Dairy Flat School.
- **Surface water risks**: The potential for contaminants in leachate and stormwater to reach surface water (Rangitopuni Stream) and enter the food chain via crop irrigation was assessed. Conservative modelling of potential leachate seepage through the lining system and into groundwater showed that risks to public health from this pathway are negligible. Stormwater from the site can contain metals, such as zinc and copper, associated with vehicle movements. These metals are present in the Stream both upstream and downstream of the Landfill discharges. The assessment shows that stormwater discharges from the Landfill do not pose an unacceptable health risk.
- **Roof collected drinking water**: Community concerns about contaminants depositing on roofs used for drinking water collection have been considered. The assessment found that the physical properties (high volatility and low water solubility) of the contaminants associated with discharges to air at the Landfill mean that there is negligible potential for these contaminants to be present in roof collected drinking water.

The SHRA demonstrates that, with current and proposed controls in place, the extension and continued operation of Redvale Landfill does not pose unacceptable risks to human health via any identified exposure pathway.

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.

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 south-west and north-east, with the highest incidence of calm during night and early morning, periods that can coincide with daily cover removal and initial tipping.

Under the proposal, ancillary activities for the management for landfill gas and leachate, as they relate to emissions to air, 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 presently has 15 nominal 1 MW generators (typically 14 operating). Future landfill gas generation with the project 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 methodology

A Screening Health Risk Assessment (SHRA) has been undertaken to provide an initial, conservative evaluation of whether contaminants released from the existing and extended Redvale Landfill could pose any potentially unacceptable health risks off-site. If the screening results indicate that all risks are within acceptable limits, further detailed quantitative assessment is not justified.

The SHRA follows established international human health risk assessment frameworks, adapted for a screening-level evaluation. The SHRA involves three main steps:

- **Hazard assessment**: Identification of contaminants of potential concern and relevant toxicological reference values. Established health-based criteria from New Zealand (such as the New Zealand Drinking Water Standards) or international bodies such as the US EPA and the California Office of Environmental Health Hazard Assessment (OEHHA) were used.
- **Exposure assessment**: Development of a conceptual site model (CSM) to identify potential sources, transport pathways, and human receptors. Only *complete exposure pathways*, those where there is a source, transport mechanism and receptor, were carried forward for quantitative assessment. This assessment has relied on other technical assessments undertaken for the Project including the assessments of air and odour, hydrogeology, industrial and trade activities and stormwater.
- **Risk characterisation**: Comparison of conservatively estimated exposure concentrations with toxicity reference levels to derive:
  - Hazard Quotients (HQs) for non-carcinogenic effects (HQ < 1 = acceptable).
  - Risk Ratios (RRs) equivalent to a 1 in 100,000 lifetime cancer risk for carcinogenic effects (RR < 1 = acceptable).

  Potential additive or cumulative risks across multiple contaminants and exposure pathways have been evaluated.

5 Potential sources and exposure pathways

5.1 Identification of potentially complete pathways

The primary source of contaminants associated with the Redvale Landfill is the municipal solid waste that has been accepted over its operational life. The waste itself is contained within the landfill and there are systems in place to avoid windblown litter. However, contaminants are mobilised and transported from the waste mass via two principal media: leachate and landfill gas. There are systems in place to contain and manage both leachate and landfill gas to avoid or minimise the release of contaminants to the environment. There are also systems to avoid stormwater coming into contact with leachate (all water that comes into contact with waste is contained and treated as leachate).

Potential pathways for the release of contaminants into the environment are:

- Leachate – containing metals, ammonia, oils, and organic compounds.
- Landfill gas – primarily methane and carbon dioxide, with trace volatile organic compounds (VOCs) and reduced sulphur compounds.
- Stormwater – carrying typical urban-derived metals (e.g., zinc, copper) from operation of vehicles on site roads, etc.

- Dust and cover materials – potentially containing low-level contaminants from contaminated soils and waste handling.

The SHRA considers long term exposure to contaminants and is not intended to address short term exposure that may occur from an unintended release. In the event of an unintended release of contaminants, emergency response measures would include steps to minimise exposure to contaminants. T+T is not aware of any such releases having occurred over the lifetime of the Redvale Landfill.

The potential contaminant sources identified above were assessed across multiple potential exposure pathways, as summarised in Table 5.1.

Table 5.1: Evaluation of potentially complete exposure pathways

Pathway type	Description	Receptor	Assessment outcome
Leachate to groundwater → surface water → irrigation of crops	Potential migration to Rangitopuni Stream. A consent is held to take water from the stream for irrigation of tomatoes.	Public consumers of retail produce	Potentially complete (very conservative)
Leachate to groundwater used for drinking water	Potential migration to groundwater abstracted for drinking water	None (no consented groundwater takes within 2 km)	Incomplete
Air discharges (inhalation)	Exposure to airborne VOCs and sulphur compounds from generator, BeneVap, and fugitive emissions	Nearby residents and sensitive receptors	Complete
Air discharges → deposition onto roofs → roof-collected drinking water	Contaminants depositing and washing into roof water	Nearby residents and sensitive receptors	Incomplete due to the high volatility and low solubility of the contaminants of potential concern
Stormwater discharge to Rangitopuni Stream→ irrigation of crops	Contaminants (principally metals) in stormwater runoff (note: metals are present both upstream and downstream of the site discharge). A consent is held to take water from the Rangitopuni Stream for irrigation of tomatoes.	Public consumers of retail produce	Potentially Complete
Dust and cover materials (windborne transport of dust)	Off-site dust exposure.	Residents Negligible potential for exposure given low contaminant levels at source, dust controls and separation distance	Incomplete

Of all evaluated pathways, only inhalation of airborne contaminants and potential indirect exposure via irrigation of a commercial tomato crop with surface water from the Rangitopuni Stream are

considered *complete or potentially complete*. All other pathways were screened out due to engineering controls, low contaminant concentrations, or absence of plausible receptors.

5.2 Discussion of roof collected drinking water pathway

The potential for deposition of contaminants onto roofs used to collect drinking water has been identified as a concern for the local community, given the prevalence of roof collected drinking water, including at Dairy Flat School.

The contaminants released to air from landfill operations are highly volatile and poorly soluble in water. These physical properties mean they remain in the vapour phase rather than attaching to particles or dissolving into rainwater.

Wet deposition (via rain washout) is negligible because these compounds have low water solubility, meaning they do not efficiently dissolve into rainfall as it falls.

Dry deposition (the settling of vapour molecules onto surfaces) was modelled using the CALPUFF dispersion model. Even using highly conservative assumptions – such as assuming that all deposited mass over an entire year is washed into rainwater without any volatilisation back into the air – the estimated concentrations in roof-collected water were generally several orders of magnitude below health-based drinking-water guidelines. Only vinyl chloride (chloroethene) did not automatically "screen out" using the extremely conservative assumptions. However, calculation of its volatilisation half-life on roof surfaces indicated it would re-evaporate in less than one second, making entrainment into rainwater physically implausible.

Overall, vapour-phase contaminants from landfill air emissions will not remain on roof surfaces or accumulate in rainwater used for potable supply, and therefore deposition onto roofs used to collect drinking water is not considered a viable exposure pathway.

6 Results of screening health risk assessment

6.1 Inhalation pathway

6.1.1 Introduction

The screening assessment of the inhalation exposure pathway for the Redvale Landfill extension has considered all complete pathways for airborne contaminants associated with the site — namely the discharges from the landfill gas generators, the leachate evaporator (BeneVap), and fugitive landfill gas emissions. Each source was separately characterised and then evaluated cumulatively to determine whether offsite receptors (e.g., nearby residents and sensitive sites such as Dairy Flat School) could experience any unacceptable health risks from inhaling contaminants in air.

6.1.2 Sources of contaminants in air

Generator emissions

Landfill gas is destroyed in a series of electricity generators. The combustion of gas in the generators destroys not only methane, but other organic compounds present in the landfill gas. Emissions testing has identified a suite of VOCs and reduced sulphur compounds present at low concentrations in the generator exhaust, reflecting either combustion by-products or trace constituents of landfill gas. Dispersion modelling has been used to estimate a conservative low dilution factor for impacts at the closest sensitive receptor, which is applied to the concentrations in the generator exhausts.

Leachate evaporator (BeneVap)

The BeneVap treats leachate by low temperature evaporation, which can release volatile compounds present in the leachate. Stack testing and dispersion modelling have been used to predict offsite concentrations.

Fugitive landfill gas emissions

Fugitive emissions represent the small fraction of landfill gas not captured by the active gas extraction system or removed by bioremediation through the landfill cap. Fugitive landfill gas emissions occur mainly from around the active working face. A suite of monitoring data is available to characterise the trace constituents of the landfill gas. All contaminants in the landfill gas monitoring suite have been included in the screening calculations, using half the detection limit where the substance has not been detected. For contaminants of potential concern that have more than 10 test results, the average concentration has been used, otherwise the maximum concentration has been adopted. Dispersion modelling has been used to estimate a dilution factor for impacts at the closest sensitive receptor, which is applied to the concentrations in the landfill gas.

6.1.3 Inhalation risks

For each source of discharges to air, the modelled concentrations were compared against toxicity reference values (Reference Concentrations and Unit Risk factors) to determine HQs for non-carcinogens and incremental risks for carcinogens. None of the individual contaminants, or the cumulative exposure to multiple contaminants in any of the pathways, was found to pose an unacceptable health risk.

Total inhalation exposure to contaminants from all three sources of discharges to air has also been considered by summing the HQs (the sum of HQs is called the Hazard Index) and incremental risks across all sources and compounds. This approach is very conservative because it:

- Assumes that all contaminants act additively, even though they may have different toxicological mechanisms or target organs. In reality, combining all HQs and risks in this way overestimates total risk because not all substances interact or affect the body in the same manner.
- The worst-case point of exposure for each pathway is added together even though these are unlikely to coincide spatially (i.e. the most impacted location for fugitive landfill gas emissions will not be the same as the most impacted location for the emissions from the generators).

Even using this very conservative approach, the cumulative Hazard Indices and incremental risks show that exposure to contaminants via inhalation is well below levels that would pose an unacceptable health risk.

6.2 Surface water pathway

6.2.1 Introduction

The screening assessment has considered the potential for contaminants in leachate and stormwater to reach the Rangitopuni Stream and for human exposure to occur from use of the surface water to irrigate tomato plants at a nearby greenhouse.

6.2.2 Sources of contaminants in surface water

Leachate

Engineering controls and monitoring at Redvale Landfill (such as a fully engineered lining system, inward hydraulic gradient, leachate collection systems, and compliance monitoring) make it highly improbable that leachate could reach groundwater or surface water. Monitoring of downgradient groundwater quality has shown no evidence of leachate impact.

The Hydrogeological Assessment provides highly conservative estimates of contaminant concentrations that could theoretically appear in the Rangitopuni Stream if such seepage occurred. These concentrations have been used in the screening calculations.

Stormwater

The engineering controls at the landfill are intended to ensure leachate cannot enter site stormwater. Stormwater from the site can contain metals, such as zinc and copper, associated with vehicle movements. These metals are present in the Rangitopuni Stream both upstream and downstream of the Landfill discharges. The purpose of the SHRA is to assess the effects of the Project. As discussed later, the Project would only increase the risk of health effects from exposure toa contaminant if the discharges from the Landfill increased the concentration of that contaminant in the Stream.

6.2.3 Ingestion risks

The potential human exposure pathway for contaminants in surface water is consumers of tomatoes irrigated with stream water. Tomato fruit are poor accumulator of contaminants, most contaminants remain in foliage or are diluted in the high-moisture fruit. Therefore, the concentration of contaminants in tomatoes will be lower than in the water used to irrigate them. For this reason, the predicted concentrations in the Rangitopuni Stream have been compared to drinking water standards. This assumes that if water at these concentrations was safe to drink, it would also be safe to use for irrigation and subsequent consumption of produce.

The risk characterisation results for contaminants in leachate shows that the summed HQs and incremental cancer risks are at least several orders of magnitude below the thresholds for potential concern (HQ < 1; incremental risk < 1 per 100,000). Accordingly, even using very conservative assumptions, the modelled rates of leachate seepage into groundwater, which may subsequently enter surface water used for irrigation pose a negligible health risk to the public.

The concentrations of metals measured in the Rangitopuni Stream below the Landfill discharge point are below the NZDWS, with the exception of manganese and aluminium. The site discharges have no statistically significant impact on manganese or aluminium concentrations in the stream. Consequently, it is concluded that contaminants in the site stormwater discharges do not pose an unacceptable health risk.

The cumulative Hazard Indices and incremental risks show that exposure to contaminants in surface water (via a produce ingestion pathway) is well below levels that would pose an unacceptable health risk.

6.3 Cumulative exposure

The potential for cumulative exposure to contaminants via both inhalation and surface water has been considered. The most significant contaminants for the surface water pathway are metals, while for the inhalation pathway they are VOCs and reduced sulphur compounds. As the contaminants fo potential concern are different for these pathways, the health risks are no greater than calculated for the inhalation and surface water pathways individually.

7 Conclusions

A SHRA has been conducted to provide an initial, conservative evaluation of whether contaminants released from the existing and extended Redvale Landfill could pose any potentially unacceptable health risks off site. The assessment has identified the main potential exposure pathways as inhalation of airborne gaseous contaminants and exposure to contaminants in surface water (from seepage of leachate or typical urban contaminants in stormwater). Screening-level risk assessment calculations using conservative assumptions, show that the exposure to contaminants from the existing Landfill and Landfill extension do not pose any unacceptable risks to human health.

8 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.

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